

An Analysis of the Trend from the Collaborative Innovations to the Deep Integration of Industry-University-Research

Na Liu*

College of Innovation and Entrepreneurship, Bohai University, Jinzhou, Liaoning, China
enaliu@sina.com

*Corresponding author

Abstract: Industry-University-Research collaborative innovation is based on the sharing of innovation resources and complementary advantages of enterprises, universities and scientific research institutions, and the principles of cooperative research and development benefit sharing and risk sharing to form a community of interests for a period of time to jointly carry out scientific and technological innovation and promote the transformation of achievements. In the grand process of building a modern socialist country, collaborative innovation and deep integration of Industry-University-Research are playing a key role. Through trend analysis, the future development direction is clear. The future development trends are that the dominant position of enterprise innovation and the core position of technological innovation are more prominent, the tripartite signing mechanism of Industry-University-Research should be improved under the framework of the government guidance and planning, the deep integration of Industry-University-Research needs to rely on collaborative innovation alliance or community, and build a resource service platform for collaborative innovation and deep integration of Industry-University-Research.

Keywords: Industry-University-Research; Collaborative Innovation; Deep Integration; Trend Analysis

1. Introduction

Foreign scholars' research on Industry-University-Research cooperation is relatively early, mainly focusing on the use of statistical analysis and investigation research to analyze and explain the influencing factors of cooperation among the main bodies of the Industry-University-Research cooperation system, and from the macro perspective to more micro perspective to analyze and summarize successful experiences. Domestic scholars are able to grasp the mainstream research hotspots and carry out research from different depths and breadth in view of the characteristics of multi-form, multi-level and multi optimization of domestic academic research cooperation. With the continuous deepening of the practical exploration of Industry-University-Research cooperation, the theoretical research and practical application of Industry-University-Research cooperation need to break through the limitations of simple cooperation forms, develop in the direction of deep integration, and need comprehensive mechanism innovation. This will also be the core research content of this topic.

The connotation from collaborative innovation of Industry-University-Research to deep integration is essentially to emphasize the dominant position of enterprises, promote technological innovation in a market-oriented manner and improve the overall efficiency of the innovation chain by promoting the in-depth cooperation between enterprises, universities and scientific research institutions. As an old industrial base, Liaoning has a large number of enterprises, developed higher education, and numerous scientific research institutions. It has a natural foundation for the deep integration of Industry-University-Research. However, affected by many factors, Liaoning's economic development is relatively backward. A large number of scientific and technological resources of universities and scientific research institutions are idle, many technical problems of enterprises cannot be effectively solved, and the cooperation between Industry-University-Research is still at the initial stage. This research is based on the investigation and research, in-depth analysis of the problems existing in the collaborative innovation of Industry-University-Research in Liaoning Province. In view of the trend of the collaborative innovation of Industry-University-Research to the deep integration, it proposes an innovation mechanism that conforms to the characteristics of Liaoning Province, and provides a

brand-new solution for solving the problem of Liaoning Province from the collaborative innovation of Industry-University-Research to the deep integration. Through the research of this topic, we will build a perfect innovation mechanism, strengthen the transformation and collaborative innovation of scientific and technological achievements, improve the quality of higher education personnel training, resolve the dilemma that scientific research achievements cannot be transformed into industrial application technology, improve the integrated innovation ability and the efficiency of transformation and application of achievements, and serve the economic and social development of Liaoning and the revitalization of the old industrial base.

2. Theoretical Basis

The theoretical basis is to study the general laws or main laws of social and economic movement, and provide common theoretical guidance with guiding significance for application research. The research of this topic involves the three helix theory, strategic alliance theory, stakeholder theory and new public service theory.

2.1. Triple-helix Theory

The Triple-helix theory is a typical collaborative innovation theory, which is used to analyze the new interactive relationship between the government, universities and enterprises. In the era of knowledge economy, as the three major elements in the social scientific and technological innovation system, they are connected according to the requirements of the market, forming a triple spiral relationship in which three forces interact and influence each other. The core of the triple helix theory is that with the emergence of the knowledge economy, scientific research institutes and universities in the region have become the main knowledge assets and have higher value. The roles of the government, universities and enterprises can be changed at any time in the Industry-University-Research cooperation. The roles of leaders, participants and promoters are constantly changing with the progress of the cooperation. The three cooperation parties promote each other, overlap each other, benefit each other, and jointly promote the application, industrialization and upgrading of scientific and technological achievements.

