

Innovation Mechanism of Common Technology Collaboration in Emerging Industries within the Context of Big Data and the Internet of Things

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In the era of big data and the Internet of Things (IoT) technologies, the collaboration and development of commonly-used industrial technologies are significantly influenced by various factors across multiple fields. These technologies play a crucial role in enhancing the core competitiveness of businesses. Collaborative approaches to the research and development (R&D) of these technologies provide opportunities for business transformation and future growth. This study explores the current development status of commonly-used industrial technologies, analyzes China's achievements in innovative technology development, and proposes strategies for government-business collaborative R&D to foster industrial technological advancement and boost companies' independent innovation capabilities. By applying regression analysis, the study constructs a data-driven model to evaluate and optimize the resource allocation for industrial technology innovation, highlighting key variables such as R&D investment, the number and quality of partners, market demand, and technological capabilities. This model demonstrates how businesses can enhance innovation outcomes through targeted adjustments in resource inputs, offering practical insights for improving industrial technology development and competitiveness.

Keywords: Big data; Internet of Things; commonly-used industrial technology; cooperation and innovation; mechanism innovation; regression analysis

1. INTRODUCTION

A collaborative approach to the research and development of industrial technology innovations provides important technical support for enterprises in manufacturing and can be applied in many fields [1–3].

The state and government departments implement macro-control to achieve commonly-used technology integration between various industries. While fostering basic technological progress, they focus on improving the core competitiveness

of various industries and driving the economic development of the entire region. Shared technology and R&D collaboration provide support for the development of basic, forward-looking, and innovative technologies in an environment of continuous improvement in industrial technology. Moreover, they encourage the development and advancement of China's scientific research field [4, 5].

Figure 1 shows the growth of big data and the development of the Internet of Things in various regions of China in 2021. Especially in South China and East China, because of their prominent position in the nation's economic structure, there is more economic and capital investment in technology

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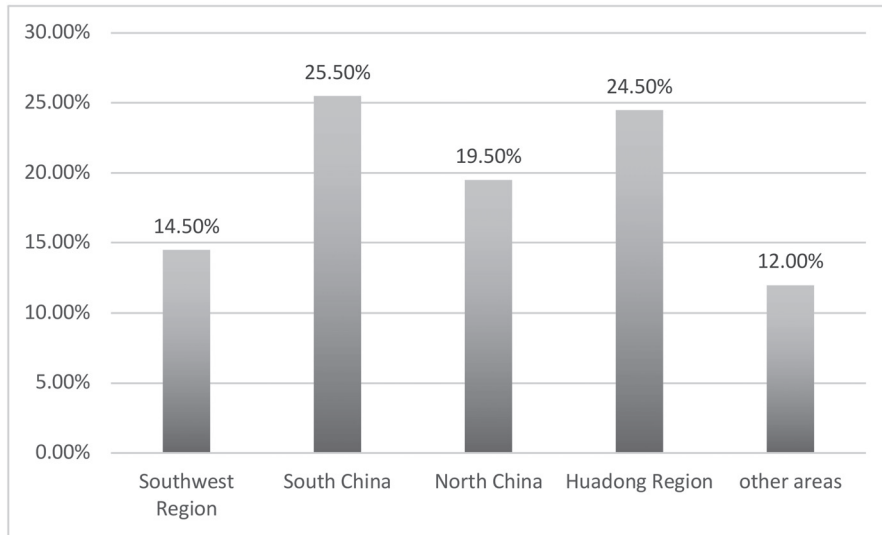


Figure 1 The growth of big data and the development of the Internet of Things in various regions of China in 2021.

than in other areas. Therefore, these regions also have clear advantages in terms of collaboration and the development and application of technology [6, 7].

Through cross-industry technological cooperation, different enterprises can share resources and technologies in the R&D stage, which not only reduces R&D costs, but also improves the efficiency of technological innovation. For example, the industrial technology alliances in the United States and Japan have improved the quality and market competitiveness of products by sharing core technologies. This experience provides a valuable reference for China's industrial technological innovation.

