Research on the Evaluation System of Innovation Ability of Researchers in the Communication Industry

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Abstract. The key factor for China's communication industry to improve its core competitiveness is to cultivate outstanding talents with innovative ability in the field of communication. This paper takes the employees of telecom operators in China as the research object to establish the indicators of the constituent elements of innovation ability. From the perspective of communication industry researchers, the model of combining analytic hierarchy and fuzzy comprehensive evaluation is adopted to provide a quantitative innovation ability evaluation system for communication industry researchers. This study used SPSS and MATLAB for data measurement.

Keywords: communication industry researchers · innovation ability evaluation system · analytic hierarchy method · fuzzy comprehensive evaluation method

1 Introduction

The communication industry is the technical foundation of various fields in our country and plays a pivotal role in many fields. Innovation in the communication industry occupies an important position for national innovation. The personnel engaged in forward-looking research in the communication industry are the backbone of the country's future innovation. The improvement of national science and technology competitiveness depends on the improvement of the scientific research and innovation ability of such personnel, and needs to be scientifically evaluated [1].

Since the 18th National Congress of the Communist Party of China, General Secretary Xi has repeatedly emphasized that "we must take innovation as the first driving force for development, talent as the first resource to support development, and innovation at the core of the overall development of the country" in his public speeches and reports. It clearly pointed out the view that "only innovators advance, only innovators are strong, and only innovators win".

Starting from exploring the constituent elements of scientific research and innovation ability of researchers in the communication industry, this paper actively explores

P. Qi and Z. Chen (Eds.): ICBDIE 2023, AISR 178, pp. 476–485, 2024.
https://doi.org/10.2991/978-94-6463-238-5_67

and strives to establish a fair, just, scientific and reasonable evaluation system for scientific research and innovation ability. This is not only conducive to the discovery of high-quality scientific and technological talents, but also lays the foundation for the professional evaluation of researchers, which is conducive to creating a fair and just career development atmosphere in the industry. It is of great practical significance for improving the quality of practitioners [2].

2 Significance of Innovation

2.1 The Meaning of Innovation

Innovation refers to the behavior of using existing knowledge and materials to improve or create new things, methods, elements, paths, and environments in a specific environment based on idealized needs or to meet social needs, and can obtain certain beneficial effects. Yu Huadong believes that innovation is the driving force for the economic growth and development of capitalism, and without "innovation", there will be no development of capitalism [3]. In general, innovation is the application of new technologies or methods.

2.2 Importance of Innovation

The Law of the People's Republic of China on Higher Education points out: "The task of higher education is to cultivate high-level professionals with innovative spirit and practical ability, develop science and technology culture, and promote socialist modernization." Therefore, improving the innovation ability of researchers in the communication industry is of great significance to the development of science and technology in the country, the development of higher education, and the growth of individuals.

Yang Yang's article "Research on the Path of Information and Communication Technology to Drive China's High-quality Economic Growth" clearly pointed out the importance of improving the innovation ability of the communication industry. First, the need to build an innovative country and enhance China's comprehensive national strength; Second, it is conducive to improving the comprehensive capability and level of the communication industry as a whole [4].

2.3 Cultivate Innovative Talents

President Xi stressed in the report of the 20th National Congress of the Communist Party of China that we must adhere to the principle that science and technology are the primary productive forces, talents are the primary resources, and innovation is the primary driving force. To this end, it is necessary to take the cultivation of innovative scientific and technological talents as a strategic measure to build an innovative country, and face up to the importance of innovative talents in the pace of the times.

Zhao Wei, Bao Xianhua and others proposed an iceberg model for the evaluation of innovative talents from the perspective of behavioral characteristics, in which the basic factors above sea level include innovative knowledge, innovative skills and influence. Differentiating factors below sea level include innovation capacity, innovation motivation, and management ability. Collins also started from the organizational level, arguing that the competency characteristics of R&D personnel can be divided into three aspects: first, technical ability, followed by personality characteristics, and finally problem-solving ability. In Sui Yifan's "University: How to Cultivate Innovative Talents - and Talk about the Successful Experience of Famous American Universities", it is pointed out that there are four major elements in talent training: clear training goals, scientific training models, potential training objects and excellent cultivators [5]. Therefore, we must also start from these four elements to do a good job in the cultivation of creative talents. In Qiao Wanmin's article "Open Education: A New Perspective on the Training of Innovative Talents", he believes that the use of open education for the cultivation of innovative talents can achieve better results [6].

Cultivating innovative talents is conducive to promoting the progress of the times, and cultivating innovative talents in information and communication engineering can make our country at the forefront of science and technology in the world. Therefore, we hope to promote the cultivation of innovative talents in information and communication engineering and clarify the direction of improvement by exploring the innovation ability of researchers in the information and communication industry.