2.2. Strategic Alliance Theory

Strategic alliance is a loose cooperation mode formed by two or more enterprises with common strategic interests and equal operating strength through various agreements and contracts to achieve the strategic objectives of jointly owning the market and using resources. It is characterized by complementary advantages or advantages, risk sharing and horizontal two-way or multi-directional flow of production elements. All parties of the alliance maintain the autonomy of operation and management in their respective core fields, and there is a certain degree of competition between them [1]. Strategic alliance is an important way to enter new markets, acquire new skills and improve the competitive position of enterprises. The two sides of a strategic alliance usually have their own advantages or resources, and can assist other participants to achieve long-term win-win or multi win. The degree and effect of achieving goals is the performance of the alliance.

2.3. Stakeholder Theory

Stakeholder management theory refers to the management activities carried out by the managers of enterprises in order to comprehensively balance the interests of all stakeholders. Compared with the traditional shareholder supremacy, this theory believes that the development of any enterprise can not be separated from the input or participation of all stakeholders, and the enterprise pursues the overall interests of stakeholders rather than the interests of some subjects. In the field of Industry-University-Research cooperation, the core stakeholders are schools, students, enterprises and research institutions. There is a complex relationship between these four, and the choice of the mode of industry university research cooperation should fully consider the conflict of interests of the stakeholders. Colleges and universities provide technical support for Industry-University-Research cooperation, and enterprises invest funds. The goal of colleges and universities is to cultivate practical talents, and the goal of enterprises is to obtain technical talents and maximize their respective interests.

2.4. The New Public Service Theory

The new public service theory emphasizes that the government function should be more inclined to the decision-making level than the policy implementation; The public interest is a goal rather than a by-product, which requires the government to commit itself to creating an unfettered and sincere dialogue environment; serve citizens rather than customers, and pay attention to the interests of all citizens in the principle of fairness and justice; citizens protect their rights and interests and promote social governance by participating in policy formulation [2]. In the collaborative innovation of Industry-University-Research, the cooperation between enterprises, universities and scientific research institutes is a kind of market behavior, and the government should realize the function transformation and emphasize the service responsibility. Guided by the common interests of all subjects in the cooperation of Industry-University-Research, the exchange and communication among the subjects should be strengthened. Through the establishment of a more perfect collaborative innovation platform of Industry-University-Research, intermediary services should be provided for all subjects participating in the cooperation to solve the problems arising in the cooperation.

3. Problem Analysis of Collaborative Innovation of Industry-University-Research

At present, although the collaborative innovation of Industry-University-Research has been widely carried out and achieved certain benefits, there are still many problems, which are highlighted in the following four aspects.

3.1 Lack of Overall Strategic Planning

Researchers in universities and scientific research institutions pay more attention to personal honor, and professional title evaluation mainly measures academic level, resulting in the phenomenon of emphasizing theory and neglecting practice. The enterprise is short-sighted, lacks long-term goals and plans, pursues short-term benefits, chooses time-saving shortcut such as direct introduction of products, and does not increase R & D investment in independent innovation. Some government officials believe that independent innovation has a long cycle, slow efficiency, difficult management and coordination, and it also has to bear a great deal of responsibility and risk, which limits the policy preference and financial support for collaborative innovation.

3.2 The Enthusiasm of Enterprise Participation Is Not High

Although the enthusiasm of enterprises and industries to participate in the integration of production and education has been improved to a certain extent, generally speaking, it still shows a trend of "Schools are active and enterprises are passive". At present, schools are still the main ones, and the participation enthusiasm and participation degree of enterprises are low. On the one hand, there is a conflict between the profit nature of enterprises and the public welfare nature of education, and both schools and enterprises cannot find a balance of interests in cooperation. On the other hand, there is a lack of policy incentive system for enterprise participation at the national level, and there are few preferential policies in taxation.