In China, the national government supports technological cooperation and innovation among enterprises through a series of policies, especially in the field of high technology. These policies not only promote the progress of domestic enterprises in technological research and development, but also narrow the technological gap with developed countries. For example, in recent years, China has promoted the application of big data and Internet of Things technologies through policy guidance, and improved the overall technological capabilities and market competitiveness of enterprises.

With the support of big data and IoT technologies, enterprises can collect, analyze and use data more efficiently, promoting technological innovation and cooperation. These technologies not only accelerate the research and development process of industrial technology, but also provide new platforms and opportunities for cross-industry cooperation, especially in southern and eastern China, where government funding and policy support have made the application of these technologies more popular.

Through the application of big data and IoT technologies, cooperation between industries is no longer limited to technology sharing, but has also expanded to multiple fields such as resource allocation and supply chain optimization. This synergy effect not only enhances the core competitiveness of various industries, but also accelerates the overall development of regional economies, especially in high-tech industries and manufacturing industries, where technological cooperation has driven the improvement of product quality and the expansion of market share.

Take southern and eastern China as an example. Due to the important position of these regions in China's economic structure, the government's capital and technology investment is more concentrated. Enterprises in these regions are relatively advanced in technological innovation and cooperation, and can better utilize technologies such as big data and IoT to achieve cross-industry technological collaboration and innovation.

2. THE KEY AND STATUS OF EMERGING INDUSTRIES' COMMON TECHNICAL COLLABORATION AND INNOVATION MECHANISM

2.1 Big Data and the Internet of Things are Key Factors Influencing Industrial Technologies

Big data and the Internet of Things technology are key factors that affect the collaboration of emerging industries and technological innovations, assisted by the policies established by national government departments. In recent years, China has introduced several policies to promote the R&D of commonly-used technologies for new industries, effectively closing the large gap between China and developed Western countries regarding the R&D of new industries and technologies and, to a certain extent, improving the core competitiveness of domestic enterprises [8-10]. Table 1 shows China's total output value regarding new industries from 2015 to 2021, and the development trends of 2022 and 2023 are estimated based on previous statistics. We find that industrial co-technical collaboration on innovation has significantly increased GDP since 2015 in the context of big data and the Internet of Things. With the gradual saturation of big data and internet of things technology, the growth of collaboration among new industries on commonly-used technology development and innovation has gradually decreased. This indicates that the fast lanes developing in China's economic reconstruction have entered a relatively stable stage in recent years. During the

Table 1 Total output value of industrial co-technical cooperation in industrial common technology for 2015-2023.

Number	Year	Output value/100 million yuan	Increase
1	2015	2800	
2	2016	3600	28.57%
3	2017	4700	30.56%
4	2018	6200	31.91%
5	2019	8000	29.03%
6	2020	10100	26.25%
7	2021	12300	17.80%
8	2022	13600	10.57%
9	2023	15700	15.44%

development of commonly-used technology innovation and collaboration among new industries, the focus has been on the innovation and development of high-tech industry areas. State and government departments should provide corresponding policies and systems to regulate the practical application of new industries' common technologies.

In industrial co-technical collaboration in development R&D, China's establishment of a collaborative development system based on corporate innovation has significant scientific importance. With the innovation and development of new industries, the development model of innovation is an important means by which national co-technologies collaborate on R&D and innovation.

2.2 Status of Common Industrial Technology in the Industrial System

The development and application of new industries' commonly-used technologies promote industrial development and economic progress. It plays an important role in upgrading and developing common industrial technologies. In the field of common technology R&D throughout the entire industry, policies and the budget allocated to the R&D department can help ensure the long-term development of industrial technology collaboration and achieve the best development model for enterprises [11, 12].

