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Research on Quantitative Evaluation Model of Railway International Talents Competence

Jing JIN[1, a, *], Yuxin Jiang[2, b], Wen HUANG[3, c]

[1, 2] China Academy of Railway Sciences Corporation Limited, China
[3] Guangzhou Hejin Jiayuan Real Estate Development Corporation Limited, China
[a] 65254631@qq.com, [b] 1191863631@qq.com, [c] 663689567@qq.com
*corresponding author

ABSTRACT. Based on the competency theory, this paper analyzes and summarizes the current situation of railway international personnel training, establishes the competency model of railway international talents, selects Delphi method, AHP, Fuzzy and 360-degree evaluation method according to its characteristics, and introduces the triangular fuzzy function theory to determine the index weight, so as to provide a comprehensive quantitative evaluation method of railway international talents competence. It can provide quantitative reference for the recruitment, selection, training and allocation of international talents for railway enterprises.

KEYWORDS: International talents, Competency model, Quantitative evaluation

1. Introduction

The concept of “competence” originated in the field of American psychology. [1] In the early research, the definition of competency only includes knowledge, skills and attitude. Later, with further research, it includes personal characteristics, social motivation and value. But these extensions are difficult to quantify analysis, and change or improve through specific training, which is not formed in a short time either. Although competency theory has formed a relatively mature definition of talent quality, which is widely used in education, business and other fields and obtained the good achievement, it has not been extensively used in the railway industry.

2. Current Situation of Training International Railway Talents

At present, the specialty of railway talents is concentrated on engineering, and more than 80% of them are railway engineering and technical professionals. There is a short supply for talents who are familiar with China's railway technical standard system, grasp more than one major and have international vison.

According to the national “Belt and Road” initiative and the strategic need for railway enterprises to expand the international market, China Railway Corporation has taken the lead in international training since 2015, aiming at improving English proficiency and expanding international business. The training requires the trainees to have a certain language foundation, teaching English speaking, reading, writing, listening and translation with College English textbooks. However, the training content is not directly linked to the work, and this kind of cramming teaching is difficult to achieve comprehensive improvement in short term. It is of vital importance to decide what kinds of competency should be improved through training.

3. Competency Model of Railway International Talents

The research object of this paper is railway international operation and management talents. The competency indexes come from three different channels: research literature, recruitment advertisement and event interview. By summarizing, screening and classifying various sources of competency indexes, and soliciting experts' opinions, an international talent competency directory is formed. Then, based on literature research, case analysis and event interview, different indexes are sorted, integrated and classified according to three categories of knowledge, skills and professional quality, forming international competency indexes system with three first level indexes and 15 secondary indexes. The final model is shown in Figure 1.

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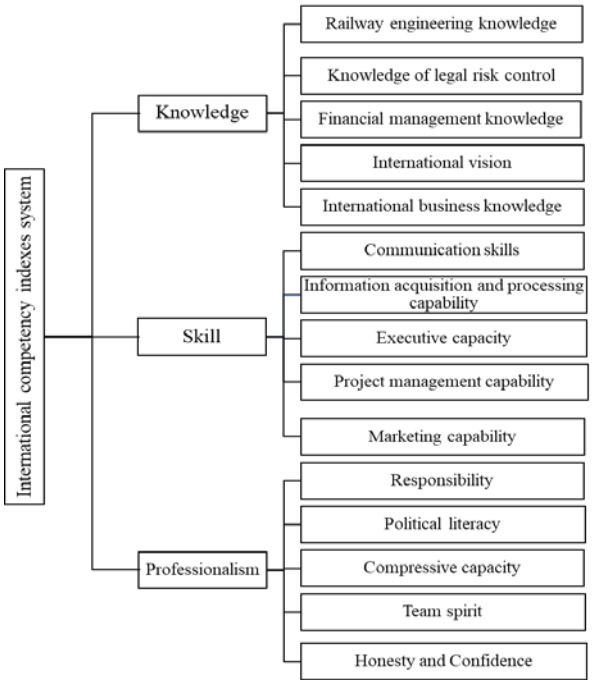

Fig.1 Competency Model of Railway International Operation and Management Talents

4. Quantitative Evaluation of Competency Model of Railway International Talents

This paper puts forward with a competency model for railway international talents through constructing the judgment matrix by Delphi method, the Triangular fuzzy function theory, and analytic hierarchy process Then, 360-degree evaluation method is adopted to determine the evaluation group members with different weights. Finally, the fuzzy comprehensive evaluation method is used to comprehensively evaluate the value of competency for international talents.

