

China's High-quality Marine Ship and Crew Development Environment Optimization Recommendations based on the Fuzzy Comprehensive Evaluation

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Abstract. logistics transportation in the world still occupies the main position, and presents a new development trend and characteristics. In order to adapt to the development of this maritime direction, it is necessary to have a multi-dimensional, multi-level and multi-structure crew of a high-quality seagoing vessel. They can give full play to their initiative and decision-making and have the ability to deal with a variety of complex maritime environmental problems. Fuzzy comprehensive analysis method has been widely used in all kinds of evaluation because of its characteristics of multi-index and multi-level evaluation. Based on the method of fuzzy comprehensive analysis and weight analysis combined with the analytic hierarchy process, this paper establishes an effective development environment optimization model aiming at the particularity of the career development environment of maritime practitioners, which can provide powerful help to China's shipping industry.

Keywords: High quality sailors; Fuzzy comprehensive evaluation; AHP method; Develop environmental optimization models.

1. Preface

As a forerunner to the ocean, the crew is an important force in building a maritime power. The implementation of the strategy of maritime powers, the development, utilization, protection and control of the oceans are inseparable from the crew. At the same time, the strategy of maritime powers provides the crew with a broader space for development and the stage of actual talents [1, 2]. Standing on the new starting point of the construction of a strong ocean, facing the "four traffic" goals and the new requirements of the "three-way" construction of maritime affairs, comprehensive analysis of formal tasks, based on the stage characteristics of the development of the crew, all require the development of the crew and the strategy of strengthening the country by the sea. Combine and fully implement the strategy of strengthening the country of the crew and formulate the development strategy and planning plan for the Chinese crew. Casting is the "Chinese dream" of the sea boat crew.

2. Development Status of China Sea Boat Crew Team

The development scale of China's sea-going crew is mainly based on the comprehensive education of the students in the maritime colleges [3]. The statistics released by the China National Maritime Safety Administration are shown in Figure 1. The total number of Chinese crew members is increasing year by year, but the growth rate of sea-going crews has slowed down noticeably. The corresponding number of national maritime college enrollments has peaked sharply in 2012. The decline has slightly rebounded in 2016, and the recruited crew has not been able to digest it, resulting in an oversaturated crew market. The enrollment of major universities has also dropped sharply year by year.