By developing collaborative scientific co-technology research and development cooperation policies, state and government departments can implement a common technology R&D exchange between enterprises, enhance industrial system development, and meet the requirements of industrial technology cooperation [13]. Technology research and development channels based on industrial technology innovation should be established, and the progress of industrial technology and sustainable economic development should be monitored.

The United States and Japan Industry Common Technology Innovation Alliance has a better collaborative experience developing commonly-used technologies for emerging industries. The two nations collaborate to develop and explore industrial and technological innovations and apply them successfully. An industrial commonly-used technology innovation alliance can be achieved through standardized scientific investment, guarantees, and knowledge-sharing mechanisms. The common technical foundation of each enterprise can be shared, and the overall technology and

product quality can be improved [14, 15]. Technological advancement has led to each enterprise's core competitiveness within the industry. The industrial common technology innovation strategy alliance between the United States and Japan provides a good reference and policy guideline for China's development of commonly-used industrial, technological innovation and collaborative cooperation. It promotes the joint research, development, and collaboration of China's common technology industries [16].

The development and application of industrial joint technological innovation plays a vital role in industrial development and economic progress. First, the literature emphasizes the role of joint technological innovation in promoting industrial technology upgrading, and points out that the rational allocation of policies and R&D budgets is crucial to promoting long-term technological cooperation and innovation, which helps enterprises achieve the best development model. Secondly, by promoting joint technology R&D cooperation policies, the state and government departments can promote technological exchanges among enterprises, enhance the overall development of the industrial system, and ensure the smooth flow of technology R&D channels. In terms of international experience, the industry joint technology innovation alliances in the United States and Japan provide a successful cooperation model, which improves the technical foundation and product quality and enhances the core competitiveness of enterprises through standardized investment, guarantee mechanism and knowledge sharing. These international experiences provide valuable inspiration for China in developing industrial joint technological innovation cooperation, especially in promoting cross-enterprise joint R&D and improving the efficiency of technological innovation.

3. CONSTRUCTION OF A NEW COMMON INDUSTRIAL TECHNOLOGICAL INNOVATION MECHANISM

3.1 New Types of Commonly Used Cooperative Systems for Industrial Technology Innovation and Development

With the continuous development of big data and the industrial Internet of Things, the Bai Paper of Cydier investigated the actual development of the Industrial Internet of Things in a