3.3 There Are Conflicts in the Distribution of Interests among the Parties Involved

The parties involved in Industry-University-Research have different positions and roles in the cooperation, and have different understanding of the distribution of interests. In some cases of Industry-University-Research, enterprises have high enthusiasm and the technology provided by universities and scientific research institutions is also very good, but the process of cooperation is very difficult. The purpose of Industry-University-Research cooperation is to obtain their own interests, but the interests of all parties can not be well handled. All parties have different understanding of the value of technology, have different requirements for the expected cooperation benefits, and the incentive policy for the personnel participating in the Industry-University-Research is not perfect.

3.4 Lack of Long-term Effective Cooperation Mechanism

There are many short-term cooperation between Industry-University-Research around the project, and the teams serving the enterprise tend to be individualized and highly mobile, resulting in a lack of

long-term tracking and research on relevant technical fields, which is not conducive to solving major technical problems that restrict industrial development[3]. There are more point-to-point cooperation around a certain field, and less cooperation and innovation around the industrial chain. In particular, enterprises, research institutions and universities form strategic alliances, and the mechanism of forming interest communities in development strategies, project development, platform construction and talent training is not complete.

4. Trend Analysis from Collaborative Innovation of Industry-University-Research to Deep Integration

"China's education modernization 2035" further requires to explore and build a full chain, networked and open collaborative innovation alliance with deep integration of Industry-University-Research. It can be seen that the general idea of collaborative innovation and deep integration of Industry-University-Research has basically taken shape, and the relevant policy guidance is increasingly clear. In the grand process of building a modern socialist country, collaborative innovation and deep integration of Industry-University-Research are playing a key role. Through trend analysis, the future development direction is clear.

4.1. The Status of Enterprises as the Main Body of Innovation and the Core of Technological Innovation Has Become More Prominent

Technological innovation is an innovation aimed at creating new technologies, or an innovation based on scientific and technological knowledge and the resources it creates. Give play to the role of enterprises as the main body of technological innovation, promote the concentration of innovation elements to enterprises, and promote the deep integration of Industry-University-Research. In the face of profound and complex changes in the environment at home and abroad, actively promoting the development of scientific research to high-end, accelerating the transformation of applied basic research achievements, and opening up the channel of Industry-University-Research, all need to consolidate the enterprise's main position of innovation [4]. Enterprises are the most active innovation subjects. In the history of science and technology development, many scientific and technological innovation achievements are completed by enterprises, and many basic research innovations are also transformed into products through enterprises.

Further consolidating the dominant position of enterprises in innovation will better inject inexhaustible power into China's scientific and technological innovation. Give play to the main role of enterprises in technological innovation [5]. First, it is necessary to recognize the leading position of enterprises in technological innovation, and change the understanding and positioning of enterprise innovation from the social concept and policy orientation; Second, we should try our best to stimulate the vitality of enterprise innovation through the marketization mechanism, so as to avoid excessive government intervention and distortion of the innovation market; Third, it is necessary to provide support for scientific and technological innovation of enterprises in terms of common technology platform, talent recruitment and recognition, and intellectual property protection, so that scientific research personnel of enterprises can explore the frontiers of science and technology without worry.

Technological innovation plays a core role in the overall innovation of enterprises, which directly promotes the rapid development of enterprise productivity, influences or drives the institutional innovation and management innovation of enterprises, and comprehensively promotes the development of enterprises. The technological knowledge of enterprises has a feedback effect on the innovation principle through the practice of technological innovation. Adhering to the core position of technological innovation has important theoretical value and practical significance for laying out the practice of Industry-University-Research cooperation, breaking through the "bottleneck" problem of key core technologies, and strengthening the national strategic scientific and technological force.

4.2 Improve the Tripartite Signing Mechanism of Industry-University-Research under the Framework of Government Guidance and Planning

The focus of the government's work is to enhance the macro-control ability in the market economy, strengthen market supervision and social management, and promote the public service level. Looking at the promotion process of Industry-University-Research cooperation by the government, there is a lack of macro-control on the cooperation subject projects and too much emphasis on the short-term

economic benefits of enterprises. However, the top-level design concept is insufficient, and the technical achievements provided by scientific research parties are often inconsistent with the market demands of enterprises, which has become an obstacle to the coordinated development of Industry-University-Research cooperation subjects. The government should not only coordinate Industry-University-Research cooperation, formulate and supervise the implementation of relevant policies and plans, but also provide support for the operation of the system and mechanism of Industry-University-Research, and lead, manage, promote and supervise the development of Industry-University-Research cooperation.