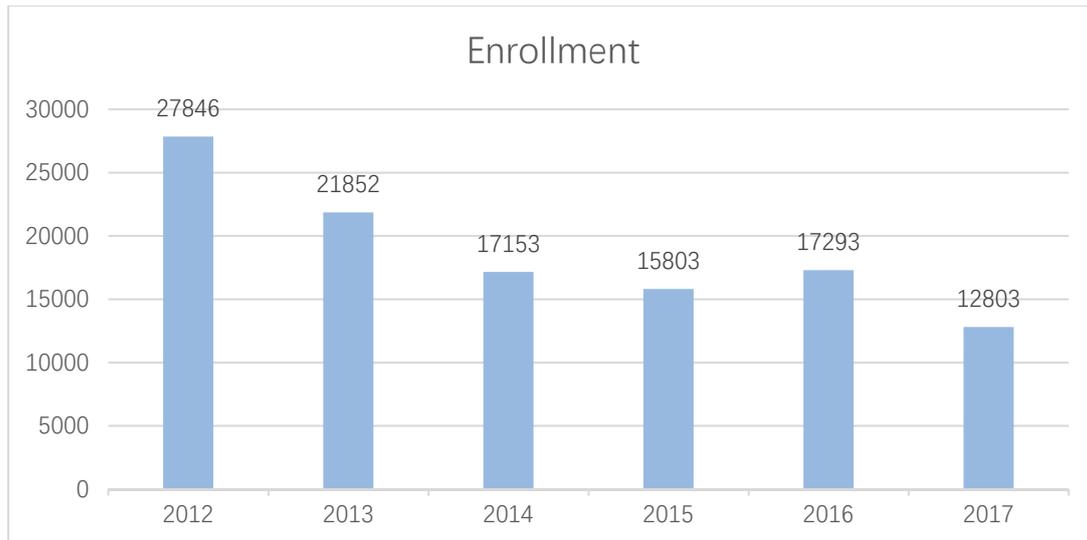


Fig.1 Statistics on enrollment of national maritime colleges from 2012 to 2017

3. Analysis of the Current Situation of the Development of the Crew of Chinese Sea-going Vessels

3.1 The Development Status of the Crew of Seagoing Ships

The problems of insufficient source of crew of China's sea-going vessels, unreasonable team structure, low overall cultural quality and unsatisfactory management system and mechanism are prominent [4, 5], which cannot meet the needs of the rapid development of China's shipping economy. These phenomena will cause the following problems:

3.1.1 The Crew is in a State of Serious Loss

The competition in the crew market worldwide is mainly concentrated on the competitiveness of high-quality sea-going crews, and the academic structure is an important manifestation of the quality indicators of sea-going crews. The overall senior crew of China has low academic qualifications and is born under the bachelor's degree. There are fewer seafarers and more rare undergraduate courses. The reason can be attributed to the fact that the crew of sea-going vessels are less satisfied with the salary structure and level. Compared with the work of sea-running ships, they hope to have a well-paid job on land. Secondly, due to the long time of going to sea, the family's health, marriage and love issues also prompted the highly educated crew not to choose to enter the crew market easily [6, 7].

3.1.2 The Age Structure of the Crew is Prone to Polarization

The age structure of the crew and crew members is prone to polarization. The main manifestations are in several aspects: First, due to the low barriers to entry for sea-going crews, 40% of junior high school and below cultural level personnel, the existing ship information technology and equipment are not well on board. Application; and the grade is 22-28 years old. Second, the time to form an advanced crew is generally around 40 years old, and the number is small [8]. The number of sea-going crews between 29 and 40 years old is gradually reduced. The reason can be attributed to the longer time of the ship, the relatively boring environment on board, the crew's confusion about future development plans, and reduced loyalty [9], unwilling to continue. Adhere to the work of the ship, causing the crew's age structure to be prone to faults and polarization.

3.1.3 It is Difficult for the Crew to Communicate with the Staff of the Foreign Enterprise

In recent years, the shipbuilding industry has developed rapidly. China has a good development result in maritime trade, attracting many shipping companies from abroad to develop cooperation and cooperation in China. Multi-language mastery and communication are indispensable for sea-going crews, especially for sea-going vessels. Senior crew members and captains are mostly foreigners, and

English is the main language [10], which challenges the effective and smooth communication of sea-going crew members who have just entered the crew market.

4. Optimization and Evaluation of the Development Environment of High Quality Sea Boat Crew

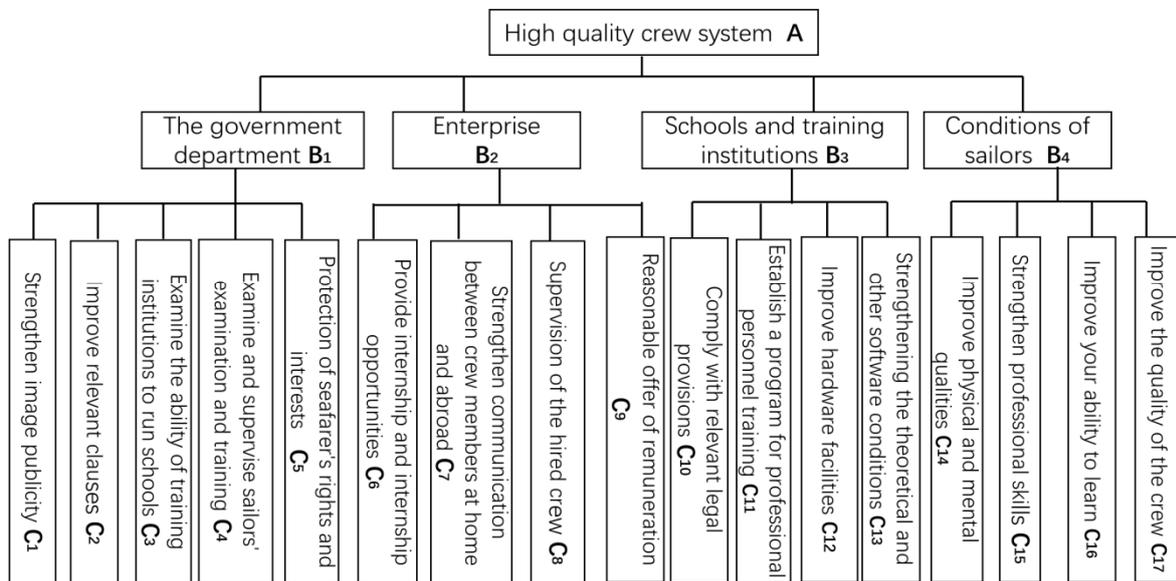
A high-quality crew system is an important part of maritime development. As a necessary skill before the crew can get on board, the system must be built to suit the crew. Due to the complexity of the system, in order to establish a high-quality crew system, it must be considered by the government, enterprises, training institutions and crews [11]. This process has certain complexity, so it is suitable to analyze many the pros and cons of the factors [12].