4.1 Constructing Triangular Fuzzy Judgment Matrix

The Delphi method is used to let experts compare the importance of each level indexes in the international competency model according to their own experience. According to the rules of 1-9 scale method and the triangular fuzzy function theory, the traditional single relative importance value is transformed into a fuzzy numerical interval with upper and lower bounds.

If there are n evaluation indexes, the constructed triangular fuzzy judgment matrix is $B=(b_{ij})_{n\times n}$, where, $b_{ij}=[l_{ij},m_{ij},u_{ij}]$ is a closed interval with m_{ij} as the median.

If K experts participate in the evaluation, b_{ij} is a comprehensive triangular fuzzy number, and its value is obtained from the following formula. [2]

$$b_{ij}=\frac{1}{K}\otimes\left(b_{ij}^{1}+b_{ij}^{2}+.....+b_{ij}^{k}\right)\quad\left(k=1,2,...,K\right)\qquad(1)$$

4.2 Constructing Fuzzy Evaluation Factor Matrix r

Then the established triangular fuzzy judgment matrix is mathematically changed to obtain the fuzzy evaluation factor matrix R as follows.

$$R=\begin{bmatrix} 1 & 1-\frac{u_{12}-l_{12}}{2m_{12}} & \cdots & 1-\frac{u_{1n}-l_{1n}}{2m_{1n}} \\ 1-\frac{u_{21}-l_{21}}{2m_{21}} & 1 & \cdots & \cdots \\ \cdots & \cdots & 1 & \cdots \\ 1-\frac{u_{n1}-l_{n1}}{2m_{n1}} & \cdots & \cdots & 1 \end{bmatrix} \quad (2)$$

4.3 Calculating and Adjusting Judgment Matrix q

$Q=M\times R$ (3)

Where, matrix M is the matrix composed of all the median values in triangular fuzzy judgment matrix.

Then, the matrix Q is transformed into the judgment matrix with diagonal l according to columns, which is denoted as judgment matrix P, then $P=(p_{ij})_{n\times n}$, and $P_{ij}=1/p_{ji}$ is satisfied. [0][2]

4.4 Hierarchical Single Ranking and Consistency Tests

Each row of elements in P is continuously multiplied to the n-th power to get the vector $W^*=(w_1^*,w_2^*,\ldots,w_n^*)^T$.

$$w_i^* = \sqrt[n]{\prod_{j=1}^{n} p_{ij}} \quad (4)$$

W * is normalized to obtain the weight vector.

$$W_i = w_i^* / \sum_{i=1}^{n} w_i^* \quad (5)$$

Sum the elements of each column in P to get the vector $S=(s_1,s_2,\ldots,s_n)$.

$$s_j = \sum_{i=1}^{n} p_{ij} \quad (6)$$

Calculate the maximum eigenvalue λ_{max}.

$$\lambda_{max} = SW = \sum_{i=1}^{n} \frac{(PW)_i}{nW_i} \quad (7)$$

The formula of consistency test is as follows.

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (8)$$

$$CR = \frac{CI}{RI} \quad (9)$$

RI is the random consistency index, which is related to the matrix order n.

The smaller the CR, the greater the consistency. When CR is less than 0.1, it means that the consistency test is passed. At this time, the above feature vector is the final indexes weight. If the consistency test fails, the original judgment matrix must be modified until the consistency test is passed. [3]

4.5 Hierarchical Total Ranking and Consistency Tests

From top to bottom, calculate the weight of all factors in the same level for the overall goal.

Suppose that the k-1 level has the weight of n factors for the overall goal. $w^n= (w_1^n,w_2^n,\ldots,w_j^n,w_n^n)^T$.

