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Evaluation Indicators System Construction and Instances Research On Scientific and Technological Talents based on Entropy and Unascertained Measurement Model

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Abstract:

The indicator system is simplified with entropy weight measurement, including personal knowledge, ability, performance, and contributions, based on the growth characteristics of basic, applied, and achievement researchers, with basic researchers as the research objective. The evaluation model of science and technology talents is established with unascertained theory in this study. The key factors affecting science and technology talents are identified using the new model, which could provide a theoretical basis for comprehensively mastering science and technology talent work and effectively judging the trend of talent development.

Keywords: Evaluation system of scientific and technological talents, entropy weight, unascertained measurement model, instances research

1 Introduction

A scientific talent evaluation strategy is the key to discovering talent and stimulating the innovation vitality of scientific and technological personnel, and it is a practical problem that must be addressed immediately in today's society's development. Economically developed western countries are primarily based on the concept and method of science and technology talent evaluation to form a relatively efficient evaluation mechanism. For example, in Britain, the evaluation system consists primarily of "developmental evaluation concept" and "staff review and development plan" at Cambridge University [1], in the United States "peer review" is carried out and tenure professor of colleges, and in Germany, they follow the dynamic evaluation concept [2]. In China, research has primarily focused on evaluation system development and methods [3–5]. Based on different perspectives and using different methods, this study focuses on competitiveness, development efficiency, agglomeration, policy efficiency, development environment, and other aspects.

The discussion and research on the evaluation of scientific and technological talents in academic circles can be summarized from the following two perspectives.One is to conduct research on the evaluation method of scientific and technological talents. Analysis hierarchy process (AHP) [6], fuzzy comprehensive evaluation [7] and entropy right [8] are the main evaluation methods. In the concrete implementation process, the qualitative evaluation method represented by peer review is mainly adopted, supplemented by bibliometric method. Second, to carry out the evaluation index system construction research on the evaluation of scientific and technological talents in different industries, different types of institutions and different stages of development. Hu Lizhe et. explored the establishment of an evaluation index system for high-level scientific and technological talents in the field of natural resources, focusing on the four aspects of moral character, performance and influence, innovation quality and contribution, and quality, and put forward the evaluation method of "moral issues with one vote veto + other dimensions according to grade" [9]. Zhang yu for innovative science and technology talents, build the quality characteristics, ability characteristics and performance characteristics for level indicators, basic quality, knowledge structure, personality traits, experience, innovation ability, management ability, innovation, social recognition, actual benefit for the secondary index talent classification evaluation index system, and put forward the talent classification evaluation Suggestions [10]. Niu Guiqin and others divided young scientific and technological talents into five categories: basic frontier research, social public welfare research, applied technology development and achievement transformation, science communication, and science and technology management, and constructed an evaluation index system [11] for young scientific and technological talents including development potential, influence, important positions, social benefits and other indicators.Tian Jun combined with the actual needs of scientific and technological talents evaluation in Shanxi Province and the construction needs of "Belt and Road" construction, and constructed the evaluation index system of scientific and technological talents from the dimensions of innovation knowledge, innovation motivation, innovation ability and output performance[13].

The above related studies have enriched the understanding of all sectors of society on the evaluation of scientific and technological talents from different perspectives, and have positive enlightening significance for the practice of the evaluation of scientific and technological talents. However, in general, the above studies mostly analyze problems and put forward suggestions from the local or micro perspective, but less from the systematic or overall perspective. The relationship between the evaluation of scientific and technological talents and the environment and the relevant elements of the evaluation of scientific and technological talents has not received enough attention. This paper jumps out of the evaluation activity of scientific and technological talents, tries to construct the framework of the evaluation system of scientific and technological talents, puts forward the problems faced by the evaluation of scientific and technological talents and the corresponding improvement ideas from the systematic perspective, so as to improve the overall efficiency of the evaluation of scientific and technological talents. By constructing a multiple evaluation indicators system, the entropy measurement method is used to rank the importance of qualitative factors and calculate the weight, so that the evaluation results are objective, true and reliable, and simplify and clarify the evaluation process. The research results are expected to provide countermeasures and theoretical support for improving the evaluation system and mechanism of scientific and technological talents in China.