Using AHP to analyze the high-quality crew system, taking into account the high efficiency and convenience factors, evaluate a number of favorable conditions and select the best solution to establish the system. This method proposes a quantitative decision-making method based on a large number of uncertainties, fuzziness, random factors and their relationship. The combination of qualitative and quantitative methods is a complex decision-making problem that is clear and reduces the quantification. The calculated workload and difficulty save manpower and material resources and have strong practicability.

4.1 Analytic Hierarchy Process (AHP) Analysis of Factors Influencing the Crew to be of High Quality

Factors influencing the establishment of a high-quality crew system are summarized according to the analytic hierarchy process (ahp), and its hierarchical structure is shown in table 1 below.

Table 1. High quality crew system



The establishment of a high-quality crew system is affected by four factors, and here the importance of these four factors is in order: government departments, enterprises, training institutions, and students themselves. Whether the consistency of relevant factors conforms to the prescribed rules needs further inspection and analysis.

4.2 The Analytic Hierarchy Process (Ahp) is used to Test and Calculate the Consistency of Relevant Factors

According to the expert evaluation results, the judgment matrix is constructed, as shown in table 2 to table 6. The consistency test results are attached.

Table 2. judgment matrix A-B

<i>A</i>	<i>B₁</i>	<i>B₂</i>	<i>B₃</i>	<i>B₄</i>	<i>W</i>
<i>B₁</i>	1	1/3	1/5	1/7	0.055
<i>B₂</i>	3	1	1/3	1/5	0.118
<i>B₃</i>	5	3	1	1/3	0.263
<i>B₄</i>	7	5	3	1	0.564

The judgment matrix can be obtained as follows:

$$A = \begin{bmatrix} 1 & 1/3 & 1/5 & 1/7 \\ 3 & 1 & 1/3 & 1/5 \\ 5 & 3 & 1 & 1/3 \\ 7 & 5 & 3 & 1 \end{bmatrix}$$

Among them;

$$M_1 = \frac{1}{105}, M_2 = \frac{1}{5}, M_3 = 5, M_4 = 105;$$

$$\bar{W}_1 = \sqrt[4]{M_1} = 0.312, \bar{W}_2 = \sqrt[4]{M_2} = 0.669;$$

$$\bar{W}_3 = \sqrt[4]{M_3} = 1.495, \bar{W}_4 = \sqrt[4]{M_4} = 3.201;$$

the eigenvectors; $W_i = \begin{bmatrix} 0.055 \\ 0.118 \\ 0.263 \\ 0.564 \end{bmatrix}$ Calculation of the maximum eigenvalue of judgment matrix

$$AW = \begin{bmatrix} 1 & 1/3 & 1/5 & 1/7 \\ 3 & 1 & 1/3 & 1/5 \\ 5 & 3 & 1 & 1/3 \\ 7 & 5 & 3 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0.055 \\ 0.118 \\ 0.263 \\ 0.564 \end{bmatrix} = \begin{bmatrix} 0.228 \\ 0.483 \\ 1.080 \\ 2.328 \end{bmatrix}, \lambda_{max} = \sum_{i=1}^4 \frac{(AW)_i}{4W_i} = 4.118$$

$CI = 0.039, RI = 0.90, CR = \frac{CI}{RI} = 0.044 < 0.10$, Therefore, judgment matrix A-B has good consistency.