There are m factors in the k-level, and the weight of the upper level factor j under the single criterion, $q^m=(q_{1j}^m,q_{2j}^m,\ldots,q_{mj}^m)^T$

Then the total weight of all factors under factor j in the K level is as follows.

$$W_j = W_n * q_m \tag{10}$$

Assuming that there are n sub-indexes in the k level, all consistency test indexes of the k level are calculated, $CI_k=(CI_1^{(k-1)},CI_2^{(k-1)},\ldots, CI_n^{(k-1)})$; $CR_k=CR_{(k-1)}+CI_k/RI_k$.

When $CR_k<0.1$, it shows that all levels of indicators have good consistency within the k-level range, and the above weights are the final indexes weights. [3]

4.6 Determining Evaluation Indexes and Rating Level

Determining the evaluation indexes set U, then determining the comment set is V. Using six-degree method to measure competency, and the competency level is defined as C, $C\in[0,5]$, Corresponding to the level from low to high, then the evaluation grade V = {level 1, level 2, level 3, level 4, level 5}. In order to facilitate calculation, enterprises can give each grade corresponding specific score when using the model. [4]

4.7 Determining the Evaluation Group and Weight

Based on the principle of 360-degree evaluation method, the railway enterprise determines the personnel composition of the evaluation group according the purpose, occasion, role and the attribute of the evaluated person. The evaluator set is $C= (c_1, c_2,\ldots,c_n)$.Then, give different weights to the evaluators, $W_B=(w_{b1},w_{b2},\ldots,w_{bn})$, the sum of the weight values is 1.

4.8 Constructing Fuzzy Membership Matrix

Based on each evaluation index, the relationship between each evaluator and each index of each evaluation object is determined. The k-th member of the evaluation group scored the h-th index and the j-th level of the i-th person, and obtained the membership matrix Y_i^k of the evaluation indexes.

$$Y_i^k = \begin{bmatrix} y_{i11} & \ldots & y_{i1j} \\ \ldots & \ldots & \ldots \\ y_{ih1} & \ldots & y_{ihj} \end{bmatrix} \tag{11}$$

The y_{ihj} means the result of U_{ip}, which can be rated as the j-level membership degree, and its value is determined by the evaluation score of the evaluation group members. Assuming that there are n members of the evaluation group, n membership matrix is formed.

Then determine indexes weight allocation set as $A=(a_1,a_2,\ldots,a_h)$, $h\in[1,15]$. The value a_i is the index weight W_i calculated in the previous section.

4.9 Establishing Fuzzy Evaluation Model

A comprehensive fuzzy evaluation model for the international competence of the k-th member of the evaluation group for the i-th talent is established as follows.

$$B_i^k = A * y_i^k * V = (b_{i1}^k, b_{i2}^k, ..., b_{ij}^k),\ j \in [1,5] \tag{12}$$

b_{hj}^k is the j-level comprehensive evaluation value of the k-th expert on the h-th main factor.

Then the scoring matrix of the i-th talent is as $B_i = (B_i^1, B_i^2, ..., B_i^k), k \in [1,n]$.

Finally, combined with the determined scoring weight of the evaluation group, the i-th talent's final score is as

follows.

$$Z_i = B_i * W_B \quad (13)$$

The comprehensive evaluation model of the i-th talent and the h single index is as follows.

$$L_i^h = W_B * Y_i^h * V \quad (14)$$

The final level is determined according to the score, Then, the ability level required by all kinds of talents should be clarified. Calculate the competency defect G. The required level of post competency is defined as Cr, and the competency level of individual is defined as Co.

$$G = Cr - Co, G \in [0,5] \quad (15)$$

If G = 0, it proves that the competency meets the requirements of the post and there is no defect, which is the best matching person for the position; CO > CR proves that the individual competency is greater than required by the position.

5. Conclusion

This paper summarizes the current situation and existing problems of the training of international talents in the railway field, establishes the competency model of railway international talents by means of literature research, case analysis and event interview. When the quantitative competency model is constructed, subjective and objective factors taking into account, AHP, Delphi method, 360-degree evaluation method and fuzzy comprehensive evaluation method are selected to comprehensively determine the index weight. The triangular fuzzy function theory is introduced to optimize the selected method according to the characteristics of the model, so as to improve the accuracy of the evaluation results.

Finally, the value for competency of specific international talent is obtained, and the talent competency defects are clarified. This paper can provide reference for quantitative evaluation method to railways enterprises by realizing the accurate matching of international talents and posts in recruitment, selection, training and other areas.

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