

# *Competitiveness Evaluation and Path Exploration of Innovative Talents in High-Tech Enterprises: Taking Liaoning Province as an Example*

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**Abstract:** Innovative talents are one of the main innovation subjects of high-tech enterprises. Their competitiveness is a key indicator that affects the innovation ability of enterprises. As the country attaches more importance to the innovation ability of enterprises, it has gradually become an important issue in the construction and improvement of high-tech enterprises that how to evaluate the competitiveness of innovative talents of enterprises in multiple dimensions and plan a reasonable path for talent construction in combination with the characteristics of regional talents has gradually. According to this, this paper analyzes the basic characteristics of innovative talents in high-tech enterprises, summarizes the key factors affecting their competitiveness, and further builds an evaluation system for the competitiveness of innovative talents. The article puts forward a construction path to enhance the competitiveness of talents according to the current situation of talent development in Liaoning Province, and provides ideas for enhancing the innovation ability of high-tech enterprises and improving the construction of the province's innovation ecosystem.

## 1. Introduction

As the central government gradually attaches importance to scientific and technological innovation, the optimization direction of the innovation ecosystem and target tasks have gradually become clear in China <sup>[1]</sup>. Under this background, high-tech enterprises, as a key factor in promoting the national economy and enhancing national innovation capabilities, have gradually formed a unique enterprise innovation ecosystem to improve their innovation capabilities and sensitivity to external disturbances. The discovery and retention of talents is the core of the healthy and long-term development for high-tech enterprises <sup>[2]</sup>. As an important innovation subject, innovative talents have become a strategic resource that affects the construction of the regional innovation ecosystem, and enhancing their competitiveness has become the key to improving the regional core competitiveness and promoting the construction of the regional innovation ecosystem.

In order to adapt to the new requirements of innovative enterprises for talents, literature <sup>[3]</sup> proposes that it is necessary to cultivate high-quality compound professionals with international competitiveness in order to enhance the competitiveness of innovative talents. In this context, many scholars have put forward specific plans to enhance the competitiveness of innovative talents from the perspective of talent training <sup>[4-5]</sup>. However, it is too simple to consider only from the perspective of talent training. Comprehensive consideration should be taken from multiple dimensions in order to improve the competitiveness of innovative talents in high-tech enterprises, which give full play to the good effect of benign interaction and common growth between enterprises and talents <sup>[6]</sup>. In addition, there are regional differences in the development of talents and the demand for innovative talents of high-tech enterprises <sup>[7]</sup>. In the evaluation of talent competitiveness, it is necessary to fully consider the actual development and target demand of the region. And only on this basis, the exploration of the path to enhance talent competitiveness is of practical significance.

Based on this, this paper analyzes the basic characteristics of innovative talents in high-tech enterprises, and summarizes the key factors that affect the competitiveness of their talents. On this basis, the article constructs an evaluation system for the competitiveness of innovative talents, and finds four key indicators. Combined with the current situation of talent development in Liaoning Province and the key influence indicators of the competitiveness of innovative talents, the article puts forward the construction path for improving the competitiveness of talents in Liaoning Province, which provides ideas for improving the level of talent team construction and enhancing the innovation ability of high-tech enterprises.

## **2. Factors Influencing the Competitiveness of Innovative Talents in High-tech Enterprises**

### **2.1. Basic Characteristics of Innovative Talents in High-Tech Enterprises**

Innovative talents in high-tech enterprises refer to scientific and technological talents who have been engaged in basic research, applied research and experimental activities for a long time, grasp the development direction of this discipline, follow the frontier trends, and propose research topics or key projects according to the development trend. These groups have rich innovation achievements, own intellectual property rights, new technologies, new products and new brands, and are the backbone of innovation and development of high-tech enterprises. The competitiveness of innovative talents covers many factors such as the quantity, quality, structure, proportion, flow, and environment of national or regional human resources. It is the core issue of regional talent construction and the fundamental factor to promote regional innovation.

Compared with general scientific and technological talents, innovative talents in high-tech enterprises usually have five basic characteristics: (1) lasting stability in scientific activities; (2) multiple inputs to scientific undertakings; (3) innovation of scientific and technological achievements; (4) Innovation of technological achievements and benefits; (5) Comprehensiveness of development.

### **2.2. Influencing Factors of the Competitiveness of Innovative Talents**

According to the actual indicators of Chinese talent statistics and the realistic connotation of the innovation talent competitiveness of high-tech enterprises, this paper divides the influencing factors of innovation talent competitiveness into three main aspects: talent input, talent output and environment.