2 Basic Theories and Methods

2.1 Entropy Weight Measurement to Simplify Talent Evaluation Indicators System

The value of each evaluation indicator is distinguished based on the concept and principle of entropy weight measurement. Information entropy measures individual diversity. For a given indicator system, the larger the entropy, the higher the difference in the evaluation value and the higher the comparative effect of the indicator on the evaluation object. This indicates that the indicator could provide more useful information to decision-makers [13]. However, if each indicator value is similar or equal, the indicator entropy is close or equal to the maximum, and the indicator has no ability to distinguish the object evaluation comparison at this time. Therefore, entropy rights are introduced based on entropy to measure the evaluation and differentiation ability of each indicator. The smaller the entropy right, the smaller the differentiation ability of the indicator.

Many scholars have used the entropy weight to evaluate talents, most of which is used to weigh each indicator [14,15]. This study is different, and the entropy weight is mainly used to eliminate indicators with weak distinguishing abilities to ensure more objective evaluation results. The calculation steps are as follows:

(1) Calculate the indicator standard value y_{ij} as follows:

$$y_{ij} = \frac{X_{ij}}{\sum_{i=1}^{i=m} X_{ij}} \quad (1)$$

(2) Calculate the indicator entropy value b_j as follows:

$$b_j = -k\sum_{i=1}^{m} y_{ij} \ln y_{ij} \quad (2)$$

(3) Calculate the indicator entropy weight w_{bj} as follows:

$$w_{bj} = \frac{1 - b_j}{\sum_{j=1}^{j=n}(1 - b_j)} \quad (3)$$

where y_{ij} indicates the standard value, x_{ij} indicates the indicator value, b_j indicates the indicator entropy value; $k = 1/\ln m$, n is the number of indicators, and m is the number of samples.

2.2 Using the Unascertained Measurement Theory to Evaluate Scientific and Technological Talents

The unascertained measurement model [16] uses a certain number in [0,1] to indicate the unascertained state of objects. The measurement function was rigorously constructed, and the evaluation results were excellent and reliable. In this model, the evaluation indicators are divided into several grades, and we can obtain the unascertained measurement of indicators in different grades using measure functions, obtain the comprehensive measure of different evaluation objects, and rank the evaluation objects based on the evaluation criteria.

(1) Unascertained measurement of a single indicator.

Let the object set $X = \{ X_1, X_2, \cdots, X_n \}$, where the i^{th} evaluation object is X_i. Let the indicator set $I = \{I_1, I_2, I_3, \ldots, I_m\}$, where the j^{th} evaluation indicator is I_j. X_{ij} represents the j^{th} evaluation indicator value of the i^{th} object. Let the grade set $U = \{ U_1, U_2, \cdots, U_p \}$, where the k^{th} evaluation grade is U_k. When the k^{th} evaluation was better than the $k+1^{th}$ evaluation, it was recorded as $U_k > U_{k+1}$. When $U_1 > U_2 > \cdots > U_p$ or $U_1 < U_2 < \cdots < U_p$, $\{U_1, U_2, \cdots, U_p\}$ is considered as an orderly segmentation class of the set U.

$u_{ijk} = u(X_{ij} \in U_k)$ represents the attribution degree of x_{ij} to the k^{th} grade, and the following is formulated:

$$0 \le u(X_{ij} \in U_k) \le 1 \quad (4)$$

$$u(X_{ij} \in U) = 1 \quad (5)$$

$$u(X_{ij} \in U_{i=1}^{k} U_i) = \sum_{i=1}^{k} u(X_{ij} \in U_i) \quad (6)$$

where $i=1, 2, \cdots, n$, $j=1, 2, \cdots, m$, $k=1, 2, \cdots, p$. Specifically, formula (4) indicates "non-negative boundedness," formula (5) indicates "normalization," and formula (6) indicates "additivity." u that satisfies formulas (4)–(6) is an unascertained measure. When u cannot satisfy formulas (5) and (6), it is considered theoretically unreliable.