Government departments are important participants in collaborative innovation activities of Industry-University-Research, and can guide, supervise and manage innovation activities according to law through the formulation of policies and regulations and the guidance of public opinion [6]. First, it should provide financial support for collaborative innovation activities of Industry-University-Research, directly expand the scale of cooperative innovation, or use policies and mechanisms to stimulate innovation subjects, increase innovation investment or guide external investment injection, so as to alleviate the resource constraints of collaborative innovation of Industry-University-Research. Second, it should formulate and improve laws and policies related to collaborative innovation activities of Industry-University-Research, strengthen the supervision and operation mechanism management of innovation activities, form effective constraints on innovation subjects, reduce the risk of knowledge spill over of cooperative innovation, and improve the efficiency and enthusiasm of collaborative innovation of Industry-University-Research subjects. Third, it should focus on strengthening the leading mechanism of Industry-University-Research cooperation, comprehensively plan, adjust settings, and achieve comprehensive implementation [7]. The adjustment is carried out from the nature and type of research institutions, which is helpful to get rid of the shackles of the system and promote it to the market as soon as possible. Establish a strategic alliance of Industry-University-Research under the leadership of the government. Based on the perspective of scientific and technological innovation, the trend of high-tech development is designed and promotes the leading position in the strong field.

4.3 The Deep Integration of Industry-University-Research Needs to Rely on Collaborative Innovation Alliance or Community

The collaborative innovation alliance of Industry-University-Research should be a compound and close cooperation mode and play a positive role in promoting collaborative innovation. The innovation subjects of Industry-University-Research make comprehensive use of various resources and contact to form institutions and institutional arrangements. Under the conditions of consistent interests, consistent objectives and smooth information channels, all parties have formed close cooperative relations, covering the whole chain from innovation chain to industrial chain, covering basic research, applied research and industrial operation, including the transfer and flow of innovation elements such as technology, information, capital and talents. This alliance enables all parties to establish long-term strategic development goals, highlight the synergy and integration of cooperation among all parties, establish a system that can ensure the transformation of scientific and technological achievements into industrial products, and enhance the overall innovation ability of the alliance on the premise of ensuring the sharing of interests and risks.

Guided by the relevant theories of Industry-University-Research, correctly handle the relationship between the market and the government, and establish a "double guidance" linkage mechanism guided by the government and market demand, which will help to build a good ecosystem for the alliance development and promote the sustainable and healthy development of the alliance [8]. First, we should make a rational layout of alliance construction based on market demand. The market is the most efficient way of resource allocation, maximize benefits and optimize efficiency, and promote the effective incentive of property rights and the free flow of factors. Second, the government promotes and guides the alliance to carry out collaborative innovation. The government gives play to its advantages in institutional innovation, enriches policy tools, and guides members of the Industry-University-Research alliance to face each other in the talent chain and innovation chain, forming a community of shared future and stakeholders. Third, the market and the government "double guidance" link to build a good ecosystem for the development of the alliance. All parties in the alliance should give full play to their own advantages, actively conserve endogenous power under the dividend of government system innovation, and realize the organic combination of social development needs and their own development needs.

4.4 Build a Resource Service Platform for Collaborative Innovation and Deep Integration of Industry-University-Research

The international Industry-University-Research service platform has developed rapidly. After a long time of continuous exploration, it has rapidly transitioned from a physical platform to a virtual platform. Many countries and regions have begun to apply the network platform for Industry-University-Research collaboration and innovation. Internationally, the "platform building" mode is that all parties of Industry-University-Research, through the joint construction of research and development centers, technology transfer centers, test bases and other platforms, promote the organic combination of the advantageous resources of all parties, jointly research and develop new products and technologies, and improve the core technology and competitive strength of all parties [9]. The trend of virtual Industry-University-Research in the world is developing rapidly. Japan relies on electronic network technology to form a standardized network system of science and technology intermediaries as the main means to carry out Industry-University-Research activities; Europe has established an innovative technology network covering all EU countries, and achieved a good science and technology intermediary effect; The United States has also formed a large national scientific research intermediary network to promote the industrialization of scientific and technological intermediary services, which has played an obvious role in promoting Industry-University-Research cooperation and scientific and technological progress.