### **2.2.1. Talent Input**

The investment of innovative talents in high-tech enterprises is the fundamental prerequisite for the formation of the competitiveness of innovative talents. The government department's investment in high-tech innovative talents, including increasing the investment in personnel and optimizing the investment structure, has a significant impact on improving the overall quality of the innovative talent team, and is a guarantee for improving regional innovation capabilities. The higher the investment in innovative talents, the stronger the competitiveness of talents, the richer the resources that need to be developed and utilized in the region, and the relatively strong advantages of scientific and technological talents.

### **2.2.2. Talent Output**

As an external manifestation of the competitiveness of innovative talents, the output of innovative talents of high-tech enterprises is one of the important symbols to measure the level of regional scientific and technological development. The greater the output of innovative talents, the greater the contribution of innovative talents to regional economic development, and the stronger the competitiveness of innovative talents. Measures such as deepening the reform of the science and technology system, improving the science and technology reward system, and increasing investment in science and technology will help improve the national awareness of innovation and technology, and improve the level of scientific and technological theories and patent achievements. It is an important way to increase the output of innovative scientific and technological talents.

### **2.2.3. Talent Environment**

The environment for innovative talents covers a wide range, including soft environment and hard environment, material environment and human environment, working environment and living environment, macro environment and micro environment, etc. It is a complex of social and material conditions for the survival and development of scientific and technological talents, and the sum of external factors that affect the growth of scientific and technological talents.

In general, the environment for innovative talents mainly includes the economic environment, working environment and living environment, etc., which reflects the ability of the external environment to gather innovative talents, which is embodied in the service level of government departments, the level of regional economic development, living standards, working conditions, etc. Establishing a good talent environment is not only a necessary condition for talent training, but also plays an important role in attracting talent, enhancing talent stickiness, and avoiding talent outflow.

## **3. Innovative Talent Competitiveness Evaluation System**

### **3.1. Competitiveness Evaluation Indicator of Innovative Talents**

Based on the four principles of dynamic continuity, emphasis on environmental construction, comprehensive and key combination, and scientific and realistic combination, this paper puts forward the evaluation indicators of innovative talent competitiveness. The specific indicators are shown in Table 1.

In the proposed evaluation system, each indicator level is different, but there is still correlation between the indicators. In order to avoid the overlapping of information reflected by the indicators, the article uses SPSS for factor analysis. By studying the internal structure of the variable correlation coefficient matrix or covariance matrix, look for a small number of random variables

that control all variables to describe the association between multiple variables.

Table 1: Evaluation indicators of innovative talent competitiveness

competitiveness of innovative talents	A. innovative talent input competitiveness	A1	total funds raised for scientific and technological activities (10,000 yuan)
		A2	science and technology appropriation from local finance (million yuan)
		A3	internal expenditure on scientific and technological activities (10,000 yuan)
		A4	internal expenditure of R&D funds (100 million yuan)
	B. innovative talent output competitiveness	B1	technology market transaction contract amount (10,000 yuan)
		B2	number of patent applications accepted (cases)
		B3	number of granted patent applications (pieces)
		B4	number of domestic valid patents
	C. innovative talent environment competitiveness	C1	GDP (100 million yuan)
		C2	urban road area per capita (square meters)
		C3	park green space per capita (square meters)
		C4	GDP per capita (100 million yuan)
		C5	average salary of employees (yuan)
	C6	number of health institutions	
	C7	number of beds in health institutions	

### 3.2. Factor Analysis Principle and Result Analysis

Assuming that there is no significant difference between the 15 factors in the evaluation elements of the competitiveness of innovative scientific and technological talents in my country, the KMO and Bartlett spherical tests are carried out, and the results are shown in Table 2. It can be seen from the table that the KMO value is  $0.686 > 0.5$ , which is suitable for applying factor analysis, but because its value is  $< 0.7$ , the effect of applying factor analysis still has room for improvement; the Bartlett sphericity test Sig. value is  $0.00 < 0.05$ , that is, the variable independent of each other to a certain extent.

Table 2: KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.686
Bartlett's Test of Sphericity	Approx. Chi-Square	767.254
	df	105
	Sig.	0.00

Using SPSS11.5 for processing, its variance decomposition principal component extraction analysis table is shown in Table 3.