The membership of each indicator to every evaluation grade comprises a matrix $(u_{ijk})_{m\times p}$, which is called the unascertained measurement matrix of a single indicator.

$$(u_{ijk})_{m\times p} = \begin{bmatrix} u_{i11} & u_{i12} & \cdots & u_{i1p} \\ \vdots & & \ddots & \vdots \\ u_{im1} & u_{im2} & \cdots & u_{imp} \end{bmatrix} \quad (7)$$

(2) Calculation of the weight of each indicator

To eliminate bias owing to individual preferences, the information entropy method was used to calculate the indicator weights. Set: the weight w_{ij} represents the contribution degree of the indicator I_j *of* X_i, and it satisfies$0 \le w_{ij} \le 1$, $\sum_{j=1}^{m} w_j = 1$, and the importance degree y_{ij} represents the importance of the indicator I_j to evaluate X_i. These values were calculated as follows:

$$y_{ij} = 1 + \frac{1}{lgp} \sum_{k=1}^{p} u_{ijk} \cdot lg u_{ijk} \quad \textbf{(8)}$$

$$w_{ij} = \frac{y_{ij}}{\sum_{j=1}^{m} y_{ij}} \quad \textbf{(9)}$$

Vector $W_i = \{w_{i1}, w_{i2}, w_{i3}, \ldots, w_{im}\}$ is the indicator weight vector of the object X_i.

In the calculation, when $u_{ijk}=1$, $lg u_{ijk}=0$.

(3) A comprehensive measurement evaluation vector of multi-indicators is as follows:

Set:

$$u_{ik} = u(Xi \in U_k) = \sum_{j=1}^{m} w_{ij} u_{ijk} \quad (8)$$

and $0 \le u_{ik} \le 1$, $\sum_{j=1}^{m} u_{ik} = 1$, then, $\{u_{i1}, u_{i2}, \ldots, u_{ip}\}$ is the comprehensive measurement evaluation vector of multi-indicators of X_i.

(4) Confidence identification criteria

The evaluation grade was determined based on the confidence identification criteria. For the orderly segmentation of evaluation space U, it is unscientific to judge the maxima and minima of the evaluation vector based on the multi-indicator comprehensive measure. Set the general value of the confidence degree λ:$0.5\le\lambda\le1$. For the orderly segmentation $U=\{U_1, U_2, \cdots, U_p\}$, when $U_1>U_2>\cdots>U_p$ or $U_1<U_2<\cdots<U_p$, if k_0 satisfies:

$$k_0 = min\left\{k: \sum_{i=1}^{k} u_i \ge \lambda, k = 1, 2, 3, \dots, p\right\} \tag{9}$$

then, the object X_i belongs to the k_0^{th} evaluation grade U_{k0}.

In addition, the same method can be used to evaluate the other two types of scientific and technological talent. Attention and different types of scientific and technological talent evaluations are based on different samples, and the unascertained weights of different indicators would be different to realize the variable weight evaluation of the evaluation system for different types of talent.

3 Instances Application

3.1 Establish an Evaluation Indicators System for Talents

As research objects for existing scientific and technological researchers, 7,254 research teachers from superior universities and certain basic platforms were selected to collect data from these scholars, including the organization's internal and external data. Basic and academic information as well as data on social activities were statistically analyzed. Following cleaning, processing, sorting, and analysis of the data, 14 level-1 and 48 level-2 indicators related to the evaluation and assessment of scientific and technological talents were obtained, and a broad evaluation indicator set was determined.

According to formulas (1)–(3), using Mathematica 12.3, the entropy and entropy weights were calculated for all indicators. Subsequently, indicators with very small entropy weights are removed, and a simplified evaluation indicator system is developed, which contains four level-1 and twenty four level-2 indicators, as shown in Table 1.

1Table 1. Evaluation Indicators System Of Scientific And Technological Talents Simplified with The Entropy Weight Measurement

Level-1 Indicators	Level-2 Indicators
Knowledge hierarchy	Age
	Educational background
	Foreign visit experience
	Technical title
	Professional relevance
Research ability	Post position
	Academic position
	Glories
	Social positions
	Academic part-time
Research performance	Recent representative papers
	H-index

Level-1 Indicators	Level-2 Indicators
	High-level papers
	Recent national projects
	Recent provincial projects
	Applied patents
	Granted patents
	Standard / Software copyright
	National awards
	Provincial awards
	Work performance
Research contribution	Collaborative ability
	Years in this major
	Funding amount / bring benefits

3.2 Determine the grading criteria of the evaluation indicators

This study divides the science and technology talent evaluation into five grades from high to low, based on literature research and investigation analysis: *I* (outstanding), *II*(leading), *III*(excellent), *IV*(potential), *V*(general). The 24 indicators were divided into 14 quantitative indicators and 10 qualitative indicators, and a classification range was formulated. The grading criteria for some indicators are listed in Tables 2 and 3.