Based on the development needs of enterprises, the Industry-University-Research service platform should be built, and there are no other intermediate links between scientific research achievements and applications. Scientific research projects directly come from the actual needs of enterprises, and the research results are directly applied to production. Project demonstration, management, implementation and application are carried out according to the scientific research mode of Industry-University-Research. With the active participation of enterprises, the scientific research carried out by colleges and universities has more clear objectives. The enterprise's product planning and technical level have been improved in scientific research cooperation with universities. The core functions of the system include [10]: information release subsystem, which releases demand information and supply information; the service docking subsystem provides the member service docking function, verifies the supply and demand information released by the members, matches the supply and demand, and puts forward matching suggestions; the contract management subsystem inputs the contents agreed by both parties after negotiation into the system, generates a formal contract, and manages the whole process of contract execution; the tracking and feedback subsystem is used for the tracking service during the cooperation process, the three-party evaluation after the cooperation is completed, and the information feedback during the whole service process.

5. Conclusions

Universities should not only comply with the diversified needs of enterprises for technological innovation, but also actively contact enterprises. And universities should stimulate and tap the needs of enterprises for technological innovation through in-depth consultations, and explore and cooperate with relevant scientific research institutes to establish technology research institutes and special research and development centers. Colleges and universities should create conditions to form collaborative innovation alliances or communities, form a long-term mechanism oriented by market demand, with enterprises as the main body and universities and scientific research institutions taking the initiative, and form a greater joint force in tackling technological innovation problems in the same or similar fields.

Acknowledgements

This work is supported by Liaoning economic and social development cooperation project in 2021 (No: 2021lshzyb-09): Trend analysis and mechanism innovation of from industry-university-research institute collaborative innovation to deep integration.

References

[1] J. P. Wang. "Research on joint governance of vocational colleges based on strategic alliance theory," *University Education*, vol. 9, no. 6, pp. 182-185, 2020.

- [2] Y. Xin, Y. He. "Research on the new management mode of postgraduates from the perspective of new public service theory," *Survey of Education*, vol. 10, no. 41, pp. 94-96, 2021.
- [3] B. M. Chen. "Some problems and policy suggestions exist in the current combination of industry, university and research," *China University Science & Technology*, vol. 23, no. 11, pp. 42-45, 2009.
- [4] X. Wei. "Consolidate the main position of enterprise innovation," *People's Daily*, 2020-09-29(5).
- [5] L. Ma. "The dominant position of enterprise innovation calls for practical policies," *China Youth Daily*, 2021-03-19(03).
- [6] S. M. Yang, J. L. Jia, Q. X. Lan. "Collaborative innovation of industry-university-research institutes and changes in government functions—Based on the identification of the evolution of functional dimensions and analysis of policy texts," *China University Science & Technology*, vol. 35, no. 11, pp. 84-88, 2021.
- [7] L. Qu. "Research on the function of government in industry-university-research cooperation," *Employment and Security*, vol. 32, no. 20, pp. 35-36, 2020.
- [8] M. Li, X. H. Gao, X. W. Liu. "Analysis on Problems and Countermeasures of Establishing Industry-Academia-Research Collaboration Innovation Alliance," *Modern Education Management*, vol. 39, no. 10, pp. 47-53, 2019.
- [9] N. Ye, L. F. Luo, Z. R. Jie, H. Y. Wang. "The Research on the Formation of College Industry-Study- Research E-Service Platform," *Journal of Jilin Institute of Chemical Technology*, vol. 33, no. 10, pp. 29-34, 2016.
- [10] M. Shao, Z. E. Mei. "The Functional Requirements Analysis of Industry-University-Research Collaboration Technology Service Platform," *Value Engineering*, vol. 32, no. 29, pp. 4-8, 2013.