3 Construction of Innovation Capability System for Researchers in the Communication Industry

Due to the wide range of innovation capability system of researchers in the communication industry, it is affected by multiple factors from various aspects such as index design, data collection and processing, and practical application of models. In order to achieve the rigor of the system and achieve the expected evaluation effect, the systematic principle, the guiding principle, the principle of combining qualitative and quantitative, the principle of multi-subject evaluation and the principle of operability are followed in the process of system design. According to the above principles, we use the onion model to build from the perspective of the employees themselves, and divide the innovation ability into three levels: external, middle and internal, including seven first-level indicators and twenty-seven second-level indicators including innovative knowledge, innovative skills, role targeting, values, self-awareness, innovative quality, and innovation motivation. Table 1 describes the specific model:

Table 1. Indicators of components of innovation capacity

Innovation ability index system for researchers in the communication industry	Outer factors	Knowledge	Basic knowledge system
			Professional knowledge system
			Innovative knowledge system
		Skill	Logical reasoning ability
			Reverse thinking ability
			Hands-on ability
			Invention and creation ability
			Independent learning ability
			Information processing ability
			Integration ability
	Middle-level factors	Role targeting	Life value goals
			Recognize and grasp the rules
		Values	Cooperation spirit
			Value orientation
		Self-awareness	Self-confidence
			Optimism
			Self-analysis
	Inner factors	Quality	Persistence
			Preciseness
			Skepticism
			Responsibility
			Imagination
			Insight
		Motivation	Passion for innovation
			Adventurous spirit
			Initiative
			Curiosity

4 A Method for Evaluating the Innovation Ability of Researchers in the Communication Industry

In order to prevent the interference of human factors in the evaluation process of the innovation ability of researchers in the communication industry, the mode of combining analytic hierarchy method (AHP) and fuzzy comprehensive evaluation method (FCE) is selected. This way has strong logic, practicability and systematic, which can ensure the accuracy and perfection of the system to the greatest extent. This study used SPSS and MATLAB for data measurement.

4.1 Analytic Hierarchy Method (AHP)

In this paper, the analytic hierarchy method is mainly used to determine the weight of each indicator of the model. According to the hierarchical model, the relative importance of the elements in each secondary index is compared and judged by constructing a comparison judgment matrix. Then two pairs of judgment matrices are formed to calculate the index weights.

4.2 Fuzzy Comprehensive Evaluation Method (FCE)

Fuzzy comprehensive evaluation method is mainly used in the verification process of the system. Taking the evaluation index of the hierarchical model as the evaluation index, the FCE questionnaire is produced, and the comprehensive evaluation results of each measured object are calculated according to the ranking weight of each evaluation index obtained by the AHP method according to the results of the recovered FCE questionnaire.

5 Innovation Capability Evaluation Process

5.1 Determine System Weights

In this paper, the analytic hierarchy method (AHP) is used to determine the weight of each evaluation index in the innovation ability evaluation system of researchers in the communication industry, and the specific steps are as follows:

Construct a judgment matrix
In each level of the evaluation system, the importance of each level 2 indicator is determined based on the results of the survey. At the same time, the importance of each index is compared in pairs, according to the 1–9 annotation method, 1 represents the same importance, 9 represents the former is much more important, so as to quantitatively analyze the relationship between the indicators and form the form of a judgment matrix. Aij in the table indicates the importance of Ai compared to Aj. Taking the calculation of innovation skill level as an example, this paper constructs the judgment matrix as follows:

$$\begin{bmatrix} 1.00 & 3.00 & 0.50 & 1.00 & 1.50 & 2.50 & 2.00 \\ 0.33 & 1.00 & 0.25 & 0.29 & 0.33 & 0.50 & 0.40 \\ 2.00 & 4.00 & 1.00 & 2.00 & 2.50 & 3.00 & 2.50 \\ 1.00 & 3.50 & 0.50 & 1.00 & 1.50 & 2.50 & 2.00 \\ 0.67 & 3.00 & 0.40 & 0.67 & 1.00 & 2.00 & 1.80 \\ 0.40 & 2.00 & 0.33 & 0.40 & 0.50 & 1.00 & 1.20 \\ 0.50 & 2.50 & 0.40 & 0.50 & 0.56 & 0.83 & 1.00 \end{bmatrix}$$

Calculate the weights for each metric

In order to calculate the specific weight of each indicator, the hierarchy is sorted by a single level, that is, the maximum feature value and feature vector of the matrix are obtained, the influence degree of each factor of the skill level is determined, and the ranking is determined. In this calculation, we use the square root method to solve the feature vector. Taking the calculation of the innovation skill level as an example, the square root method steps and results are as follows:

Start by calculating the product Mi for each row of the matrix

$$M_i = \prod_{i=1}^{7} q_{ij} \tag{1}$$

$$\text{We can calculate } M_i = \begin{Bmatrix} 11.25 \\ 0.00158 \\ 300 \\ 13.125 \\ 1.92 \\ 0.064 \\ 0.1157 \end{Bmatrix}$$

Next, calculate the nth power root Wi of MI

$$W_i = \sqrt[7]{M_i} \tag{2}$$

$$\text{We can calculate } W_i = \begin{Bmatrix} 1.413 \\ 0.398 \\ 2.258 \\ 1.444 \\ 1.0976 \\ 0.6752 \\ 0.7348 \end{Bmatrix}$$

Normalize the vector, $W = [W_1, W_2, W_3, W_4, W_5, W_6, W_7]$ is a feature vector.