2Table 2. Quantitative Indicators Grading Criteria for Scientific and Technological Talents

Evaluation Indicator	I(U_1)	II(U_2)	III(U_3)	IV(U_4)	V(U_5)
Age I_1	<35	[35,40)	[40,45)	[45,50)	>50
Study abroad experience I_3(year)	> 5	[5,3)	[3,2)	[2,1.5)	<1
Number of recent representative papers on I_{11}	>10	[10,5)	[5,3)	[3,1)	<1
H index number I_{12}	>50	[50,30)	[30,10)	[10,5)	<5
		......			
Funding amount / bring benefit I_{24}(million)	>5	[5,3)	[3,1)	[1,0.5)	<0.5

3Table 3. Qualitative Indicators Grading Criteria for Scientific and Technological Talents

Evaluation Indicator	I(U_1)	II(U_2)	III(U_3)	IV(U_4)	V(U_5)
Score range	1–0.8	0.8–0.6	0.6–0.4	0.4–0.2	<0.2
Academic degree I_2	Doctor	Master	Scholar	No Education	
Technical title I_4	Senior	Sub-senior	Medium	Junior	No title

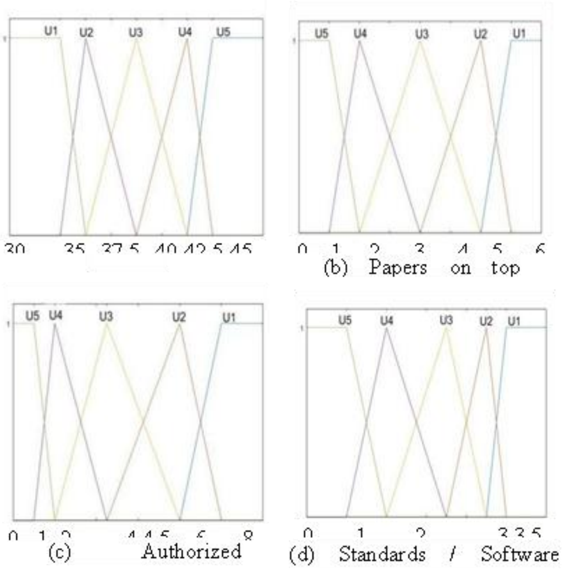
Evaluation Indicator	I(U_1)	II(U_2)	III(U_3)	IV(U_4)	V(U_5)
Score range	1–0.8	0.8–0.6	0.6–0.4	0.4–0.2	<0.2
Professional correlation degree I_5	Higher	High	Low	Lower	uncorrelated
		......			
Collaborative ability I_{22}	Very outstanding	Excellent	Good	Commonly	Up to standard

3.3 Evaluation of the instance X_1

As an example, consider the technology personnel X_1. He is 36 years old, has a Ph.D., a senior professional title, has no experience studying abroad, has recently published 20 academic papers, five top journals papers, a H index of 9, a professional correlation of 0.78, two national projects and six upgrade projects in recent years, 13 patents, ten authorized patents, nine standards/software rights, no national awards, one upgrade award, engaged in the job for 6 years, has no administrative position, no academic position, outstanding collaborative ability, and bringing in funding amount/ benefits of 4.62 million yuan.

(1) Building a single-indicator measure function:

According to the definition of a single indicator measure function, set the interval maximum (or minimum) of level *I* indicators, interval average of level *II* and level *III* indicators, and interval minimum (or maximum) of level *IV* indicators as classification standards, and establish single indicator measure functions of all indicators, including age, education, study abroad experience, technical title, and recent representative papers. Limited to space, only a part of the measurement functions is displayed here, as shown in Figure 1.



1Figure 1. Single Indicator Measure Functions of a Part of Indicators

(2) Building a single indicator measure matrix:

By incorporating scientific and technological personnel information into single-indicator measure functions, a personnel evaluation measure matrix can be obtained. This measurement function was built based on a linear model. The single-indicator measurement matrix is as follows:

$$(u_{ijk})_{24\times 5} = \begin{bmatrix} 0.6 & 0.4 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0.5 & 0.5 & 0 & 0 & 0 \\ 0.4 & 0.6 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0.4 & 0.6 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.12 & 0.88 & 0 \\ 0 & 0.5 & 0.5 & 0 & 0 \\ 0 & 0 & 0.333 & 0.667 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0.6 & 0.4 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 \\ 0.4 & 0.6 & 0 & 0 & 0 \\ 0.25 & 0.75 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.2 & 0.8 \\ 0.62 & 0.38 & 0 & 0 & 0 \end{bmatrix}$$

(3) Calculate the indicator weights:

The weight of each indicator can be calculated according to formulas (8) and (9), as shown in Table 4, where y represents the degree of significance and w represents the weight.