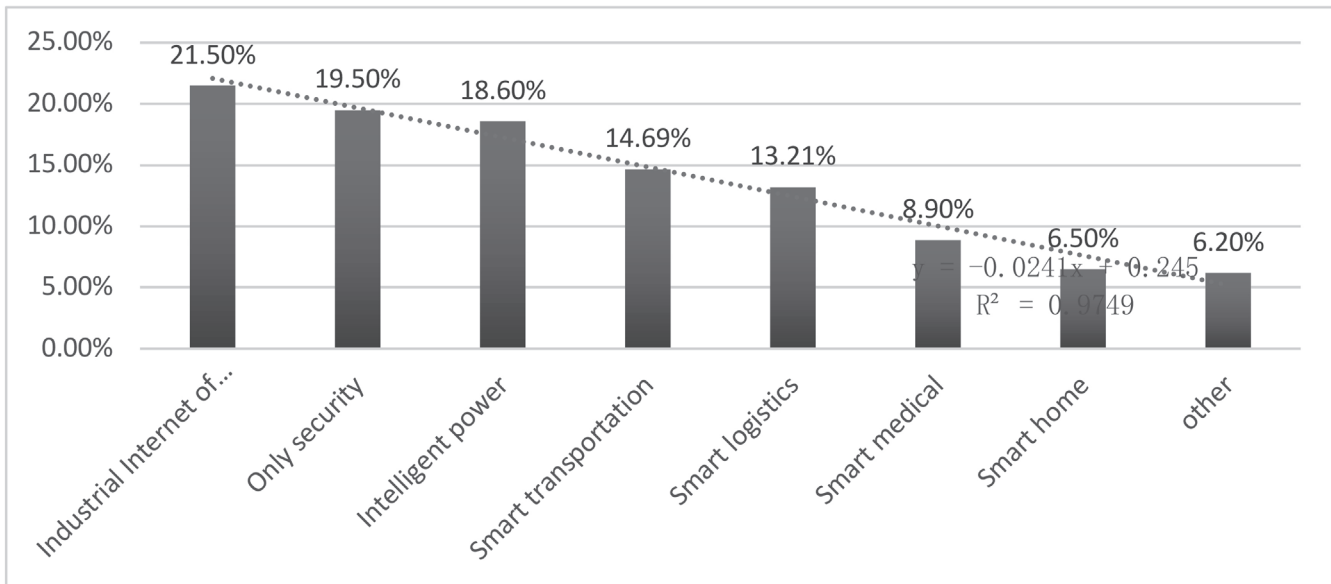


Figure 2 The proportion of the Industrial Internet of Things in new industrial common technology development R&D collaboration.

white paper. As shown in Figure 2, the industrial Internet of Things accounts for 21.5% of the entire industry. First, industry plays a key role in promoting the establishment of a cooperative system for enterprises' research and innovation cooperation. During the R&D process, the Industrial Internet of Things effectively promoted the supply of new common technological innovation cooperation throughout the industry. It ensured the improvement of system efficiency and mechanism innovation. Today, with the continuous improvement and development of the Industrial Internet of Things, the precise control and system enhancement of the new type of common technology innovation supply process can ensure the long-term progress of industrial common technology innovation. common technical cooperation in the research The research and development of new industries' common technology play a critical role in the innovation of technological products within the industry but face the risk of investment in the early stages of joint research and development of common technical cooperation and uneven investment in joint technology research and development of human energy. This problem has led to an uneven interest in constructing new types of common technical cooperation within the construction system. To effectively reduce the uneven investment in technology development and innovation, an important basis for capital export in terms of technology applications can be achieved by establishing a proportional investment policy [17, 18]. In realizing the construction of common technical cooperation in the research and development system, unnecessary investments, an expanded investment output ratio, and a win-win situation are needed. In constructing new common technical cooperation in research and development systems, it is necessary to avoid hidden dangers such as car theft and technical theft, reduce the risks and challenges brought about by common technology research and development, and achieve a more accurate application of common technology. This is conducive to common technology research and development—improving core competitiveness.

3.2 The Main Body of the Company as a New Type of Common Industrial, Technological Innovation

A new management system and mechanism for new types of commonly-used technology innovation and development should be established. The cooperation and innovation of various industries in common technology innovation should be prioritized, forming a trend of common technology research and development in the industry, enabling open management of new common technology systems, realizing common technology research, and meeting industrial development needs. In promoting and improving the field of common technology research and the development of innovative industries, we must, within the group innovation system, realize common technological innovation in the regional economy, enhance the overall vitality of the innovation system, and stimulate the investment and output of various enterprises in the development of new common technology research and development.

In the field of commonly-used technology R&D, major domestic innovation enterprises have played an important role. As shown in Figure 3, the Ministry of Industry and Information Technology and Y from the EU jointly released the Fortune of China's Industrial Innovation List. Among the 50 innovative enterprises, Beijing, Shanghai, Shenzhen, and Tianjin are the main areas with a concentration of innovative co-technology R&D enterprises and are, therefore, the primary manufacturing hubs for cluster-based contribution technology R&D.

3.3 Research on the Development Model of the New Common Technology Industry

Through effective control of new common technology research and development, the transformation of innovative

