Research on System of Teaching Evaluation of the Maritime Teachers Based on AHP

Fanyi Kong[1, a], Yang Liu[1, b], Xin Liu[1, c], Xiuping Sui[1, d]

[1]Maritime College, Shan Dong Jiao Tong University, Wei Hai, 264200, China

[a]kfy2006@yeah.net,[b]bgodkissyou@126.com,[c]caxinzaixian@163.com,[d]sui xiuping@126.com

Keywords: Maritime teacher, Teaching Ability, Evaluation, AHP.

Abstract. Maritime teaching is to a special professional education in higher education. The teaching ability of maritime teachers' is directly related to the future of student's professional level. And it is of great significance for navigation class education. But the teaching ability evaluation of many maritime colleges' teachers is subjective without using a simple and scientific method so that their weights aren't established. In the paper, using Analytic Hierarchy Process (AHP), we study with related factors of teaching of maritime teachers and determine the relevant indicators of this evaluation with applying science and reasonable method to evaluate, thus we establish the System of Teaching Evaluation of the Maritime Teachers.

Introduction

With the development of shipping industry, China shipping companies are stepping onto the top of the world stage, but the competition is becoming more and more competition. Especially, China's economy is facing the impact of the international financial crisis so that it is already too great challenges for shipping with shipping enterprises in China facing pressure from the external and internal environment. Nowadays China has become the world's largest exporter of seafarers, therefore the maritime teaching quality problem has been gained by the wide attention of Marine industry. Our country's higher navigation education is to accept the supervision and management by the ministries of education and maritime administration. So the teaching plan should not only meet the requirements of the national academic education, but also need to meet the provisions of the STCW convention and maritime authorities. Maritime colleges and universities, therefore, must establish and implement the correct system of the quality management, and in the case of running efficiently the system, we could guarantee the quality of navigation class teaching so as to ensure the quality of maritime graduates.

In the navigation teaching, teachers' teaching level is one of important indicators to measure teaching quality of the maritime college. And it can directly affect the success of shipping talented person's training work. Therefore, teaching quality evaluation of navigation teachers will be one of the main means in order to guarantee and improve the teaching quality of maritime colleges, so this is a very worthy of study and practice. For maritime teachers teaching evaluation, it should be scientific, comprehensive and fair reflected the real level of teaching to good guide role for the teaching. However, most of the maritime teaching quality evaluation are started from analyzing their qualitative factors at present, and used for combining college's leaders and teams evaluation and student evaluation. Application of fuzzy judgment based on AHP model in the evaluation of teaching quality and The model of teaching evaluation index based on AHP and the other relevant articles are not basic on the maritime teachers teaching evaluation. In this research, the current domestic research is relatively small. So this paper considers the comprehensive maritime teachers teaching related factors using analytic hierarchy process (AHP), and determines the evaluation of the relevant indicators, which applied science and reasonable method to evaluate, thus establishes System of Teaching Evaluation of the Maritime Teachers.

The basic steps of application of AHP

Establish judgment matrix

According to the practical problems, we can establish the hierarchical structure, then the Judgment matrix is gained. Judgment matrix refers to the matrix which reflects the various indexes of the same level factors influence with the upper indexes, and adopts the quantitative method. Then the final results are obtained by comparing with the importance of every index in the same level, and they will be stowed in the corresponding position in the matrix. The comparison of paired index, the estimate of the relative importance of the index j to the index i is recorded for a_{ij}, according to the provisions of the values in table 1. [1,2]

Table 1 the values method of element a_{ij}

Intensity	Explanation
1	Two factors contribute equally to the objective
3	Experience and judgment favor one factor over another
5	Experience and judgment strongly Favor one factor over another
7	An factor is strongly favored and its dominance demonstrated in practice
9	The evidence of favoring one factor over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values when compromise is needed
reciprocal	If the ratio of importance of factors i and j to a_{ij} then the ratio of importance of factors i and j to $a_{ji} = 1/a_{ij}$

According to table 1, building the form of matrix, that is the judgment matrix, that is,

$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{21} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{n4} \end{bmatrix}$. If there is $a_{ij} = 1$, Two factors of A_i and A_j contribute equally to the objective,

that is, Weight values are equal. If there is $a_{ij} > 1$, A_i is more important than A_j. If there is $a_{ij} < 1$, A_i is not more important than A_j. According to the above characteristics, there is $a_{ji} = 1/a_{ij}$ so that judgment matrix A is positive reciprocal matrix.

Calculate the weight value of index

Set on a certain criterion, the weight vector of each index for the equation (1), which is

$$W = W(W_1, W_2, \cdots, W_n)^T. \tag{1}$$

Therefore, W can be obtained by solving the following equation(2),

$$AW = \lambda_{\max} W \tag{2}$$

In the equation (2), $\lambda_{\max}$ is to the largest eigenvalue of the judgment matrix A.

