Grey Cluster Evaluation Model for Competitiveness of Area Shipping Talent

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Abstract. In the paper, a scientific evaluation system for the competitiveness of shipping talent is given according to the concept of shipping talent and the researched results, and a specific evaluation model is built to evaluate the competitiveness of shipping talent by using Grey cluster and AHP. At last, an example is given to show the effectiveness and practicality of the model.

1. Introduction

In regional shipping economic competition, shipping talents are the most important strategic resources for regional development; the competitiveness of shipping talents constitutes an important part of shipping economy in the region and Plays a decisive role in the competition more and more. In Jiangsu, the shortage of shipping talents, especially senior shipping talents, has severely restricted the rapid development of the shipping industry. Therefore, the competitiveness of regional shipping talents has gradually become the focus of attention of shipping industry in all regions. At present, there is no scientific and complete evaluation index system and evaluation method for evaluating the competitiveness of shipping talents in China.

2. Evaluation Model of Shipping Talents Competitiveness

2.1 Evaluation System.

Deeply research has conducted on the competitiveness of shipping talents and main factors affecting the competitiveness of shipping talents are filtered and designed in this paper, and an evaluation system for the competitiveness of shipping talents is built as shown in table 1.

Tab 1 Shipping talent competitiveness evaluation system

The evaluation index system of shipping talents competitiveness		
Shipping Talent Competitiveness IndexU	Soft environment competitivenessU1	Senior shipping management personnel income level U11
		proportion of added value of shipping companies to GDPU12
		Main business income of shipping companiesU13
		Ratio of per capita consumer spending to incomeU14
	Hard environment competitivenessU2	Number of hospital beds per 10,000 peopleU21
		Number of buses per 10,000 people U22
		Average length of road per personU23
		Average public green area per personU24
		penetration rate of household living water U25
	Scale competitivenessU3	Number of shipping employeesU31
		Ratio of shipping employees to human resourcesU32
		t satisfaction of key shipping talenU33
	Quality and efficiency competitivenessU4	Proportion of Graduates from Shipping UniversitiesU41
		proportion of shipping talents who have obtained master's degree or aboveU42
		average creation value of shipping talents U43
		Percentage of working experience personnel over 5 years U44
		Average throughput of per shipping talent(TEU)U45
	Develop competitivenessU5	Number of Higher Maritime InstitutionsU51
		Number of participating marine vocational trainingU52
		Average public education expenditure per personU53

2.2 Evaluation Index Weight.

In this article AHP are used, proceed as follows:

(1) Constructing judgment matrix: use the 1-9 scale method for a pair wise comparison, construct all judgment matrixes among the 3 first-level indicators and among the second-level indicators under the first-level indicators, here only gives two results of the judgment matrix, see table 2 and table 3

Tab 2 Judgment matrix $U \sim U_i$

	U				
	U_1	U_2	U_3	U_4	U_5
U_1	1	1/2	2	1/3	4
U_2	2	1	3	1/4	1/3
U_3	1/2	1/3	1	1/2	1/3
U_4	3	3	2	1	1/2
U_5	1/4	3	3	2	1

Tab 3 Judgment matrix $U_4 \sim U_{4j}$

	U_4				
	U_{41}	U_{42}	U_{43}	U_{44}	U_{45}
U_{41}	1	1/2	1/3	1/2	2
U_{42}	2	1	1/3	2	1/3
U_{43}	1/4	1/3	1	2	2
U_{44}	2	3	1/2	1	4
U_{45}	1/2	1/2	1/3	1/4	1

(2) Calculating eigenvectors: using computer programming methods. the calculation results are as follows:

$$X = [0.1424 \quad 0.1622 \quad 0.2016 \quad 0.2515 \quad 0.1423] \tag{1}$$

$$X_1 = [0.2801 \quad 0.2119 \quad 0.2302 \quad 0.1808] \tag{2}$$

$$X_2 = [0.1917 \quad 0.1814 \quad 0.1803 \quad 0.1734 \quad 0.1762] \tag{3}$$

$$X_3 = [0.3218 \quad 0.3246 \quad 0.3536] \tag{4}$$

$$X_4 = [0.1619 \quad 0.1422 \quad 0.2021 \quad 0.2504 \quad 0.1464] \tag{5}$$

$$X_5 = [0.3207 \quad 0.3428 \quad 0.3365] \tag{6}$$

(3) Consistency test: by checking the consistency of above five eigenvectors, each eigenvector has satisfactory consistency, so it can be used as a weight vector.

2.3 Comprehensive Evaluation of Competitiveness of Shipping Talents.

Assuming that $V = \{v_2, v_2, \cdots, v_s\}$ is a collection of s kinds of judgments, called a judgment set, this paper uses Likert scale 5, divide the competitiveness level of each secondary evaluation index into 5 levels, V= (v1, v2, …v5) = (strongest, stronger, medium, weaker, weakest), Assign value with 1,2,3,4,5 respectively, which is

$$V = \{v_1, v_2, v_3, v_4, v_5\} = \{1,2,3,4,5\} \tag{7}$$

When it is considered that the competitiveness level of an indicator is between two levels, 1.5, 2.5, 3.5, 4.5 can be assigned.

