Research Article

Pre-Evaluation of Industrialization Project of Local Science and Technology Achievements Based on FAHP

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In order to build a scientific pre-evaluation system for the industrialization of local science and technology (sci-tech) achievements, based on the analysis of the characteristics and laws of the industrialization projects of sci-tech achievements, the pre-evaluation of the industrialization projects of sci-tech achievements at home and abroad, the importance of the pre-evaluation of the industrialization projects of local sci-tech achievements and the research methods, the pre-evaluation index system of industrialization projects of local sci-tech achievements has been established from six aspects: policy environment, technical performance, economic benefits, resource guarantee, organizational guarantee, and social benefits. The research took the smart manufacturing project in Xiqing District of Tianjin as the object of empirical analysis and applied the fuzzy analytic hierarchy process (FAHP) to comprehensively evaluate the project. The overall score of the smart manufacturing project was 87.639, and the evaluation result was good and in accordance with the actual situation. The feasibility and validity of the evaluation index system and the evaluation model are verified, the risks of economy and policy in the industrialization of sci-tech achievements are reduced, and the optimization rate of the industrialization project is improved, which provide a reliable basis for local governments to realize the industrialization of sci-tech achievements.

1. Introduction

The development of science and technology is the internal driving force of economic growth, and the industrialization of sci-tech achievements can greatly promote economic development [1, 2]. At present, all countries in the world are actively adjusting their strategies to seize the commanding heights [3] of industrialization of sci-tech achievements. There are many scientific discoveries and technological breakthroughs around the world every year, and very few of them have been successful in industrialization. China has ranked first in the number of global patent applications for many years, but the level of industrialization is significantly behind that of developed countries. One of the very important reasons is that the current pre-evaluation work for the industrialization of sci-tech achievements in my country is not in place.

Pre-evaluation is the prerequisite and basic work for the industrialization of sci-tech achievements [4, 5]. The implementation of effective pre-evaluation can not only distinguish the promising projects, promote project establishment, and optimize resource allocation but also propose improvement directions and measures for unsatisfactory projects, laying the foundation for later project establishment [6].

The pre-evaluation of the industrialization of local sci-tech achievements refers to the scientific and technological management activities in which the competent department of sci-tech employs peer experts to review and evaluate the sci-tech achievements in accordance with the prescribed forms and procedures and make corresponding appraisal conclusions. It is suitable for China's national conditions at this stage, the government's macromanagement of sci-tech

work means. The main functions of the pre-evaluation of the industrialization of local sci-tech achievements are as follows: it can distinguish the authenticity of sci-tech achievements and provide credible appraisal opinions for the market; review the sci-tech achievements and evaluate the advanced nature, innovation, novelty, and practicability of sci-tech achievements; affirmation and encouragement of scientific research achievements of sci-tech personnel; to provide the necessary basis for sci-tech awards, enjoying relevant policies and scientific research projects; to evaluate the scientific research and development strength of scientific research institutes; and it marks the end of a scientific research project cycle and provides appraisal conclusions for the end. It is of great significance to correctly judge the quality and level of sci-tech achievements through pre-evaluation, promote the improvement of sci-tech achievements, encourage sci-tech personnel to actively carry out sci-tech innovation activities, accelerate the transformation of sci-tech achievements, and promote economic and social development.

2. Characteristics and Study Method of Pre-Evaluation of Industrialization Project of Sci-Tech Achievements

Grasping the basic laws of the industrialization project of sci-tech achievements is a prerequisite for building a pre-evaluation index system and promoting the industrialization level.

2.1. Characteristics and Laws of Industrialization Projects. The transformation of science and technology into actual productivity is a common concern in the world today. The industrialization of sci-tech achievements has both scientific and economic nature and has certain regularities in itself. The industrialization process of sci-tech achievements can be roughly divided into four stages, namely, the market forecasting stage, the achievement generation stage, the achievement transfer stage, and the achievement use stage [7–9]. The connotation of the stages and the relationship between them are shown in Figure 1.

The industrialization project of sci-tech achievements has the following basic characteristics: First, the direct purpose of the industrialization project of sci-tech achievements is to obtain economic benefits. Second, sci-tech achievements are the results of innovation and are differentiated, but they are inseparable from technological development paradigm, so it has its own regularity [10, 11]. Third, it requires continuous advancement, which may lead to the failure of the whole project if one link is interrupted. Fourth, it contains multiple links and various elements, and it is bound to be promoted in a combined way. Lastly, the whole process is faced with a variety of high risks, such as technical risks, market risks, and business risks, and at the same time, it should be of high profitability.

Summarizing the experience of industrialization at home and abroad, the key conditions for the industrialization of sci-tech achievements are as follows: to ensure the allocation

of high-quality talents, sufficient funds, and other key elements; to meet the market demand so that the achievements can be transformed into economic benefits; and the government should issue the necessary policies to support and protect them and create a good environment for industrialization [12–14].

2.2. The Pre-Evaluation of the Industrialization Projects. The pre-evaluation of sci-tech industrialization project is a complicated and systematic work. The comprehensive evaluation of sci-tech achievements can be obtained from the evaluation process, evaluation indicators, evaluation criteria of evaluation indicators, and evaluation results of various content (indices). On the whole, the pre-evaluation methods, processes, standards, and priorities for technological industrialization projects are different for different institutions at home and abroad [15, 16].