The accurate of each index weight value can be calculated by the following process,

i. Calculate the product of each line elements of judgment matrix A to obtain the M_i, that is,

$$M_i = \prod_{j=1}^{n} a_{ij} (i, j = 1, 2, \cdots, n) \tag{3}$$

ii. Calculate the Nth root of M_i that is $\overline{W}_i$.

$$\overline{W}_i = \sqrt[n]{M_i} \tag{4}$$

iii. The Vector is $\overline{W} = (\overline{W}_1, \overline{W}_2, \cdots, \overline{W}_n)^T$ which will be of the normalization processing, that is,

$$W_i = \overline{W}_i / \sum_{i=1}^{n} \overline{W}_j (i, j = 1, 2, \cdots, n) \tag{5}$$

So Vector $\overline{W} = (\overline{W}_1, \overline{W}_2, \cdots, \overline{W}_n)^T$ is obtained to ask the weight vector.

iv. Calculate the maximum eigenvalue of judgment matrix A

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} (AW)_i / W_i \tag{6}$$

$(AW)_i$ stands for the ith element of vector AW in the formula.

Check the consistency

Because policy makers knowing the question is not comprehensive and the decision problem is be of complexity, judgment matrix A can not be of the consistent, especially when the deviation of consistency is too large, it will cause problems. After getting the $\lambda_{\max}$, we also must carry out checking consistency of judgment matrix A and calculate the consistency index CI and relative consistency index CR, the following of calculation process, such as formula $CI = \dfrac{\lambda_{\max} - n}{n-1}$ (7) and $CR = \dfrac{CI}{RI}$ (8).

RI stands for the average consistency index which is the calculation according to more than enough random judgment matrices, as shown in table 2.[3,4]

Table 2 the average consistency index

order of the matrix	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

The consistency of judgment matrix A is associated with CR, and the smaller the CR, the better judgment. Generally if there is $CR \leq 0.1$, the judgment matrix A has a good consistency, that is, the characteristic vectors of each index weight can be applied.

Table 3 The hierarchy chart of teaching evaluation index of maritime teachers

	Primary indexes	Secondary indexes
Teaching Capability of Maritime Teachers (A0)	moral level and nautical literacy of maritime teachers (A1)	political attitude and thinking consciousness of maritime teachers(A11)
		moral cultivation and behavior of maritime teachers(A12)
		cognitive ability about own role of maritime teachers(A13)
		knowing the navigational capabilities of maritime teachers(A14)
		understanding the development prospects and direction of navigation professional (A15)
	course design capacity of maritime teachers (A2)	locating capability for maritime course(A21)
		the combination of practice and class ability of maritime teachers(A22)
		designed capacity of maritime curriculum program(A23)
		capability of development and utilization of maritime curriculum resources(A24)
		capability of reform and innovation about maritime courses(A25)
	teaching design and implementation capacity of maritime teachers (A3)	capability of practice demonstration of maritime teachers(A31)
		capability of class's organization and management of maritime teachers(A32)
		capability of language expression of maritime teachers(A33)
		capability of guiding the student of maritime teachers(A34)
		capability of teaching innovation method of maritime teacher(A35)
	students' learning and understanding ability in the maritime classroom (A4)	Grasping the ability of the maritime students' learning psychology(A41)
		Familiar with the maritime students' having their ability(A42)
		Grasping the ability of students' understanding maritime knowledge(A43)
		Familiar with the laws of maritime students' intelligence development(A44)
		Grasping the ability of the maritime students' mental health(A45)
	teaching reflection and evaluation capacity of maritime teachers (A5)	implementation capacity of the teaching evaluation of maritime teachers (A51)
		designed capacity of the teaching evaluation of maritime teachers (A52)
		reformed capacity of the teaching evaluation of maritime teachers(A53)
		Ability of applying a variety of methods for teaching evaluation(A54)
	academic research and application capacity of maritime teachers (A6)	capability of publishing papers, and works of maritime teachers(A61)
		capability of research of maritime teachers(A62)
		capability of using new technology to promote teaching for maritime teachers(A63)
		capability of promoting the development of maritime students(A64)

The specific application of AHP in System of Teaching Evaluation of the Maritime Teachers

Establish the index system of Teaching Evaluation of the Maritime Teachers

According to the current used index of teaching evaluation of teachers in many maritime colleges, this paper mainly will establish index system of teaching evaluation of the maritime teachers from the following six aspects which are A1, A2, A3, A4, A5 and A6. In this paper, according to the AHP, it will establish a structure model of three level layers that is shown in table 3.