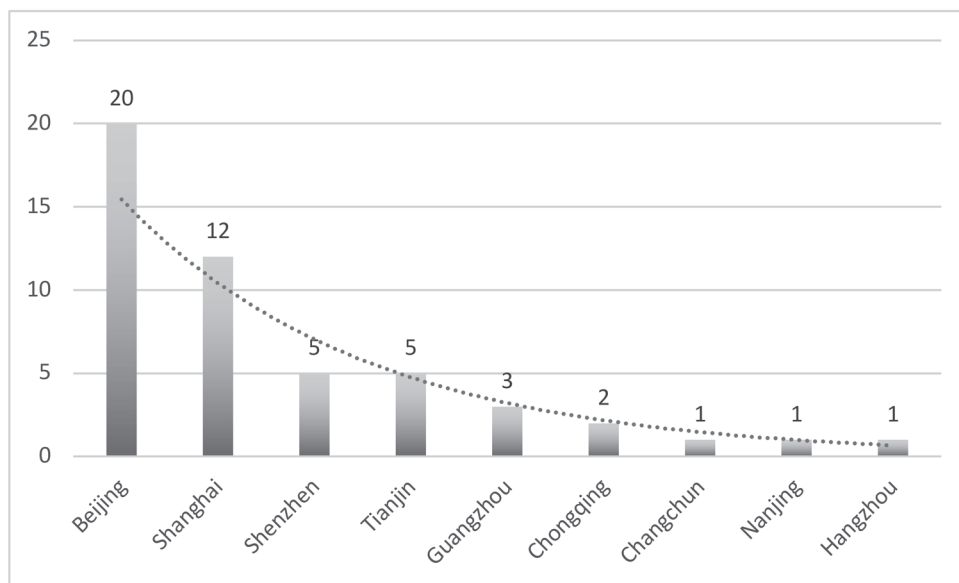


Figure 3 Distribution of the top 50 major domestic innovation enterprises in 2021.

results, and the reasonable control of the spread of common technology cooperation, research and development results in the internal diffusion of the industry. Ensuring the reasonable application of industrial common technology R&D and innovative achievements can effectively enhance the core competitiveness of enterprises, prevent the emergence of industrial common technologies from expanding at will, and have a greater impact on enterprises' input and output ratios. State and government departments should introduce clearer policies and legal support for managing commonly-used technology R&D and capital investment, which are conducive to new commonly-used technology R&D and enterprise production and development. Internal enterprises must also establish a clear mechanism and development plan for expanding and applying new common technology R&D within the industry. By establishing a reasonable common technical management diffusion mechanism and approach, the multiparty influencing factors can be analyzed, and common technology research and development cooperation can be promoted toward a more reasonable development path.

For different industries and enterprises, an innovative tool resulting from R&D can effectively strengthen the core competitiveness of enterprises. The national government, large enterprises, and research institutions should play important roles in common technology R&D. They should give full play to the country's human and material investment in industrial common technology R&D through the establishment of special scientific research plans, implement a national science and technology revitalization strategy, and achieve industrial common technological innovation. Development has enabled the industry to maintain the competitive advantage of continuous cooperation in common technologies, and promote the improvement of new common industrial technologies within the industry. It is necessary to form a good atmosphere for common technology research and development within the enterprise, provide clear direction for policy and funding support for the development of common technology in the industry, and, in the process of

building an innovative commonly-used technology research and development system, allow more enterprises to participate and ensure the survival of the enterprise. This is a good development situation that coexists with common technology.

4. EFFECTS OF EXAMPLE ANALYSIS: THE IMPACT OF KEY COMMON TECHNOLOGY RESEARCH AND DEVELOPMENT ON INNOVATION PERFORMANCE

Applying key common technologies in the research and development of innovative performance management through instance analysis is essential. The capital investment of various enterprises in technology R&D and innovation should be collected. The factors that influence enterprises' joint R&D and contributions should be identified. The impact of key common R&D technologies on the competitiveness of enterprises should be studied to increase competitiveness and enhance corporate performance.

The Internet of Things and big data provide key support for industrial joint technological innovation through real-time data collection, analysis and sharing. The Internet of Things connects various devices to achieve real-time data transmission and monitoring, which enhances the collaborative efficiency in the process of technology research and development; big data helps companies identify technology development trends and market demands and optimize resource allocation through the analysis of massive amounts of information. The combination of the two not only improves the speed and accuracy of technological innovation, but also promotes cross-industry cooperation and promotes the improvement of the overall industrial technology level, thereby enhancing the competitiveness of enterprises and the economic benefits of the industry.