4Table 4. Evaluation Indicators Values of technology personnel X_1

Indicator	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}
y	0.5818	1	1	0.5693	0.5818	1	1	0.5818	1	1	1	0.772
w	0.0301	0.0517	0.0517	0.0294	0.0301	0.0517	0.0517	0.0301	0.0517	0.0517	0.0517	0.0399
Indicator	I_{13}	I_{14}	I_{15}	I_{16}	I_{17}	I_{18}	I_{19}	I_{20}	I_{21}	I_{22}	I_{23}	I_{24}
y	0.5693	0.6047	1	0.5818	1	1	1	1	0.5818	0.6506	0.6891	0.5874
w	0.0294	0.0312	0.0517	0.0301	0.0517	0.0517	0.0517	0.0517	0.0301	0.0336	0.0356	0.0304

The indicator weight vector is:

W = （0.0301, 0.0517, 0.0517, 0.0294, 0.0301, 0.0517, 0.0517, 0.0301, 0.0517, 0.0517, 0.0517, 0.0399, 0.0294, 0.0312, 0.0517, 0.0301, 0.0517, 0.0517, 0.0517, 0.0517, 0.0301, 0.0336, 0.0356, 0.0304）

(4) Multi-indicator comprehensive measurement evaluation vector:

According to formula (10), the evaluation vector is as follows:

U =(0.3725, 0.1443, 0.0816, 0.1147, 0.2869)

(5) Confidence identification:

Considering confidence degree λ=0.5. According to the confidence evaluation criteria, the multi-indicator comprehensive measure evaluation value is calculated from large to small based on formula (11), K_0=0.3725+0.1443=0.5168>0.5. Similarly, the value is calculated from small to large as K_1= 0.2869+0.1147+0.0816+0.1443=0.6275> 0.5. The results of the discrimination are consistent; therefore, this scientific and technological personnel belong to level *II* , the leading talent.

3.4 Evaluation of the instances X_2 and X_3

According to the aforementioned analysis method, two other technology personnel were evaluated using the unascertained theory. The measured data for X_2 and X_3 are as follows:

Personnel X_2 is 46 years old, Ph.D., sub-senior professional title, seven recently published academic papers, two top journals papers, H index is 5, professional correlation is 0.76, one provincial project in recent years, three patents, two authorized patents, engaged in the job for 16 years, good collaborative ability, bringing funding amount/bring benefits of 80 thousand yuan.

Personnel X_3 is 40 years old, has a Ph.D., a sub-senior professional title, has recently published 20 academic papers, 20 top journal papers, has a H index of 19, a professional correlation of 0.88, two national projects and two provincial projects in recent years, engaged in the job for eight years, excellent collaborative ability, and bringing in funding amount/ benefits of 1.3 million yuan.

According to formulas (8) and (9), the weight of each indicator can be calculated, as shown in Table 5 and Table 6, where *y* represents the significance degree and *w* represents the weight.

5Table 5. Evaluation Indicators Values of technology personnel X_2

Indicator	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}
y_2	0.6204	1	1	0.5693	0.6204	0.5693	1	1	1	1	0.7197	1
w_2	0.031	0.0499	0.0499	0.0284	0.031	0.0284	0.0499	0.0499	0.0499	0.0499	0.0359	0.0499

Indicator	I_{13}	I_{14}	I_{15}	I_{16}	I_{17}	I_{18}	I_{19}	I_{20}	I_{21}	I_{22}	I_{23}	I_{24}
y_2	1	1	0.6047	0.6047	1	1	1	1	0.5693	0.5693	0.5818	1
w_2	0.0499	0.0499	0.0302	0.0302	0.0499	0.0499	0.0499	0.0499	0.0284	0.0284	0.029	0.0499