Finally, calculate the maximum characteristic root λmax, $\lambda max = \sum_{i=1}^{7} \frac{AW_I}{nW_i}$.

Table 2. RI Value Table

Degree	1	2	3	4	5	6	7	8
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41

We calculated that λ max = 7.022362.

Consistency testing of matrices

When the judgment matrix has satisfactory consistency, its maximum characteristic root is slightly larger than the short matrix order, and the other characteristic roots are close to zero. This indicates that the conclusion drawn by the AHP method is basically reasonable.

The calculation steps for consistency inspection are as follows:

First, calculate the consistency indicator CI,

$$\mathrm{CI} = \frac{\lambda \mathrm{max} - \mathrm{n}}{\mathrm{n} - 1} \tag{3}$$

$\mathrm{CI} = 0.003727 \neq 0$, then calculate the random consistency ratio CR,

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}} \tag{4}$$

(CR - Random consistency ratio; CI - Calculate consistency indicators; RI - Average random consistency index of judgment matrix).

The RI value table is as shown in Table 2

Through the data in the table, $\mathrm{CR} = 0.002824 < 0.1$, which indicates that the matrix has a relatively satisfactory consistency, proving that the operation of the pairwise judgment matrix is reasonable. The weight distribution of other indicators can be calculated in the same way.

Determination of combination weight

The composite weight refers to the degree of influence of each secondary indicator on the highest-level indicator. Based on the weight of the secondary indicators for the primary indicators calculated above, we measured the weight of the primary indicators and the highest-level indicators. Multiplying the two will determine the composite weight value of each element. The specific calculation results are as shown in Table 3.

5.2 Fuzzy Comprehensive Evaluation

Regarding the evaluation system for communication industry researchers that has already been established, a study was conducted on employees of China Mobile, China Telecom, and China Unicom using the FCE questionnaire. The questionnaire uses the Likert 5-level grading principle to indicate the degree of completion of employees in that indicator, with L1, L2, L3, L4, and L5 representing very good, good, fair, poor, and very poor, respectively. By statistically analyzing and calculating the evaluation results,

Table 3. Weight Distribution of Innovation Capability Indicators

Target layer	Criterion layer		Indicator layer		
	Target	Relative weight	Target	Relative weight	Absolute weight
Innovation ability	Knowledge	0.0955	Basic knowledge system	0.2631	0.0251
			Professional knowledge system	0.5472	0.0522
			Innovative knowledge system	0.1897	0.0181
	Skill	0.1426	Logical reasoning ability	0.1761	0.0251
			Reverse thinking ability	0.0496	0.0071
			Hands-on ability	0.2815	0.0401
			Invention and creation ability	0.1801	0.0257
			Independent learning ability	0.1368	0.0195
			Information processing ability	0.0842	0.012
			Integration ability	0.0916	0.0087
	Role targeting	0.0946	Life value goals	0.3125	0.0296
			Recognize and grasp the rules	0.6875	0.1153
	Values	0.1677	Cooperation spirit	0.4167	0.0699
			Value orientation	0.5833	0.0789
	Self-awareness	0.1353	Self-confidence	0.3302	0.0447
			Optimism	0.4929	0.0667
			Self-analysis	0.1769	0.0323
	Quality	0.1826	Persistence	0.1626	0.0297
			Preciseness	0.1316	0.024
			Skepticism	0.1641	0.03
			Responsibility	0.1158	0.02115
			Imagination	0.2343	0.0428
			Insight	0.1915	0.03473

(*continued*)

Table 3. (*continued*)

Target layer	Criterion layer		Indicator layer		
	Target	Relative weight	Target	Relative weight	Absolute weight
	Motivation	0.1814	Passion for innovation	0.2917	0.053
			Adventurous spirit	0.2083	0.0378
			Initiative	0.2917	0.0529
			Curiosity	0.2083	0.0378

a fuzzy relationship matrix was obtained. Based on the maximum membership degree principle, the corresponding evaluation levels of employees of China Mobile, China Telecom, and China Unicom were 88, 83, and 76 points. This result is similar to the result obtained by the Analytic Hierarchy Process, indicating that the system constructed in this paper can reasonably and scientifically reflect the level of employees' innovation ability. Using this system to evaluate communication industry researchers can provide certain constructive opinions subjectively, which is conducive to communication industry researchers evaluating their own innovation level and reasonably strengthening certain areas.

6 Conclusion

This article explores the innovation ability of communication industry researchers by constructing an evaluation system from the perspective of practitioners. From the perspective of seven primary indicators and twenty-seven secondary indicators, the Analytic Hierarchy Process and the fuzzy comprehensive evaluation method were used to comprehensively evaluate the innovation ability of communication industry researchers, ensuring the completeness and rationality of the analysis. This can accurately judge the development level of the innovation ability of communication industry researchers and make up for their shortcomings, strengthen the innovation ability of employees in a targeted manner, and improve the overall level and quality of China's communication industry.

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