2.2.1. Pre-Evaluation Features of Foreign Achievement Industrialization. The main subjects of pre-evaluation of sci-tech achievement industrialization projects abroad are large-scale technology companies, venture capital companies, and bank credit institutions. Different subjects have different pre-evaluation processes and evaluation focuses [17, 18]. The details are as follows: as the large technology companies, its first step is feasibility assessment, focusing on the assessment of technical and economic feasibility, operational feasibility, and compatibility with future enterprise production and operation activities. The second step is the technical evaluation, which is a complete and reasonable inspection of the process design and technical scheme of the transformation results from a microscopic point of view. The third step is economic evaluation, forecast economic costs, and expenditures and to see whether the project or technology has a good application prospect, to ensure that the benefits can cover the costs and expenditures. The fourth step is risk assessment to identify the probability and degree of impact of the risk.

The Venture Capital Company. There are basically four stages for the venture capital company: the first stage is mainly to understand whether the project is in line with the company's investment policy and strategy; the second stage is mainly to inspect the project management and core personnel and to initially verify the authenticity of the main indicators considered and to find out what needs to be improved; the third stage is mainly based on the indicators for a more comprehensive and detailed evaluation; the fourth stage is the decision-making stage, which comprehensively evaluates the results of the detailed investigation. The key factors to be considered in decision-making are the quality of leaders, market demand, innovation of products and technologies, and the return on investment. Regarding the key points and indicators of the investigation, several sets of index values and weights will be given for projects in different industries and at different stages of development in combination with their operational experience and theoretical analysis.

FIGURE 1: Chart of the basic process of industrialization of science and technology achievements.

Concerning the bank credit institutions, banks and other institutions have not yet formed a unified index system. Although there are different views, the five aspects of morality, ability, capital, mortgage, and environment are generally recognized (see Table 1).

2.2.2. Pre-Evaluation Features of Domestic Achievement Industrialization. The pre-evaluation of the industrialization projects of sci-tech achievements in China is mainly based on the pre-evaluation of commercial bank loans and the project evaluation of the industrialization of sci-tech achievements in various regions.

As for the commercial bank, at present, China's state-owned commercial banks mainly focus on the credit status and financial strength of the enterprises applying for loans. They have paid insufficient attention to the market prospects and development potential of the project itself. As a result, some high-quality projects have lost their industrialization opportunities due to the lack of corporate financial resources, and they cannot effectively promote the industrialization of sci-tech achievements [19–22].

As for the local provinces, some provinces and cities in China have explored and established pre-evaluation standards and related systems for the industrialization of sci-tech achievements, taking Qinghai Province and Yunnan Province as examples. Qinghai Province adopts a comprehensive evaluation method combining peer review with analytic hierarchy process. The evaluation index system for project establishment mainly includes five aspects: enterprise development capabilities, the feasibility of project technical scheme, product markets, business models, and economic benefit evaluation. In Kunming of Yunnan Province, the evaluation index system of the major science and technology projects mainly includes two parts: technology and management evaluation and economic and financial evaluation. In the evaluation, due to the different development stages of the project application enterprises, the indicator system is slightly different.

2.2.3. Deficiency in China. Although more comprehensive evaluation and selection methods and procedures have been formed in many places of China, and good results have been

TABLE 1: The main indexes of the pre-evaluation of foreign bank credit institutions.

Index category	Purpose and focus of the investigation
Moral character	Mainly to evaluate the borrower's ethical code of conduct.
Ability	Mainly the ability to make profits and repay borrowings.
Capital	The company's overall financial strength is usually measured by its net worth (total capital-total liabilities).
Mortgage	Refers to the collateral that the borrower should provide as a guarantee for repayment. Mainly to evaluate the feasibility of the borrower to provide collateral. The collateral provided by the borrower must be able to guarantee the creditor's rights.
Environment	Evaluate the internal and external business environment in order to make prejudgment in advance and take measures when necessary to ensure the security of loans.

achieved, there are still a series of problems and deficiencies, which are prominently shown as follows:

- (i) The evaluation index system is not comprehensive enough. Judging from the research results in the field of index system, the pre-evaluation in China still focuses on the evaluation of science and technology itself and economic benefits, and the nontechnical factors that have a significant impact on the success or failure of the project, such as the project implementing team, are insufficiently reflected.
- (ii) The design of the evaluation system is not strongly pertinent. Most of the existing evaluation systems do not fully involve relevant indicators of economic benefits, social benefits, and industrialization levels and do not distinguish well between national-level technology industrialization projects and local technology industrialization projects.
- (iii) There is a lack of targeted research on evaluation methods and models. There are many evaluation methods in the existing research, and evaluation methods and models emerge in an endless stream, but there is a lack of targeted research and methodology research.
- (iv) The utilization of pre-evaluation value is insufficient. Most of the pre-evaluation results are still used in project selection and elimination, and deep-level value mining is not sufficient.
- (v) The legal protection mechanism is not sound enough. Most regions mainly inherit legal protection mechanism of national overall pre-evaluation. Due to the particularity of the pre-evaluation of technological industrialization projects, the existing relevant legal system cannot form a targeted legal protection for pre-evaluation.
- (vi) The overall research level lags behind that of foreign countries. The domestic research obviously lags behind the foreign research progress, and the domestic research literature mainly focuses on tracking research and the application of ready-made methods, lacking the evaluation theory and method research for the industrialization project of scientific and technological achievements and the operation characteristics of scientific and technological system in China, and the evaluation for the local scientific and technological industrialization project is also less.