Table 2 Variable averages and standard deviations.

Factor	Average			Standard deviation		
	Dep=L	L<Dep	All	Dep=L	L<Dep	All
NPR	0.0000	40.2839	39.0126	0.0000	25.0123	28.1121
RC	3.3126	6.7659	7.1722	3.9121	6.0121	6.3899
RJ	7.2314	12.3289	12.2123	13.6667	15.3390	17.2991
DZ	0.5732	0.2867	0.7116	0.4709	0.4524	0.2912
CSD	9.1025	17.2821	19.1211			

4.1 Analysis of the Construction and Improvement of the Model

Based on Mans Feld’s research theory, technological innovation is a concentrated manifestation of industrial development and progress in commonly-used technical cooperation in industry. The industry’s internal commonly-used technology research and development innovation can effectively promote its competitiveness in technological innovation, product improvement, and long-term development. After screening 350 companies that have made great contributions to industrial common technology R&D and innovation, the 2021 new product output value NPR is used as the performance evaluation indicator for 350 companies.

When developing a model to help the industry identify key variables involved in industrial joint technological innovation, it is first necessary to identify the core factors that affect technological innovation. These key variables can be divided into several dimensions: first, technical capabilities, including the company’s existing technological level, R&D facilities, personnel skills, etc.; second, partnership, that is, the strategic alliances, technical advantages and market coverage capabilities of partners required by the company in cooperation; third, market demand, that is, whether the industry’s technological innovation is in line with market trends and changes in consumer demand; fourth, capital investment, including the company’s capital allocation in R&D activities and the sustainability of long-term investment. The model should be based on these variables and quantify the impact of each variable on the company’s innovation output through regression analysis or machine learning methods. In addition, the model should also take into account the resources that the company may need to invest in the innovation process, such as the construction of the R&D team, the establishment of the technology platform, and the expansion of the cooperation network. Through the analysis of the model, companies can evaluate the optimal allocation of resources under different conditions, find the path that best promotes technological innovation, and thus improve the efficiency and effectiveness of innovation activities. This model will provide a quantitative basis for corporate decision-making, help companies optimize resource allocation, and promote the maximization of innovation results.

With NPR as an important reference factor for performance indicators, through the introduction of virtual variables D, corporate scientific and technological talents that affect the development of the common technology of the enterprise, the actual transformation efficiency of the common technology RJ, the corporate support DZ, and the technical maturity

CSD, a regression analysis based on the industrial common technology research model was conducted. This model is applied to analyze companies in the fields of 350 industries’ common technology research and innovation and to determine the role of performance indicators in promoting common technology development across different industries. A common technology research model with innovative performance as an important indicator has been established. The indicators and scope of the parameters are used to achieve clearer model evaluation. This model is a good evaluation tool and guides different enterprises regarding industrial common technology cooperation with the research and development of innovative performance analysis, as shown in (1).

$$NPR = \beta_0 + \beta_1 RD_i + \beta_2 RC_i + \eta_0 D_{1i} + \eta_1 D_{1i} RD_i + \sigma \epsilon_i \quad (1)$$

$D_{1i} RD_i$ can be understood as “Enterprises carrying out key common technology research and development have impacted enterprises’ investments in funds and manpower.

4.2 TOBIT Regression Results and Analysis of Key Common Technologies

Based on the regression analysis results of the above 350 common technical research and innovation enterprises, the laws of sample parameters of each enterprise are analyzed. Corresponding descriptive statistical research is conducted, and the actual transformation efficiency of corporate scientific and technological talent that affects the development of the common technology of the enterprise and the actual transformation efficiency of common technology are determined. RJ, the corporate support DZ, and the technical maturity CSD are analyzed, as shown in Table 2. Based on the TOBIT regression theoretical analysis method, the estimation results of each parameter are shown in Table 3.