Table 3 shows the ordering of the magnitude of the variable feature root values. The first-ranked factor C1 eigenvalue is 7.610, accounting for 50.737% of the total variance of the original variable; the second-ranked factor A3 eigenvalue is 3.131, accounting for 20.876% of the total variance of the original variable; A1 eigenvalue is 1.431, accounting for 9.539% of the total variance of the original variable; the B4 eigenvalue is 1.057, accounting for 7.047% of the total variance of the original variable. The eigenvalues of the above four variables are all greater than 1, and the total accounts for 88.200% of the factor factors of the competitiveness evaluation of modern service

industry in Liaoning Province. Therefore, taking these four main factors as comprehensive variables for evaluating the competitiveness of innovative scientific and technological talents, the ranking of the competitiveness of innovative scientific and technological talents in 30 regions of the country (excluding Tibet) was obtained, as shown in Table 4.

Table 3: Total Variance Explained

Component in order	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.610	50.737	50.737	7.610	50.737	50.737
2	3.131	20.876	71.613	3.131	20.876	71.613
3	1.431	9.539	81.152	1.431	9.539	81.152
4	1.057	7.047	88.200	1.057	7.047	88.200
5	0.771	5.142	93.341			
6	0.384	2.557	95.899			
7	0.265	1.768	97.667			
8	0.142	0.949	98.616			
9	0.095	0.636	99.252			
10	0.054	0.357	99.609			
11	0.045	0.301	99.910			
12	0.009	0.058	99.968			
13	0.003	0.021	99.990			
14	0.001	0.008	99.998			
15	0.000	0.002	100.000			

Extraction Method: Principal Component Analysis.

Table 4: Scores and ranking of the national innovative scientific and technological talents competitiveness evaluation module

area	single ranking				total ranking	aera	Single ranking				total ranking
	C1	A3	A1	B4			C1	A3	A1	B4	
Beijing	6	29	7	1	12	Henan	10	3	1	8	6
Tianjin	9	27	25	21	24	Hubei	14	7	14	13	11
Hebei	11	2	9	3	7	Hunan	15	5	6	12	9
Shanxi	24	12	10	22	19	Guangdong	1	10	12	29	1
Inner Mongolia	18	21	26	6	20	Guangxi	23	9	17	15	18
Liaoning	8	24	2	5	8	Hainan	28	23	27	24	29
Jilin	22	20	19	20	23	Chongqing	20	26	21	17	21
Heilongjiang	17	19	11	14	17	Sichuan	7	4	3	7	5
Shanghai	5	28	8	23	14	Guizhou	29	25	4	28	28
Jiangsu	2	6	28	16	2	Yunnan	25	13	13	25	22
Zhejiang	3	14	24	19	4	Shaanxi	13	17	5	10	10
Anhui	16	8	18	11	13	Gansu	27	16	15	27	26
Fujian	12	15	23	18	15	Qinghai	30	30	30	30	30
Jiangxi	19	11	16	9	16	Ningxia	21	22	29	4	27
Shandong	4	1	22	3	3	Xinjiang	26	19	20	26	25

The above Table 3 shows the individual rankings and comprehensive rankings of the four indicators C1, A3, A1, and B4, which reflect the competitiveness of high-tech enterprises in each province and city in these four aspects. Provide a basis for improving the competitiveness of the

path and improving the relevant policies and plans for scientific and technological talents.

## **4. The Development Status of Innovative Talents in Liaoning Province**

### **4.1. Disproportionality of Fund Inputs in Innovative Science and Technology Activities**

It can be seen from Table 4 that although Liaoning Province ranks high in the collection of scientific research funds, the internal expenditure of scientific and technological activities ranks low, indicating that Liaoning Province's investment in scientific and technological activities for innovative talents is out of proportion. The overall ranking of Liaoning Province is relatively high, but it is still necessary to expand the scale of talents and increase the total number of R&D talents according to the current situation. At present, although the amount of science and technology funds raised in the province is increasing day by day, enterprise funds account for about 70% of the funds raised, government funds are only about 20% of the funds raised, and loans from financial institutions are only 3% of the funds raised, and its proportion to the amount of science and technology funds raised is seriously out of balance. In addition, only about half of the internal expenditure of science and technology funds is used for research and experimental development, and labor costs are too low, resulting in insufficient funds for basic research and applied research. Insufficient investment in science and technology, limited funding, and narrow space for scientific and technological development make it less attractive to innovative talents and unable to give full play to their own value to a greater extent. In addition, the input cost and attention to the construction of key scientific research institutions and laboratories are not enough, and the attention to the use of cultivating innovative scientific and technological talents needs to be strengthened.