Due to the differences between the industrialization project of local sci-tech achievements and the industrialization project of general sci-tech achievements, the local government pays more attention to the economic value and social value brought by the industrialization project of sci-tech achievements, the contribution to the optimization of the local industrial structure and the promotion of the competitiveness of the core industry, and the impact on the tax revenue and employment of the local industry. Therefore, in view of the fact that the existing pre-evaluation index of the industrialization project of local sci-tech achievements is not accurate and easy to realize the evaluation operation, this paper constructs an objective and standard evaluation index system, makes the ideal index system realistic, and can carry out quantitative processing, to ensure the rationality, objectivity, and fairness of the index comparison results. At the same time, in view of the lack of organic combination of qualitative or quantitative research methods used in the pre-evaluation of the industrialization project of sci-tech achievements, this paper adopts more effective quantitative statistical methods to conduct more detailed and in-depth evaluation and analysis of the industrialization project of sci-tech achievements and establish a normalized monitoring system covering comprehensive data and statistical basis.

2.3. Pre-Evaluation Method of Industrialization Project of Local Sci-Tech Achievements. There are many comprehensive evaluation methods with its own advantages and limitations, and each method has its own scope of application. The conventional comprehensive evaluation methods mainly include index method, efficiency coefficient method, optimal distance method, and queuing method; modern comprehensive evaluation methods include multiple statistical evaluation methods, operations research evaluation methods, systems engineering evaluation methods, intelligent evaluation methods, etc., which have developed rapidly in recent years. Principal component analysis (PCA) and factor analysis (FA) are multisystem evaluation methods, which are objective methods that do not rely on expert judgment. Therefore, the interference and influence of human factors in the evaluation can be eliminated, and they are more suitable for evaluating each other. The comprehensive evaluation of the target system with a greater degree of relevance ignores the actual importance of the indicators and overemphasizes the objectivity of the indicator data, and the evaluation conclusions are relative. Usually, PCA and FA

emphasize that the information contained in the evaluation index is independent and uncorrelated. If there is a certain correlation between the evaluation indexes (neither completely independent nor completely related), it will bring great inconvenience to the research. If too many indicators are selected, it will increase the difficulty and complexity of the analysis. If too few indicators are selected, the indicators that have a greater impact on the sample may be missed, which will affect the reliability of the results.

In this study, when establishing the pre-evaluation index system of the industrialization project of local sci-tech achievements, there are certain restrictions on the requirements of the correlation among the indexes, and considering that there are many uncertain concepts which cannot be measured objectively, so the use of principal component analysis and factor analysis are abandoned. Both the efficacy coefficient method and the comprehensive index method are applicable to target systems with clear goals or reference systems. The industrialization projects of local sci-tech achievements cannot be measured by a unified standard because of the differences in the scale, nature, and characteristics of the evaluation objects; therefore, it is impossible to get the ideal evaluation results through these two evaluation methods. It is difficult for the queuing method to precisely quantify the evaluation content and can only distinguish the superior and inferior order. The evaluation value of the optimal value distance method is based on the optimal value of a single index, when the optimal value deviates far from the general level, the evaluation result is easily influenced by the extreme value (the optimal value), making the gap between the evaluation results of most units not obvious. TOPSIS evaluation method is a common method used in multi-objective decision analysis of limited schemes in systems engineering. It finds the optimal scheme and the worst scheme among the limited alternatives and obtains the relative closeness of each evaluation object to the optimal scheme, which is used as the basis of pros and cons of evaluation. While the scope of application of data envelopment analysis is limited to multi-input and multioutput object systems, the gray relational analysis law requires the sample data to have the characteristics of time series.

The pre-evaluation of the local sci-tech achievement industrialization project in this article cannot meet this condition, and the gray relational analysis method only distinguishes the pros and cons of the project evaluation and cannot reflect the absolute level. Rough set theory is a mathematical method to deal with ambiguity and uncertainty. It does not require any prior information besides processing data. It cannot provide the weight distribution of system attributes based on objective information. Fuzzy comprehensive evaluation is also a mathematical method, which can effectively analyze and process all kinds of inaccurate, incomplete, and uncertain information. In the evaluation process, some fuzzy factors can be considered, and various factors can be used to evaluate things. On the basis of determining the degree of membership, the analytic hierarchy process is used to determine the index weight. This method has both strict quantitative description and qualitative description of fuzzy phenomena that are difficult to

quantitatively analyze. It is a very effective multifactor decision-making method that closely combines qualitative description and quantitative analysis.