The same method is used to test the judgment matrix B1 - C, B2 -C, B3 - C and B4 – C and the results comply with the consistency test principle.

4.3 Establishment and Evaluation of the Optimization Model for the Development Environment of Sea-going Ships and Crew

4.3.1 The Fuzzy Comprehensive Evaluation Method is used to Model and Analyze the Above Weights

The finite theoretic domain of evaluation object is established: $U = \{U_1, U_2, U_3... , U_m\}$. In combination with the characteristics of the Marine crew development environment, the factor set was established by the evaluation index system established by the above section:

{Government department U1, enterprise U2, school training institution U3, students themselves U4}; $I = \{\text{strengthen image publicity U11, improve relevant provisions U12, review the school and other training institutions' educational capacity U13, review and supervise students' examination and}$

training U14, seafarer rights and interests protection U15}; U2 = {provide internship and internship opportunities U21, strengthen the communication of crew at home and abroad U22, supervise the hired crew U23, and provide reasonable remuneration U24}; Abide by relevant legal provisions U31, establish professional talent training program U32, improve hardware facilities U33, strengthen software conditions such as theory education U34}; Improve physical and psychological quality, strengthen professional skills, improve learning ability, and improve students' quality

4.3.2 Determination of Evaluation Set

Evaluation set is a language description of evaluation indexes at all levels. Specific evaluation sets are:

$$V = \{\text{important, important, general important, not important, not important}\}$$

4.3.3 Weight Determination

Based on the comprehensive expert opinions, the final weight of the system is determined as follows;

$$A = \{0.1, 0.2, 0.3, 0.4\}$$

$$A_1 = \{0.05, 0.35, 0.15, 0.15, 0.3\}$$

$$A_2 = \{0.3, 0.05, 0.55, 0.1\}$$

$$A_3 = \{0.1, 0.2, 0.3, 0.4\}$$

$$A_4 = \{0.05, 0.3, 0.25, 0.4\}$$

4.3.4 The Determination of Fuzzy Judgment Matrix

According to the above system, each element of the second and third layers of the indicators was evaluated by single factor, and the single factor fuzzy evaluation matrix was obtained by statistics.

$$R = \begin{bmatrix} 0.4 & 0.3 & 0.2 & 0.1 & 0 \\ 0.25 & 0.35 & 0.3 & 0.1 & 0 \\ 0.2 & 0.35 & 0.25 & 0.1 & 0.1 \\ 0.35 & 0.15 & 0.15 & 0.25 & 0.1 \end{bmatrix}$$

$$R_1 = \begin{bmatrix} 0.4 & 0.15 & 0.2 & 0.15 & 0.1 \\ 0.6 & 0.2 & 0.2 & 0 & 0 \\ 0.35 & 0.2 & 0.2 & 0.2 & 0.05 \\ 0.5 & 0.35 & 0.15 & 0 & 0 \\ 0.5 & 0.2 & 0.2 & 0.1 & 0 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.4 & 0.25 & 0.15 & 0.2 & 0 \\ 0.3 & 0.3 & 0.25 & 0.15 & 0 \\ 0.5 & 0.2 & 0.15 & 0.1 & 0.05 \\ 0.6 & 0.3 & 0.05 & 0.05 & 0 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 0.7 & 0.2 & 0.1 & 0 & 0 \\ 0.5 & 0.25 & 0.2 & 0.05 & 0 \\ 0.3 & 0.3 & 0.25 & 0.1 & 0.05 \\ 0.4 & 0.35 & 0.2 & 0.15 & 0 \end{bmatrix}$$

$$R_4 = \begin{bmatrix} 0.7 & 0.1 & 0.1 & 0.1 & 0 \\ 0.5 & 0.25 & 0.15 & 0.1 & 0 \\ 0.5 & 0.3 & 0.2 & 0 & 0 \\ 0.4 & 0.3 & 0.25 & 0.05 & 0 \end{bmatrix}$$