Establish the judgment matrix

This paper will compare between any two in each layer of the index system of teaching evaluation of the maritime teachers so that the different judgment matrix are constructed respectively.

Establish the judgment matrix A in the primary index layer, as shown in table 4.

Table 4 judgment matrix A

A0	A1	A2	A3	A4	A5	A6
A1	1.0000	2.0000	4.0000	3.0000	4.0000	5.0000
A2	0.5000	1.0000	2.0000	1.0000	2.0000	2.0000
A3	0.2500	0.5000	1.0000	1.0000	1.0000	1.0000
A4	0.3333	1.0000	1.0000	1.0000	1.0000	2.0000
A5	0.2500	0.5000	1.0000	1.0000	1.0000	1.0000
A6	0.2000	0.5000	1.0000	0.5000	1.0000	1.0000

Similarly, the method of establishing judgment matrix A can be used for building the matrices A1, A2, A3, A4, A5, A6 such as table5, table 6 and table 7 and table 8, table 9 and table10.

Table 5 judgment matrix A1

A1	A11	A12	A13	A14	A15
A11	1.0000	3.0000	3.0000	2.0000	2.0000
A12	0.3333	1.0000	1.0000	0.5000	0.5000
A13	0.3333	1.0000	1.0000	0.5000	0.5000
A14	0.5000	2.0000	2.0000	1.0000	1.0000
A15	0.5000	2.0000	2.0000	1.0000	1.0000

Table 6 judgment matrix A2

A2	A21	A22	A23	A24	A25
A21	1.0000	2.0000	3.0000	3.0000	2.0000
A22	0.5000	1.0000	2.0000	2.0000	1.0000
A23	0.3333	0.5000	1.0000	1.0000	0.5000
A24	0.3333	0.5000	1.0000	1.0000	0.5000
A25	0.5000	1.0000	2.0000	2.0000	1.0000

Table 7 judgment matrix A3

A3	A31	A32	A33	A34	A35
A31	1.0000	3.0000	2.0000	3.0000	1.0000
A32	0.3333	1.0000	0.5000	1.0000	0.2500
A33	0.5000	2.0000	1.0000	2.0000	0.5000
A34	0.3333	1.0000	0.5000	1.0000	0.3333
A35	1.0000	0.2500	2.0000	0.3333	1.0000

Table 8 judgment matrix A4

A4	A41	A42	A43	A44	A45
A41	1.0000	0.5000	0.2000	0.3333	0.2500
A42	2.0000	1.0000	0.4000	0.8889	0.5000
A43	5.0000	2.4500	1.0000	1.8889	1.2500
A44	0.3333	1.5000	0.6000	1.0000	0.7500
A45	4.0000	2.0000	0.8000	1.3333	1.0000

Table 9 judgment matrix A5

A5	A51	A52	A53	A54
A51	1.0000	0.3333	0.5000	0.5000
A52	3.0000	1.0000	2.0000	2.0000
A53	2.0000	0.5000	1.0000	1.0000
A54	2.0000	0.5000	1.0000	1.0000

Table 10 judgment matrix A6

A6	A61	A62	A63	A64
A61	1.0000	0.5000	0.3333	0.5000
A62	2.0000	1.0000	0.5000	1.0000
A63	3.0000	2.0000	1.0000	2.0000
A64	2.0000	1.0000	0.5000	1.0000

Calculate the weight value of each index

For the index system of teaching evaluation of the maritime teachers, this paper firstly calculate the weight value of the primary index value, such as judgment matrix A, according to the instruction of second part, which would get the weight vector, that is, W = (0. 3956 0. 1797 0. 1010 0. 1355 0. 1010 0. 0868).Thus, the vector W is weight values of A1,... , A6 in at the sub-system of goal layer. In other words, the ratio of the moral level and nautical literacy of maritime teacher in the index system of teaching evaluation of the maritime teachers is 39. 56%, that is, the weight value is 0. 3956. Similarly, we can get the other weights.

By the same calculation method, the weight value of the secondary index can be calculated.

A1:W(1) = (0. 3686 0. 1095 0. 1095 0. 2066 0. 2066),

A2:W(2) = (0. 3686 0. 2066 0. 1095 0. 1095 0. 2066),

A3:W(3) = (0. 3091 0. 0922 0. 1736 0. 0976 0. 3275),

A4:W(4) = (0. 0668 0. 1333 0. 3333 0. 2000 0. 2668),

A5:W(5) = (0. 1225 0. 4231 0. 2272 0. 2272),A6:W(6) = (0. 1225 0. 2272 0. 4231 0. 2272).