The pre-evaluation of industrialization projects of local sci-tech achievements studied in this paper is affected by many factors, including both quantitative and qualitative indexes. It is necessary to combine various influencing factors to make a comprehensive evaluation of local sci-tech achievement industrialization projects, and multilevel fuzzy comprehensive evaluation method has good applicability on this issue. There is no strict requirement for data, and the method is simple and easy to operate. Therefore, this paper will use this method to pre-evaluate the industrialization project of local sci-tech achievements.

3. Construction of Pre-Evaluation Index System

3.1. Construction Process. There is no uniform procedure and steps for the pre-evaluation process of the industrialization of sci-tech achievements, but generally speaking, it roughly includes the following seven stages:

- (i) Making sure the evaluation objective and scope: according to the main objectives and functions of the industrialization of sci-tech achievements, national (regional) sci-tech development objectives, social development objectives, etc., the evaluators will analyze and study the main influencing factors listed in this method and find the most influential factors as the evaluation objectives.
- (ii) Selection of evaluation indicators: according to the types and characteristics of the project itself, scientific and reasonable evaluation indicators are selected, including qualitative indicators and quantitative indicators.
- (iii) Preliminary evaluation of the project: based on the survey and forecast data, conduct a preliminary evaluation of the project to see whether the various indicators of the project meet the minimum requirements for evaluation, especially whether they meet the national and industrial policies, environmental protection requirements, consumer safety, and other screening indicators.
- (iv) Evaluation of the selected projects in detail: for the projects qualified in the preliminary evaluation, the projects will be evaluated in detail according to the indicators of the evaluation system and comprehensive evaluation will be carried out.
- (v) Comprehensive evaluation of the project: the detailed evaluation results of the project are synthesized to obtain a comprehensive evaluation value, and then the comprehensive evaluation value is made to select the best project with the highest evaluation value.
- (vi) Organizing expert seminars: for valuable projects, expert seminars are organized to modify and improve the project plan based on expert opinions with a summary report.

- (vii) Evaluation summary: summarize the whole evaluation work, put forward the evaluation conclusion, and write the summary report.

According to the above basic steps, the basic process of pre-evaluation industrialization projects of local sci-tech achievements is preliminarily designed, as shown in Figure 2.

3.2. Principles of Constructing. The design of pre-evaluation index system is the key content of the whole pre-evaluation system design. The selection of index determines the focus of future evaluation, and the design of index system will affect the rationality of pre-evaluation results to a great extent. The design of the index system should be scientific, standardized, and reasonable. On the basis of the following, the law of sci-tech achievements and drawing lessons from the new evaluation system at home and abroad, especially the pre-evaluation index design experience of venture capital industrialization project of sci-tech achievements, and combining with the development conditions and characteristics of China's current industry, this paper discusses and designs a set of scientific, normative, and comprehensive index system suitable for China a pre-evaluation index system integrating operability. The construction principle of pre-evaluation index system is reflected in the following aspects:

- (i) Scientific principles: scientificity is reflected in the correctness and maturity of scientific theory, the maturity and feasibility of the technology line, and the standardization and advanced degree of research methods.
- (ii) The principle of usability: the usability of technology describes the difficulty and universality of technology. If the technology is used under harsh conditions, the risk will increase. The investigation of technology applicability includes the following: the number of technology applicable industries; whether technology is restricted by national conditions, geographical conditions, and natural resources; whether the technology is compatible with the existing standards and products in the market; and whether the technology can be flexibly applied or improved to meet the needs of the market.
- (iii) The principle of feasibility: feasibility refers to the probability that the product (or technical service) formed by the industrialization of sci-tech achievements can play its specific function without failure under the specified conditions and within the specified time. It requires the improvement of engineering technology and product technology. High-tech production is to seek its supporting and perfect engineering technology and product technology, and product performance needs to reach the feasibility standard.
- (iv) The principle of cost-effectiveness: the products formed by the projects based on the industrialization of sci-tech achievements belong to high-tech

products with high added value. The success of the industrialization project largely depends on the profitability of products and services. It is necessary to analyze the excess returns that can be obtained by the investment of capital, the return on equity investment, the return on equity investment, and the return on equity investment. This paper analyzes the factors such as the gross profit rate of products and services that reflect the profit margin of the project, and the relevant indicators established according to the criteria directly reflect the profitability of the venture capital the industrialization project of sci-tech achievements.

In addition, in the pre-evaluation of the industrialization of local government sci-tech achievements, it is necessary to discuss one matter for special situation.

3.3. Establishment of Pre-Evaluation Index System. When establishing the index system, this article refers to relevant research materials, according to the characteristics of industrialization projects of local sci-technological achievements, combined with the influencing factors of general sci-tech evaluation, comprehensively using expert investigation methods, correlation analysis, and discriminative analysis based on the principles of comparability and operability, comprehensiveness and representativeness, hierarchy and system, scientificity, and accuracy. Six first-level indicators and twenty-five second-level indicators were selected, and the evaluation index system of local sci-tech achievements is completed in Table 2.