Evaluation vector B can be obtained from $A = \{0.1, 0.2, 0.3, 0.4\}$:

$$B = A \circ R = (0.35, 0.3, 0.25, 0.25, 0.1);$$

Evaluation vector B1 can be obtained from $A_1 = \{0.05, 0.35, 0.15, 0.15, 0.3\}$;

$$B_1 = A_1 \circ R_1 = (0.35, 0.2, 0.2, 0.15, 0.05);$$

Evaluation vector B2 can be obtained from A2

$$B_2 = A_2 \circ R_2 = (0.5, 0.25, 0.15, 0.2, 0.05)$$

Evaluation vector B3 can be obtained from A3

$$B_3 = A_3 \circ R_3 = (0.4, 0.35, 0.25, 0.15, 0.05)$$

Evaluation vector B4 can be obtained from A4

$$B_4 = A_4 \circ R_4 = (0.4, 0.3, 0.25, 0.1, 0)$$

It's normalized;

$$\begin{aligned} B &= (0.28, 0.24, 0.2, 0.2, 0.16) \\ B_1 &= (0.368, 0.211, 0.211, 0.158, 0.05) \\ B_2 &= (0.435, 0.217, 0.130, 0.174, 0.043) \\ B_3 &= (0.333, 0.292, 0.208, 0.125, 0.042) \\ B_4 &= (0.381, 0.286, 0.238, 0.095, 0) \end{aligned}$$

According to the principle of maximum membership, it is important for government departments to strengthen image publicity, provide internship and internship opportunities, abide by relevant laws and regulations, and improve the physical and psychological quality of crew members.

5. Conclusion

In terms of government departments, relevant government departments such as the maritime safety administration should actively respond to the relevant policies of navigation education, effectively coordinate and cooperate, and give preferential treatment and salary guarantee to the maximum extent possible to the seafarers, so that they can have a good sense of belonging, honor and pride when facing work. Actively attract high-quality talents at home and abroad, select qualified talents to invest in maritime education, deepen and expand the theoretical knowledge of crew, and enrich and comprehensively the knowledge of sailors on ships.

In terms of image publicity, developed multimedia software and relevant websites such as maritime bureau are used to publicize the achievements of China's maritime education in recent years, and a series of national strategies such as "going deep into the ocean, going deep into the sea" are adopted to attract relevant talents. In order to make more seafarers aspire to maritime work to participate in maritime work and avoid the loss of high-quality seafarers.

In terms of internship and internship opportunities, the internship period should be extended appropriately and the internship opportunities for sea-going ship crew should be increased through school-enterprise cooperation, so that the crew can learn more systematic and abundant theoretical knowledge on campus, and everyone can operate, practice and pass in enterprise practice. The significance of education to achieve high-quality crew talents of the school and the trust and satisfaction of the enterprise to recruit crew members on board the ship, at the same time let the crew of the ship get their own value affirmation of the triple win purpose.

In terms of relevant legal provisions: in today's complex and volatile maritime traffic and navigation, relevant government departments timely improve relevant legal provisions to fully protect the safety and all rights and interests of seafarers and crew at sea. When faced with complex situations, the crew can use their own knowledge and regulations to have confidence, basis and reliance to solve

problems. When faced with emergencies, they should not panic, withdraw or be afraid. To save the relevant government departments and at the same time to reassure the crew's family.

6. Summary

Although the development of Chinese crew faces many challenges, it also faces various opportunities. At present, the country, the industry management department, the shipping enterprise, the industry organization and the maritime academy are highly focused on the training and development of the Chinese crew team, so the training and development of the Chinese crew team is facing new opportunities. In the face of such opportunities and challenges, the future development of Chinese crew should develop strategy planning scientifically, and realize the Chinese crew "sufficient amount, reasonable structure, excellent quality" development goals.

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