According to the above evaluation model, improving technology’s contribution and the research and innovation mechanism requires a more accurate evaluation method. The calculation model is shown in (2).

$$NPR = 18.1213 + 1.2176RC + 0.2629RJ + 9.8686DZ - 0.4110DZRC \quad (2)$$

The above computing model reveals that the balanced development of enterprises in R&D investment and technology talent applications plays a significant role in improving new common technology R&D. A typical representative of

Table 3 TOBIT regression analysis structure.

Factor	Coefficient estimation	Standard deviation	Statistics	<i>P</i> value
NPR	18.1213	5.2111	3.4822	0.0005
RC	1.2176	0.6022	1.9877	0.0579
RJ	0.2629	0.1667	1.6772	0.7890
DZ	9.8686	5.7870	1.7041	0.8820
DZRC	-0.4110	0.6913	-0.5770	0.5639
SCALE:C(6)	28.3310	1.3869	21.5621	0.0000

the analysis is shown. The 350 enterprises have innovative advantages in common technology cooperation. They are constantly increasing their investment in common technology research and development to increase the output value of new products and their competitiveness in the industry. Through the formation of good joint technology cooperation and innovation mechanisms within the industry, corporate innovation capabilities have been continuously improved, promoting its strong competitive position within the industry. With the continuous accumulation of key common technology research and development, enterprises have achieved the long-term sustainable development of individual enterprises and overall industries under common technology cooperation's research and development innovation system.

Assume that a manufacturing company has the following data when participating in industrial joint technological innovation: R&D investment is RMB 30 million, partners include 5 technologically advanced companies, market demand growth rate is 8%, and the company's technical capability score is 75/100. Based on this data, the model calculates the impact of each key variable on innovation output. For example, increasing R&D investment by 20% (i.e. RMB 6 million) will significantly increase innovation output. Innovation output can be further improved by adding 2 high-quality partners. In addition, responding to market demand growth and improving technical capability scores can also help improve innovation output. Taken together, these measures will significantly increase the company's innovation output, proving that through reasonable resource allocation and data-driven decision-making, companies can maximize their benefits in industrial joint technological innovation and improve their market competitiveness and technological leadership.

5. CONCLUSION

Summarizing the practice and data theory of industrial common technology research and development fields above, we find that the research and development of industrial common technology cooperation plays an important role in promoting the industry's long-term construction and sustainable development. As the main body of common technology research and development, enterprises must establish a common technology R&D system to improve their investment in common technology R&D funds. By effectively operating the system and mechanism through integrating the technical advantages offered by enterprises within the industry, successful corporate common technology can be

built. Under the promotion of mechanisms, the company's common R&D development embarked on the fast lane, realizing the sharing of internal common technologies within the enterprise, strengthening the promotion of industrial common technology to improve the quality of different enterprises, and effectively improving businesses and their competitive advantages in the market. In promoting the long-term construction of industrial commonly-used technology R&D, talent training, as an important factor in technological innovation and development, should give attention to the R&D teams of governments, universities, scientific research institutes, and large and medium-sized enterprises. Talent gives full play to the means of talent security and promotes the long-term development of collaborative industrial technology R&D.

To promote the important role of colleges and universities in training talented students, under the operation of the industrial commonly-used technology research and development mechanism through scientific policies and development strategic support, the talent training strategy is included in the national government and enterprise development planning. Using collaboration and the development of secure platforms, R&D achievements can be shared among enterprises and research institutes, universities, and other scientific research and development institutions. This will ensure the sustainable development of collaborative technology in the industry and improve the transformative efficiency of technology R&D. The movement of high-tech talent to various industrial sectors promotes the efficient utilization of common technology R&D investment, avoiding the risks associated with the application of common technology R&D, meeting the needs of technological innovation and development in the industry, and encouraging a new collaborative approach to R&D research and the development of a different, sustainable and important driving force for enterprise innovation and development.

6. FUNDING

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