4. Principle of Fuzzy Analytic Hierarchy Process

In 1965, Zaden [23] proposed fuzzy set theory, which laid the foundation for fuzzy set theory and application research, marking the birth of fuzzy mathematics. In the 1980s, Saaty [24] first proposed the analytic hierarchy process (AHP) to solve some complex and difficult problems. Fuzzy analytic hierarchy process (FAHP) is a multifactor and multilevel composite method based on AHP. It can be divided into two categories: based on fuzzy number and based on consistent judgment matrix. The basic idea and steps of FAHP are consistent with the AHP proposed by Saaty, but the difference is that it considers the fuzziness of human judgment. Firstly, the research objectives are dealt with hierarchically; then, the fuzzy number or fuzzy function is used to describe the judgment, and the fuzzy judgment matrix is constructed to obtain the relative weight of each factor; secondly, defuzzification and normalization are carried out; and finally, the weight of the index is obtained to solve the decision of complex problems. Compared with the traditional weight determination method, FAHP can improve the objectivity of the weight. In addition, because the pre-evaluation of industrialization project of local sci-tech achievements involves many interrelated elements, many elements cannot be explained quantitatively by simple data. FAHP's advantages not only can systematically combine qualitative analysis with quantitative analysis to solve complex problems but also can

FIGURE 2: Flowchart of pre-evaluation of industrialization of sci-tech achievements.

directly and effectively combine the objective judgment results of decision-makers and decision analysts, and it is easy to calculate, simple and clear, and easy to be accepted by people to systematize, mathematicise, and model the decision-maker's thinking change process. Therefore, this study uses FAHP to study the pre-evaluation of industrialization project of local sci-tech achievements, which is scientific and applicable. The specific steps are as follows.

4.1. Construction of Evaluation Factor Set. The factor set of the evaluation system is established. The evaluation system is set as U , $U = \{u_1, u_2, \dots, u_n\}$. It is the factor set. Among them, u_i refers to the i^{th} research object that has an influence on the system.

4.2. Determination of the Set of Weights. AHP analyzes the factors and the related relationships that are contained in the complex system, organizes and hierarchizes the problem, constructs a hierarchical analysis structure model, compares the elements of each level in pairs, and obtains the relative importance according to a certain scale theory. Comparing the scale and establishing a judgment matrix, calculating the maximum eigenvalue of the judgment matrix and its eigenvector, and obtaining the order of importance of each level element to an element of the upper level, thereby a weight vector was established.

After the establishment of the evaluation index system, the membership relationship between the indicators at the lower and lower levels is determined. Pairwise comparison is made for the importance of the indicators at the same level to

TABLE 2: Pre-evaluation index system of local sci-tech achievement industrialization project.

Total index	First-level index	Second-level index
The evaluation system for the industrialization of local scientific and technological achievements	Policy environment X_1 (0.1038)	Industrial policy compliance X_{11} (0.3406)
		Environmental policy X_{12} (0.2088)
		Industrial policy conformity X_{13} (0.4506)
	Technical performance X_2 (0.2008)	Technical economy X_{21} (0.1268)
		Technical innovation X_{22} (0.5321)
		Technical feasibility X_{23} (0.1718)
		Technical risk X_{24} (0.1693)
	Economic benefits X_3 (0.4216)	Direct economic benefit X_{31} (0.3054)
		Indirect economic benefit X_{32} (0.2851)
		Rationality of economic structure X_{33} (0.0871)
		Improve product quality X_{34} (0.2251)
		Improve labor productivity X_{35} (0.0973)
	Resource guarantee X_4 (0.1668)	Human resources X_{41} (0.3302)
		Fund protection X_{42} (0.3101)
		Facilities and equipment conditions X_{43} (0.0803)
		Industrialization conditions X_{44} (0.1846)
		Research basis X_{45} (0.0948)
		Entrepreneurship X_{51} (0.0784)
	Organizational guarantee X_5 (0.0661)	Corporate governance structure X_{52} (0.2013)
		Market operation ability X_{53} (0.2013)
		Management capability X_{54} (0.5190)
		Promotion of regional industries X_{61} (0.5324)
	Social benefits X_6 (0.0409)	Impact on tax revenue X_{62} (0.1688)
		Impact on ecology and resources X_{63} (0.1269)
		Impact on employment opportunities X_{64} (0.1719)

obtain the pairwise comparison coefficient to form a judgment matrix. Set n second-level indicators $s_1, s_2, \dots, s_n$, and the constructed judgment matrix R is given by

$$R = (s_{ij})(s_{ij})_{n \times n} = \begin{bmatrix} s_{11} & s_{12} & \dots & s_{1n} \\ s_{21} & \ddots & \vdots & \vdots \\ \vdots & \dots & \ddots & \vdots \\ s_{n1} & s_{n2} & \dots & s_{nn} \end{bmatrix}. \quad (1)$$

Among them, s_{ij} represents the importance of s_i relative to s_j , which is represented by numbers from 1 to 9 in pair-to-pair comparison. This scale is adopted in matrices to determine the weights of relative criteria and to compare the alternatives linked to every criterion. Table 3 summarizes the basic ratio scale. All final weighted coefficients are shown in matrices. Alternatives and criteria can be ranked based on the overall aggregated weights in the matrices. The alternative with the highest overall weight would be the most preferable.

TABLE 3: Saaty's scale for AHP pairwise comparisons [25, 26].