6Table 6. Evaluation Indicators Values of technology personnel X_3

Indicator	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}
y_3	0.5693	1	1	0.5693	0.798	1	1	0.5693	1	1	1	0.8268
w_3	0.0275	0.0483	0.0483	0.0275	0.0386	0.0483	0.0483	0.0275	0.0483	0.0483	0.0483	0.0399

Indicator	I_{13}	I_{14}	I_{15}	I_{16}	I_{17}	I_{18}	I_{19}	I_{20}	I_{21}	I_{22}	I_{23}	I_{24}
y_3	1	0.6047	0.6047	1	1	1	1	1	1	1	0.5818	0.5738
w_3	0.0483	0.0292	0.0292	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0483	0.0281	0.0277

According to formula (10), the evaluation vector is as follows:

$$U_2=(0.0734, 0.0943, 0.0754, 0.1876, 0.5693)$$

$$U_3=(0.1934, 0.1417, 0.0959, 0.1229, 0.4461)$$

Considering confidence degree λ=0.5. According to the confidence evaluation criteria, the multi-indicator comprehensive measure evaluation values were calculated using formula (11) from large to small and vice versa. Then, X_2 is determined as general talent, and belongs to level *V*, X_3 is determined as potential talent, and belongs to level *IV*.

3.5 Analysis of evaluation results

The comprehensive weights based on the above evaluation by scientists X_1, X_2, and X_3 were compared and analyzed, as shown in Table 7.

Table 7. Comprehensive Indicators weight of talent X_1, X_2, and X_3

Level-1 Indicators	Level-2 Indicators	Comprehensive weight of X_1	Comprehensive weight of X_2	Comprehensive weight of X_3
Knowledge hierarchy X_1 : 0.193 X_2 : 0.1902 X_3 : 0.1902	Age I_1	0.0301	0.031	0.0275
	Educational background I_2	0.0517	0.0499	0.0483
	Foreign visit experience I_3	0.0517	0.0499	0.0483
	Technical title I_4	0.0294	0.0284	0.0275
	Professional relevance I_5	0.0301	0.031	0.0386
Research ability X_1 : 0.2369 X_2 : 0.228 X_3 : 0.2207	Post position I_6	0.0517	0.0284	0.0483
	Academic position I_7	0.0517	0.0499	0.0483
	Glories I_8	0.0301	0.0499	0.0275
	Social positions I_9	0.0517	0.0499	0.0483
	Academic part-time I_{10}	0.0517	0.0499	0.0483
Research performance X_1 : 0.4408 X_2 : 0.4456 X_3 : 0.4364	Recent representative papers I_{11}	0.0517	0.0359	0.0483
	H-index I_{12}	0.0399	0.0499	0.0399
	High-level papers I_{13}	0.0294	0.0499	0.0483
	Recent national projects I_{14}	0.0312	0.0499	0.0292
	Recent provincial projects I_{15}	0.0517	0.0302	0.0292
	Applied patents I_{16}	0.0301	0.0302	0.0483
	Granted patents I_{17}	0.0517	0.0499	0.0483
	Standard / Software copyright I_{18}	0.0517	0.0499	0.0483
	National awards I_{19}	0.0517	0.0499	0.0483
	Provincial awards I_{20}	0.0517	0.0499	0.0483
Research contribution X_1 : 0.1297 X_2 : 0.1357 X_3 : 0.1524	Work performance I_{21}	0.0301	0.0284	0.0483
	Collaborative ability I_{22}	0.0336	0.0284	0.0483
	Years in this major I_{23}	0.0356	0.029	0.0281
	Funding amount / bring benefits I_{24}	0.0304	0.0499	0.0277

From the above table, it is observed that the weighted sum of research ability and research performance of first-level indicators is more than 65%, and the proportion of research performance is higher than that of research ability, followed by the knowledge hierarchy, and the smallest research contribution.

In the Level-1 indicator research performance, these five indicators, including granted patents I_{17}, standard / software copyright I_{18}, national awards I_{19}, provincial awards I_{20}, and recent provincial projects I_{15} have the highest weight, which is consistent with the current science and technology innovation policy advocating new methods and ideas in our country [17]. The weight of recent representative papers I_{11} is also very high, however the weight of the Level-2 indicators H-index I_{12} and high-level papers I_{13} at the same level is very low, which is consistent with the current national policy of "breaking the four only" [18]. These indicators gradually dilute the proportion of papers and focus more on the representative research results of talent.