### **4.2. Low Output Competitiveness of Innovative Talents**

The innovation and achievement transformation ability of innovative scientific and technological talents is weak, the scientific and technological output is low, and the advantages and characteristics are insufficiently reflected, and their due contributions to the economy and society cannot be exerted. Although the number of domestic valid patents ranks fifth, the number of patent applications granted in the province accounts for 51% of the accepted patents, and the proportion of patents for inventions is only 23.3%, which is relatively low. The number of patent authorizations and patent application authorizations in the province needs to be greatly increased, and the output competitiveness of innovative talents in the province needs to be improved urgently.

### **4.3. Urgent Further Improvement in Environmental Competitiveness of Innovative Talents**

In recent years, the situation of talent environment in Liaoning Province is that the total GDP of the province has been improving year by year, but the growth rate of per capita GDP is relatively low, that is, the province's GDP share has increased significantly, but the growth rate of per capita GDP is not obvious, which affects the competitiveness of innovative talents in Liaoning Province. The lack of salary income, working conditions and living environment of innovative talents in Liaoning Province under the current economic development environment will affect the attractiveness of the province to innovative talents at home and abroad and the stability of the existing innovative talent team.

### **4.4. Insufficient Availability of Scientists and Engineers**

The number of scientific and technological personnel, scientists and engineers has not increased

significantly in Liaoning Province at present, and the brain drain of innovative personnel is serious. Absorption capacity and cultivation intensity of innovative ability for innovative scientific and technological talents in Liaoning Province are insufficient. The value of innovative talents in high-tech enterprises is not fully played. At the same time, some enterprises and industries are obviously crowded with innovative talents, resulting in redundant and useless innovative talents in some enterprises and industries, and the embarrassing situation of scarcity of innovative talents in other enterprises and industries, accelerating the transfer of redundant talents to other provinces and cities, resulting in our province is losing innovative talents.

## **5. Construction Path**

### **5.1. Improve Policies and Measures to Enhance Talent Protection**

We should fully stimulate the government to play the policy-oriented role in government inputs and increase the investment in major scientific research projects according to the province's development strategy and industrial characteristics. Give full play to the role of policy measures and economic leverage to guide and encourage enterprises and institutions to increase investment in the management and development of scientific and technological personnel resources. It is necessary to establish a stable growth mechanism for financial investment in science and technology from a strategic level, and adjust the structure of financial investment in science and technology. Increase the proportion of government funds and loans from financial institutions, increase the amount of scientific and technological funds raised and increase internal expenditures for scientific and technological activities. Make full use of the supplementary role of special funds by setting up special funds for the training of high-level and high-skilled talents. And provide innovative talents with relative stability policy support to ensure their political and living conditions <sup>[8-10]</sup>.

In addition, enterprises and financial institutions also play an important role in enhancing the competitiveness of innovative talents. Increase the investment in scientific research of the enterprise, cultivate innovative talents from the internal personnel of the enterprise, and improve their knowledge level, skills and creativity. Encourage enterprises to cooperate with colleges and universities and scientific research institutions, make full use of their scientific research, technology, and talent advantages, solve technical problems of enterprises, and improve the application speed of scientific research results, promote industrial optimization and upgrading, and enhance enterprise competitiveness. The government should improve the financing system, establish and improve financial institutions, mobilize the enthusiasm of financial institutions through government subsidized loans, taxation and other measures, and promote commercial banks to increase the projects of scientific and technological talent resource development loans, so as to enhance the protection of talents.

### **5.2. Expand the Scale of Innovative Talents and Increase the Total Number of R&D Personnel**

The total proportion of scientific and technological personnel has not increased significantly among the personnel engaged in scientific research and development institutions in Liaoning Province in recent years. There are relatively few scientists and engineers. In response to this situation, on the one hand, we should rely on the national major talent training plan to expand the scale of innovative talents in Liaoning Province. On the other hand, it is necessary to increase the emphasis on major scientific research, major engineering projects and major industrial key projects, so as to not only strive to retain the existing innovative talents in Liaoning Province, but also attract foreign high-level innovative scientific and technological talents. By increasing key disciplines, key

scientific research bases, and international academic exchange and cooperation projects, actively build a strategic platform for cultivating various R&D innovative talents, focus on supporting the development of a group of scientific and technological innovation teams and leading scientific and technological talents, and give full play to the value of innovative talents. Improving their self-identity and recognition of the province's scientific and technological environment can greatly increase the viscosity of innovative talents.