Weight	Description
1	Equal importance
3	Moderately more important
5	Strongly more important
7	Very strongly more important
9	Dominant importance
2, 4, 6, 8	Reciprocals

Based on this first index's judgment matrix, the weights of every first grade index can be calculated by the geometric calculation method of mean.

$$\bar{w}_i = \sqrt[n]{\prod_{j=1}^n s_{ij}}, \quad (i = 1, 2, \dots, n). \quad (2)$$

Then make the normalized processing, using the following equation:

$$w_i = \frac{\overline{w_i}}{\sum_{i=1}^n \overline{w_i}}, \quad (i = 1, 2, \dots, n). \quad (3)$$

The weight vector of first index is obtained as follows: $w = (w_1, w_2, \dots, w_n)^T$.

The largest characteristic roots $\lambda_{\max}$ can be calculated by the following equation:

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^n \frac{(AW)_i}{W_i}, \quad (i = 1, 2, \dots, n). \quad (4)$$

However, due to the extreme complexity of objective things, the influencing factors of subjective understanding occasionally cannot entirely meet the requirement of consistency. Thus, checking the matrix for consistency is necessary, and the process is as follows.

The consistency ratio requirements are as follows: $CR = (CI/RI) < 0.1$. $CI = \lambda_{\max}/n - 1$. The mean random consistency index (RI) is shown in Table 4.

4.3. Establishment of Evaluation Set. Several evaluation sets were selected to form an evaluation set $V = \{v_1, v_2, \dots, v_m\}$, and the evaluation criteria were divided into m grades.

4.4. Comprehensive Evaluation. First, the membership R set is calculated according to the opinions and scores of experts. According to equation (5), the comprehensive evaluation value of each level can be obtained. Finally, the evaluation of the project can be obtained through the maximum membership degree method or the weighted average method.

$$B = wR = (w_1, w_2, \dots, w_n) \begin{bmatrix} s_{11} & s_{12} & \dots & s_{1n} \\ s_{21} & \ddots & \ddots & \vdots \\ \vdots & \dots & \ddots & \vdots \\ s_{n1} & s_{n2} & \dots & s_{nn} \end{bmatrix}. \quad (5)$$

According to equation (5), the comprehensive evaluation value of each level can be obtained, and then the final evaluation can be obtained according to equation $G = B \cdot C$.

5. Empirical Analysis

5.1. Case Overview. In recent years, Xiqing District has deeply implemented the Beijing-Tianjin-Hebei Coordinated Development Plan. The economic structure has been continuously optimized, and its comprehensive strength has been at the forefront of Tianjin. For the past few years, Xiqing District has firmly grasped the opportunity of building a national advanced manufacturing research and development base, closely focusing on the Made in China 2025 plan and vigorously upgrading the level of industrial

intelligence, and achieved positive results. Research on artificial intelligence and intelligent networked automobile industry has been carried out. The state-level vehicle network pilot area was approved to build a pilot application scenario and a three-level test system, opening 24.5 km of test road. The six top-end industries, such as electronic information, automobile, and equipment manufacturing, accounted for 74.7 percent of the region's large-scale industries. In 2020, Xiqing District's high-tech manufacturing sector accounted for 26.9 percent of the total value added of large-scale industries.

In order to verify the application of the evaluation model for the industrialization of local sci-tech achievements, this article applies the Internet + smart manufacturing support direction in the first batch of smart manufacturing special fund projects in Tianjin in 2019, and an industrialization project in Xiqing District, research and development of driving scene data management platform for intelligent network vehicle simulation test, was evaluated as an example, and the actual situation of the project is completed to verify the effectiveness of the evaluation results.

5.2. Fuzzy Comprehensive Evaluation. A fuzzy evaluation model is established for this example, which is the total evaluation index and is divided into six first-level indexes: policy environment, technical performance, economic benefits, resource guarantee, organizational guarantee, and social benefits, which are denoted as x_1, x_2, x_3, x_4, x_5 , and x_6 .

According to the cascade theory, the results of the pre-evaluation are divided into five levels, and the corresponding fractionation section is $C = (0, 65, 75, 85, 95)$. The classification standard is shown in Table 5.

After constructing the completed index system, the weight of the index is determined by the analytic hierarchy process (AHP), the relative importance of the index is assigned by experts, and then the weight of the index after each expert's assignment is obtained according to the calculation method in this paper and to the final weight table with its arithmetic mean as an indicator (Table 2).

According to the classification of the evaluation set, 10 experts and representatives of enterprises in the industry were invited to pre-evaluate the project, and the quantitative scores of each secondary index were given. The score result is sorted out, and the score table is shown in Table 6. The numbers in the table represent the number of experts selected for the indicator, and the membership of the indicator is obtained by dividing the number of experts at different levels of each indicator by the total number of experts.

According to Table 6, the set of membership degree R is obtained as follows:

TABLE 4: The mean random consistency index.