Check the consistency of every index

In order to check the consistency of judgment matrix, the maximum eigenvalue of judgment matrix firstly can be calculated. Here it is the example of judgment matrix A. Due to the judgment matrix A, weight vector and formula (6) , the result which is $\lambda=6.0682$ can be obtained by using the Matlab. Followed by the formula (7) ,which is $CI = \dfrac{\lambda_{max} - n}{n-1}$, the consistency index CI of judgment matrix A can be concluded, which is CI = 0.0136.

Finally, the ratio between CI and random consistency index RI of judgment matrix with the same rank is calculated, and this ratio stands for CR, which the value of RI can be checked by table 2.By the formula (8), CR = 0.0110 can be calculated. It can be seen that CR < 0.1 so as to pass checking consistency of the primary index.

In the same way, the checking consistency of the secondary indexes also can be validated.

A1 :λ= 5. 0135 ,CI = 0. 0034 ,CR = 0. 0030< 0. 1,A2 :λ= 5. 0135 ,CI = 0. 0034 ,CR = 0. 0030< 0. 1.

A3 :λ= 5. 0163 ,CI = 0. 0041 ,CR = 0. 0037 < 0. 1,A4 :λ= 5. 0003 ,CI = 0. 0001 ,CR = 0.0000< 0. 1.

A5 :λ= 4. 0105,CI = 0. 0035 ,CR = 0. 0039 < 0. 1,A6 :λ= 4. 0103 ,CI = 0. 0034 ,CR = 0. 0038 < 0. 1.

By the above values of the CR, the consistency all secondary index can be passed.

Calculate the teaching evaluation value of the maritime teachers

The above index weight values are calculated in the weights of index layer. So in order to refine the secondary indexes, the final evaluation results of teaching capability of the maritime teachers can be calculated, the secondary indexes weight values in the primary index layer will be change into absolute weight values in the goal layer(Teaching capability of the Maritime Teachers).The calculation method is that each component value of the corresponding vector W(i) of the judgment matrices A1,... , A6 in the secondary index layer will be multiplied by corresponding weight value matrix in the primary index layer , so the calculation is W(i)'which is the final absolute weights in the secondary

index layer.For example, the following judgment matrix A1, that is,A1:A(1)'= (0. 3686 0. 1095 0. 1095 0. 2066 0. 2066)*0. 3956=(0. 1458 0. 0433 0. 0433 0. 0817 0. 0817).

Thus it can be seen that the weight value of political attitude and thinking consciousness of maritime teachers in the secondary indexes is of 0. 1458 in the whole index system of teaching evaluation of the maritime teachers. Using the same way, each absolute weight values can be concluded in the secondary index.

In conclusion, the maritime teachers' teaching integrated evaluation can be calculated by $\sum_{i=1}^{n} p(i)*W(i)'$ which consist of $p(i)$ (the value of the child i indicators) and $W(i)'$ (the absolute weight of the child I index in the teaching ability of maritime teachers). $p(i)$ can take on any arbitrary a value of 0 ~ 100. Finally, teaching evaluation's score of maritime teachers is between 0 ~ 100. Then maritime teachers 'teaching ability can be judged through the comparison of digital.

Summary

Analytic Hierarchy Process (AHP) is one of the research method of the System of Teaching Evaluation of the Maritime Teachers. It is good for many factors of which teaching evaluation of the maritime teachers has an impact to consider as a whole system. It gives priority with the quantitative methods, and the qualitative is complementary. Thus the teaching ability score of maritime teachers is calculated. Compared with previous qualitative evaluation methods, it can overcome the deficiencies of some traditional methods and objectively reflect the teaching ability of maritime teachers. However, limited by the level of researchers and experts' subjectivity in evaluation system, the applicability of the system of teaching evaluation of the maritime teachers remains to be further tested. But the method for upgrading and innovation with the maritime colleges and universities teachers' teaching ability has a distinct role.

Acknowledgements

References

[1] WU Shuqin.The Application of AHP in Construction of Competency Model for University Recruitment. Science and Technology Management Research.3(2011) 60-66.

[2] ZHAO Chun- yuan. Application of fuzzy judgment based on AHP model in the evaluation of teaching quality. Journal of Shenyang Institute of Engineering(Natural Science).7.2(2011)116-122.

[3] Xie Jian,Chu Dan, Ge Han. Research on System of Teaching Evaluation of Teachers in Colleges Based on AHP[J].China Adult Education.4(2015)96-101.

[4] Wei Wei, Han Jianhua, Wen Jikui.Evaluating Education Technology Ability of Teachers in Higher Education Based on AHP And CA.JOURNAL OF BEIJING INST TUTE OF EDUCATION NATURAL SCIENCE EDITION.3(2015)61-69.