In terms of increasing the total number of R&D personnel, improving Liaoning Province's awareness of human resources training for innovative talents is the fundamental factor to solve this problem. Establish educational innovation concepts, reform teaching content, educational methods and educational systems; strengthen innovative quality education, focus on cultivating students' innovative thinking, innovative spirit and innovative ability; accelerate the cultivation of senior innovative talents to solve the problem of scarcity of R&D personnel from the source. On this basis, it is necessary to focus on the status quo of high-level innovative talents in Liaoning Province to avoid a large outflow of talents; actively formulate relevant preferential policies to strengthen the introduction of high-level innovative talents from all over the country.

### **5.3. Improve the Quality of Innovative Talents and Improve the Efficiency of Talent Output**

Improving the quality and quantity of innovative talents is the two basic indicators for building a talent team. They are mutually related, mutually conditional and inseparable, but not positively correlated with each other, that is, simply expanding the number of talents will not lead to an inevitable improvement in the quality of talents. Therefore, it is necessary to focus on improving the quality of talents and the efficiency of talent output in high-tech enterprises.

First of all, it is necessary to adjust the structure of capital investment, increase the proportion of financial institution loans for the amount of science and technology funds raised, increase the part of the internal expenditure of science and technology funds for research and experimental development, and continuously increase the proportion of science and technology funds investment in GDP to provide sufficient training and practical opportunities for enterprise innovative talents. Secondly, we should actively adjust the structure of public education expenditure and increase the cultivation of innovative talents. Considering the situation of Liaoning Province itself, for regions with relatively weak talent competitiveness, we should learn from advanced regions and learn from their advanced experience in the construction of scientific and technological talents, and adjust the province's policy on the proportion of innovative talent funding according to the region's own development characteristics.

In addition, universities, research institutes and enterprises should be combined, and pilot projects should be carried out in enterprises while establishing key disciplines. Based on the advantages of Liaoning Province, it will increase the promotion of pilot projects, improve the practical ability of colleges and universities, solve the problems of funding and laboratory approval, and help enterprises to develop new technologies and projects, so as to increase the transaction volume of the technology market and increase the number of patent applications accepted. Formulate and implement policies and measures to encourage independent innovation of enterprises and universities, improve relevant policies for promoting the transformation of scientific and technological achievements and the industrialization of high-tech, enhance the independent research and development capabilities and output efficiency of innovative talents, and give full play to the economic promotion of innovative talents in the province.

### **5.4. Optimize the Innovation Environment and Give Full Play to the Value of Talents**

Optimizing the material environment for innovative talents is the most basic element to attract

high-tech talents. It is necessary to establish a salary distribution incentive mechanism that adapts to the development of the market economy, and boldly explore incentive mechanisms and compensation methods for attracting and retaining talents, including raising wages, increasing investment in scientific research, and providing sufficient financial support for R&D personnel. We will increase infrastructure construction and create a comfortable and safe living environment for innovative talents. It is necessary to strengthen the awareness and concept of intellectual property protection, strengthen the enforcement of intellectual property protection, resolutely crack down on various illegal and infringing acts, and optimize the legal environment for scientific and technological talents. Encourage and support enterprises to spontaneously form social organizations to protect intellectual property rights, and improve the self-protection and management capabilities of intellectual property rights. In addition, to create a good cultural environment, it is necessary to establish a lofty concept of talents, establish the selection standard of "both ability and political integrity, and focus on actual performance", and enhance the attractiveness of outstanding innovative talents with a good cultural atmosphere. Take the training, introduction and good use of scientific and technological talents as the basis for strengthening the construction of scientific and technological talents, strive to create a harmonious humanistic environment and a rigorous scientific research environment, and create a good, dynamic and sustainable environment for innovative talents to make their own value can be continuously extended, improved and realized.

## 6. Conclusion

This paper constructs the evaluation system of the competitiveness of innovative talents through analysing the basic characteristics of innovative talents in high-tech enterprises. And combining with the development status of innovative talents in Liaoning province, this paper puts forward specific measures to enhance the competitiveness of innovative talents in high-tech enterprises in Liaoning province, including (1) to improve policies and measures to enhance talent protection; (2) to expand the scale of the innovative talents and increase the total number of R&D personnel; (3) to improve the quality of innovative talents and the efficiency of talent output; (4) to optimize the innovation environment and give full play to the value of talents. It provides reference for the good development of innovation ecosystem of high-tech enterprises in Liaoning Province.

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