Order	2	3	4	5	6	7	8	9	10	11	12	13	14
RI	0	0.52	0.86	1.10	1.26	1.34	1.40	1.43	1.49	1.51	1.54	1.56	1.58

Note. Reproduced from Chang et al. (2016) [25].

$$\begin{aligned}
 R_1 &= \begin{bmatrix} 0 & 0 & 0.1 & 0.6 & 0.3 \\ 0 & 0 & 0.1 & 0.6 & 0.3 \\ 0 & 0 & 0 & 0.5 & 0.5 \end{bmatrix}, \\
 R_2 &= \begin{bmatrix} 0 & 0 & 0.1 & 0.4 & 0.5 \\ 0 & 0 & 0.1 & 0.5 & 0.4 \\ 0 & 0 & 0.1 & 0.6 & 0.3 \\ 0 & 0.1 & 0.2 & 0.5 & 0.2 \end{bmatrix}, \\
 R_3 &= \begin{bmatrix} 0 & 0 & 0 & 0.6 & 0.4 \\ 0 & 0 & 0.2 & 0.5 & 0.3 \\ 0 & 0 & 0 & 0.7 & 0.3 \\ 0 & 0 & 0.1 & 0.5 & 0.4 \\ 0 & 0.1 & 0.2 & 0.5 & 0.2 \end{bmatrix}, \\
 R_4 &= \begin{bmatrix} 0 & 0 & 0 & 0.5 & 0.5 \\ 0 & 0.1 & 0.1 & 0.6 & 0.2 \\ 0 & 0 & 0.1 & 0.7 & 0.2 \\ 0 & 0 & 0.1 & 0.6 & 0.3 \\ 0 & 0 & 0 & 0.6 & 0.4 \end{bmatrix}, \\
 R_5 &= \begin{bmatrix} 0 & 0 & 0 & 0.7 & 0.3 \\ 0 & 0 & 0.1 & 0.6 & 0.3 \\ 0 & 0 & 0.1 & 0.6 & 0.3 \\ 0 & 0 & 0 & 0.4 & 0.6 \end{bmatrix}, \\
 R_6 &= \begin{bmatrix} 0 & 0 & 0 & 0.5 & 0.5 \\ 0 & 0.1 & 0.1 & 0.6 & 0.2 \\ 0 & 0 & 0 & 0.7 & 0.3 \\ 0 & 0 & 0.1 & 0.5 & 0.4 \end{bmatrix}.
 \end{aligned} \tag{6}$$

Combined with the weight values of the second-level indicators in Table 3, the weighted average model $M(\bullet, +)$ and equation (5) are used to calculate the following: $B_1 = w_1 \cdot R_1 = (0, 0, 0.0550, 0.5549, 0.3901)$

It is worth noting here that the model chosen in this paper is the weighted average model because the result of the main factor determining model is determined by the maximum index, the remaining indexes change within a certain range and do not affect the evaluation results, which is suitable for the single optimal case. Although the evaluation results of the main factor prominent model are more detailed than that of the main factor decisive model, they partly reflect the nonmain indexes. In order to make an accurate assessment of the results of the industrialization of sci-tech achievements in this paper, all the indicators in the evaluation index system have different effects on the

TABLE 5: Classification standard.

Rank	Unideal (R_1)	Poor (R_2)	Normal (R_3)	Good (R_4)	Excellent (R_5)
Score	< 60	60–69	70–79	80–94	95–100

assessment results, so the research gives up the other models and chooses the weighted average model [27–29].

Similarly, we can get $B_2 = w_2 \cdot R_2 = (0, 0.0169, 0.1169, 0.5046, 0.3616)$, $B_3 = w_3 \cdot R_3 = (0, 0.0097, 0.0990, 0.5480, 0.3433)$, $B_4 = w_4 \cdot R_4 = (0, 0.0310, 0.0575, 0.5750, 0.3365)$, $B_5 = w_5 \cdot R_5 = (0, 0, 0.0403, 0.5040, 0.4557)$, and $B_6 = w_6 \cdot R_6 = (0, 0.0169, 0.0340, 0.5423, 0.4068)$.

Finally, the membership matrix of the pre-evaluation of the industrialization project of the scientific and technological achievements is as follows:

$$R = \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \\ B_6 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0.0550 & 0.5549 & 0.3901 \\ 0 & 0.0169 & 0.1169 & 0.5046 & 0.3616 \\ 0 & 0.0097 & 0.0990 & 0.5480 & 0.3433 \\ 0 & 0.0310 & 0.0575 & 0.5750 & 0.3365 \\ 0 & 0 & 0.0403 & 0.5040 & 0.4557 \\ 0 & 0.0169 & 0.0340 & 0.5423 & 0.4068 \end{bmatrix}. \tag{7}$$

It can be seen from Table 3 that the weight of first-level indicators

is $w = (0.1038, 0.2008, 0.4216, 0.1668, 0.0661, 0.0409)$.

According to the weighted average model, $B = w \times R = (0, 0.0061, 0.0846, 0.5486, 0.3607)$ is calculated.

Then the pre-evaluation results of the industrialization of the scientific and technological achievements are as follows: $G = B \times C = 87.639$.

5.3. Analysis of Evaluation Results. According to the final evaluation result of the fuzzy and the comprehensive evaluation method, the pre-evaluation result of the industrialization project of the sci-tech achievements is good. In order to evaluate the industrialization project of sci-tech achievements from a comprehensive point of view, so as to facilitate the comparison between similar projects, this paper adopts the grading parameter evaluation method to pre-evaluate the industrialization project of sci-tech achievements. Excellent scores are between 95 and 100, and for this kind of evaluation results of science and technology projects, the key guidance and support should be given, as the driving force of local economic development, to promote the development of industrialization. Good is 80 to 94 points, and for this kind of evaluation results of science and technology projects, local governments and science and technology management should focus on support, but the fund support

TABLE 6: Local sci-tech achievement industrialization project pre-evaluation evaluation table.