We now seek expert opinion from q experts on 27 secondary indicators, the expert serial number is $l = 1,2,\cdots,q$, d_{ijl} is the l th expert's five-level assignment to u_{ij} , according to the result of q expert's assignment, a sample matrix D of shipping talent competitiveness evaluation is got (formula 7), Among them, column, is an expert's assignment to each secondary indicator, and row is assigned to a secondary indicator by all experts.

$$D=\begin{bmatrix} d_{111} & d_{112} & \cdots & d_{11q} \\ d_{121} & d_{122} & \cdots & d_{12q} \\ \vdots & \vdots & \cdots & \vdots \\ d_{211} & d_{212} & \cdots & d_{21q} \\ \vdots & \vdots & \cdots & \vdots \\ d_{531} & d_{532} & \cdots & d_{53q} \end{bmatrix} \tag{8}$$

2.3.1 Evaluating Gray-Cluster Whitening Weight Functions.

Setting whitening weight function $f_g(d_{ijl})$ for evaluating grey cluster, the function is defined as following:

First gray class "strongest", function is:

$$f_1(d_{ijl})=\begin{cases} 1 & d_{ijl}\in[0,1] \\ 2-d_{ijl} & d_{ijl}\in[1,2] \\ 0 & d_{ijl}\notin[0,2] \end{cases} \tag{9}$$

Second gray class "stronger", function is:

$$f_2(d_{ijl})=\begin{cases} d_{ijl}-1 & d_{ijl}\in[1,2] \\ 3-d_{ijl} & d_{ijl}\in[2,3] \\ 0 & d_{ijl}\in[1,3] \end{cases} \tag{10}$$

Third gray class "medium", function is:

$$f_3(d_{ijl})=\begin{cases} d_{ijl}-2 & d_{ijl}\in[2,3] \\ 4-d_{ijl} & d_{ijl}\in[3,4] \\ 0 & d_{ijl}\notin[2,4] \end{cases} \tag{11}$$

Forth gray class "weaker", function is:

$$f_4(d_{ijl})=\begin{cases} d_{ijl}-3 & d_{ijl}\in[3,4] \\ 5-d_{ijl} & d_{ijl}\in[4,5] \\ 0 & d_{ijl}\notin[3,5] \end{cases} \tag{12}$$

Fifth gray class "weakest", function is:

$$f_5(d_{ijl})=\begin{cases} d_{ijl}-4 & d_{ijl}\in[4,5] \\ 1 & d_{ijl}\in[5,+\infty] \\ 0 & d_{ijl}\notin[4,+\infty] \end{cases} \tag{13}$$

2.3.2 Gray Evaluation Coefficient, Weight Vector and Weight Matrix Calculation.

The assignment of each expert is treated as a gray number, denoted by d_{ijl}, then $w_{ijg}=\sum_{l=1}^{q} f_g(d_{ijl})$ can be seen the sum of whitening rights of g th gray class, let

$$h_{ijg} = \frac{w_{ijg}}{\sum_{g=1}^{5} w_{ijg}} = \sum_{l=1}^{q} f_g(d_{ijl}) / \sum_{g=1}^{5}\sum_{l=1}^{q} f_g(d_{ijl}), g = 1,2,\cdots,5 \tag{14}$$

Therefore, the evaluation weight matrix can be expressed as:

$$h_i = \begin{bmatrix} h_{i1} \\ h_{i2} \\ \vdots \\ h_{in_i} \end{bmatrix} = \begin{bmatrix} h_{i11} & h_{i12} & \cdots & h_{i15} \\ h_{i21} & h_{i22} & \cdots & h_{i25} \\ \vdots & \vdots & \cdots & \vdots \\ h_{in_i1} & h_{in_i2} & \cdots & h_{in_i5} \end{bmatrix} \tag{15}$$

2.3.3 Comprehensive Evaluation.

Step 1: calculate the weight vector of the first-order index, denoted by following, then

$$Y_i = X_i \bullet H_i = \begin{bmatrix} y_{i1} & y_{i2} & \cdots & y_{i5} \end{bmatrix} \tag{16}$$

Using rows constitute a first-level indicator for evaluation gray class weight matrix:

$$Y = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_5 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{15} \\ y_{21} & y_{22} & \cdots & y_{25} \\ \vdots & \vdots & \cdots & \vdots \\ y_{51} & y_{52} & \cdots & y_{55} \end{bmatrix} \tag{17}$$

Step 2: Calculate value of competitiveness belonging to comprehensive evaluation value of each gray class, denoted by following, then

$$Z = X \bullet Y = \begin{bmatrix} Z_1 & Z_2 & \cdots & Z_5 \end{bmatrix} \tag{18}$$

Step 3: Calculate comprehensive evaluation value, denoted by following, then

$$G = Z \bullet V^T \tag{19}$$

3. Examples

Taking the status of shipping talent in a certain region as an example. Select 5 experts and assign values to each secondary indicator to get a matrix of samples D

$$D = \begin{bmatrix} 2.5 & 3 & 2.5 & 2 & 3 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 2 & 2 & 1.5 & 3 & 2 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 2 & 2.5 & 2 & 3 & 2 \end{bmatrix} \tag{20}$$

According to the above formula, evaluation weight matrix can be got

$$Y = \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \\ Y_4 \\ Y_5 \end{bmatrix} = \begin{bmatrix} 0.1132 & 0.3752 & 0.3627 & 0.2408 & 0 \\ 0.1149 & 0.3759 & 0.3548 & 0.2516 & 0 \\ 0.1147 & 0.3759 & 0.3758 & 0.2411 & 0 \\ 0.1153 & 0.3773 & 0.3674 & 0.2422 & 0 \\ 0.1143 & 0.3765 & 0.3647 & 0.2402 & 0 \end{bmatrix} \tag{21}$$

Then Z can be calculated

$$Z = X \bullet Y = \begin{bmatrix} 0.1148 & 0.3764 & 0.3652 & 0.2406 & 0 \end{bmatrix} \tag{22}$$

At last G can be calculated, $G = Z \bullet V^T = 2.9263$

4. Conclusion

Based on the grey system theory and the AHP evaluation method, it can effectively assess the strength of regional shipping talents' competitiveness, and with operable features, what's more it can be effectively targeted for improvement based on the evaluation results.

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