In the Level-1 indicator research ability, these three indicators, including academic position I_7, social position I_9, and academic part-time I_{10} have the highest weight, which reflects the importance of peer recognition and academic exchanges. This is closely related to the current talent evaluation system in China, which focuses primarily on peer reviews. Peer experts are relevant professionals and their evaluations are authoritative and credible. Academic exchange activities are an important method for scientific and technology professionals to share their concepts and introduce them, which can significantly promote the progress of science and technology.

In the Level-1 indicator knowledge hierarchy, educational background I_2, and foreign visit experience I_3 had the highest weight. I_2 reflects individual learning, summary, strain, and analysis ability, and is the basic ability. I_3 is related to relevant policies for introducing high-level talent overseas.

In the Level-1 indicator research contribution, the comprehensive weights of all four Level-2 indicators are relatively equal. Scientific research is not a matter of a single person, and it must be completed by a team. Therefore, as scientific and technological talent, business ability is certainly important, however it may also be more important for team building, management, and the cultivation of new talent.

The above analysis shows that the indicator system and relevant weights are consistent with the current relevant policies, and the index weight is reasonable. Therefore, it is effective and feasible to use this unascertained measurement method in the evaluation of scientific and technological personnel.

4 Conclusions

Using the method proposed in this study, 55 scientific and technological personnel have been evaluated successively. It is observed that scientific and technological personnel over 50 years of age primarily belong to leading talents, who have several remarkable achievements, several honors, and heavy reward weight; personnel between 45 and 50 have outstanding achievements in papers and patents, however have few honors and awards, and have difficulty producing academic benefits; personnel between the age of 40 and 45 often have remarkable research performance; and young persons under the age of 40 generally find it difficult to secure various funds.

Through the research, it is found that the new entropy weight evaluation method focuses on the ability characteristics of different scientific and technological talents. For example, the evaluation of scientific and technological talents undertaking major national research tasks needs to pay attention to the solution of the country's major strategic needs, and make important contributions to the undertaking of major national research tasks and the construction of major national scientific and technological infrastructure tasks. The evaluation of basic research talents should not be limited to the evaluation indicators such as papers and scientific research awards, but should focus on the indicators of their academic achievements' innovation, learning and creation ability, subject research ability and other indicators, that is, more attention should be paid to the originality and breakthrough of the innovation achievements of basic research scientific and technological talents. As for the evaluation of applied research and technology development talents, attention should be paid to whether they have the ability of technological innovation and integration, whether there are major technological breakthroughs, and whether the results can produce practical benefits. As for the evaluation of scientific and technological talents in social welfare research, we should focus on the effect of public service, the ability to serve the development of common key technologies in various fields, as well as the social benefits and social satisfaction generated by social welfare research activities.

In view of the above situation, there are several suggestions for the management evaluation of scientific and technological talent.

(1) Building a reasonable training and incentive mechanism for scientific and technological talents is not only conducive to the long-term development of talent, but also to conform to the local scientific and technological strength and economic operation environment, and to ensure that the policy can be smoothly implemented in the future.

(2)Classified measures to actively use scientific and technological talent. To establish and improve the policy guarantee system, we should ensure that talent can be attracted, retained, and developed well, and avoid talent not adapting to the environment. For potential scientific and technological talents, we should focus on providing policy support and long-term development of talent and provide assistance and support projects with strong exploration and high risk.

(3)Focus on the construction and development of the science and technology environment. In the use of talent, we should focus on the overall role of the team, particularly its introduction.

(4) Overcoming the limitations of the use of scientific and technological talents, gradually realizing the mutual certification of all kinds of scientific and technological talents in different regions, reducing the barriers and obstacles to the flow of scientific and technological talents, and realizing the sharing of talents across industries.

Briefly, the evaluation and use of scientific and technological talent is a systematic project that is, a process of deepening reform, promotion, and improvement. Only with the deep integration and coordinated development of the education chain, talent chain, innovation chain, industrial chain, and multi-party linkage we can stimulate the innovation vitality and potential of all types of scientific and technological talents.

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Conflict of Interest

The authors declared that they have no conflicts of interest to this work.We declare that we do not have any commercial or associative interest that represents a conflict of interest in connection with the work submitted.

Data Availability Statement

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

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