First-level index	Second-level index	Unideal	Poor	Normal	Good	Excellent
Policy environment X_1	x_{11}	0	0	1	6	3
	x_{12}	0	0	1	6	3
	x_{13}	0	0	0	5	5
Technical performance X_2	x_{21}	0	0	1	4	5
	x_{22}	0	0	1	5	4
	x_{23}	0	0	1	6	3
	x_{24}	0	1	2	5	2
Economic benefits X_3	x_{31}	0	0	0	6	4
	x_{32}	0	0	2	5	3
	x_{33}	0	0	0	7	3
	x_{34}	0	0	1	5	4
	x_{35}	0	1	2	5	2
Resource guarantee X_4	x_{41}	0	0	0	5	5
	x_{42}	0	1	1	6	2
	x_{43}	0	0	1	7	2
	x_{44}	0	0	1	6	3
	x_{45}	0	0	0	6	4
Organizational guarantee X_5	x_{51}	0	0	0	7	3
	x_{52}	0	0	1	6	3
	x_{53}	0	0	1	6	3
	x_{54}	0	0	0	4	6
Social benefits X_6	x_{61}	0	0	0	5	5
	x_{62}	0	1	1	6	2
	x_{63}	0	0	0	7	3
	x_{64}	0	0	1	5	4

should be different from the former type of projects, which can promote the development of project industrialization. Generally, the score is 70 to 79 points, and for this kind of evaluation results of the project, the inspection should be focused. Industrialization support can still be given when the project time is ripe and conditions are met. Projects with a pre-evaluation result of less than 70 points, in principle, do not obtain support. At the same time, based on the evaluation results, local governments and science and technology management departments can provide targeted guidance and assistance, environment and security-independent innovation for the majority of small- and medium-sized enterprises for independent innovation. In this paper, the comprehensive evaluation of the industrialization project of sci-tech achievements selected in this paper is good. When the project was approved, the experts unanimously agreed that the technical route of the project was reasonable, the budget of the industrialization project was scientific, and the economic and social benefits were obvious.

The evaluation results of the case analysis in this article are consistent with the actual situation, verifying the effectiveness of the evaluation method. By pre-evaluating the industrialization projects of local sci-tech achievements by local governments and science and technology management departments, on the one hand, the study can greatly reduce the risk of sci-tech project management, allow qualified sci-tech industrialization projects to be implemented, and optimize the allocation of sci-tech funds. On the other hand,

according to the evaluation results, the research puts forward guidance, suggestions, and improvement directions for sci-tech industrialization projects with unsatisfactory evaluation results, so as to lay the foundation for future projects.

6. Conclusions

- (i) This research is based on the analysis of the characteristics and laws of the industrialization of sci-tech achievements, the pre-evaluation of the importance of the industrialization of local sci-tech achievements, and the analysis of research methods. The evaluation index system has been established from six aspects: policy environment, technical performance, economic benefits, resource guarantee, organization guarantee, and social benefit. Comprehensive evaluation was carried out by using FAHP, which reduced the economic and policy risks in the industrialization of sci-tech achievements, increased the selection rate of industrialization projects, and provided a reliable basis for local governments to realize the industrialization of sci-tech achievements.
- (ii) FAHP is used to determine the weights of the factors affecting the pre-evaluation of the industrialization of local sci-tech achievements, which has strong objectivity and operability. This method effectively combines the objective judgment of the decision-

maker and the decision analyst and realizes the systematization, mathematization, and modeling of the decision-maker's thinking change process.

- (iii) Through the pre-evaluation of the industrialization of the smart manufacturing project in Xiqing District of Tianjin, the overall evaluation of the project is good and consistent with the actual evaluation results. The local government and technology management should guide and support as a driving force for local economic development and industrialization development. At the same time, verifying the reliability of the model has a certain guiding role in the industrialization of local scientific and technological achievements.
- (iv) The pre-evaluation research of industrialization projects of local sci-tech achievements has important practical significance. While reducing the project management risks of local sci-tech management departments, local sci-tech achievements can be managed according to the evaluation results, and the sci-tech achievements can be managed accordingly. Industrialization projects have a certain guiding role. However, the establishment of the pre-evaluation index system for the industrialization of local sci-tech achievements cannot be accomplished overnight. It will change with the evaluation environment and the objectives of the project establishment unit. This requires continuous improvement in future research and practice to make the pre-evaluation system more targeted and the evaluation results more effective, so as to provide a reference for the industrialization of local sci-tech projects.
- (v) Sci-tech innovation has become the first driving force to lead the development. Sci-tech progress and sci-tech achievements will play a core role in the modern economic system and social development. In the transformation of sci-tech achievements, the role positioning of governments, universities, institutions, enterprises and intermediaries, multi-party games, and cooperation mechanisms in the pre-evaluation system still needs to be further studied.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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