ISSN: 2414-1895 DOI: 10.6919/ICJE.202107_7(7).0080

Research on Standardization Design of Ship Equipment Management System

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Abstract

In the stage of vigorous development of ships in the world, countries have paid particular attention to the modernization of ship equipment, and ship equipment management is extremely important. Promoting the ship equipment operation management system is an inevitable goal to cooperate with the modernized development of ship equipment. Ship equipment management is a complex system engineering that needs to be standardized, systematic, authoritative, and scientific. This article mainly describes the standardization process of ship equipment management, and conducts standardized assessment of ship equipment management personnel, in order to operate ship equipment in a scientific and standardized manner, avoid misoperation, and control the risk of ship equipment management.

Keywords

Equipment Management; Operating Procedures; Authentication Mechanism.

1. Introduction

Modern ship equipment involves multiple fields and multiple disciplines, with complex equipment systems, diverse models, and increasing automation. At the same time as the function is improved, it also makes the operation of the equipment more difficult. Especially in recent years, my country's ships have been vigorously developed. With the renewal and iteration of equipment models, the complexity of the crew is still increasing. How to operate the equipment correctly and efficiently, realize the existing functions of the equipment, and ensure that the specified tasks are completed is particularly important. To this end, if general management standards can be formulated and incorporated into the standard system, it can provide basic guarantees for equipment management from the management and organizational levels. At the same time, the formation of standards can also promote the level of professional skills of the crew and the level of coordination among the crew. The standardization of equipment management system was established in response to this complex system, and its research has very important significance. Provide support for the realization of equipment technical indicators, the display of equipment performance, and the formation of combat effectiveness.

2. The theoretical basis of ship equipment management

2.1 Ship equipment management system concept.

The ship equipment management system takes "a set of standardized equipment operation procedures, a set of systematic safety operation manuals, a set of authoritative safety warning signs, and a set of scientific certification and assessment mechanism" as the core, The use of each stage, according to the standardized process, standardize the management work:

(1) During the construction phase, standardize the management of initial installation equipment.

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(2) During the receiving phase, "a set of standardized equipment operation procedures", "a set of systematic safety operation manuals", and "a set of authoritative safety warning signs" shall be established simultaneously.

(3) At the use stage, establish a "scientific certification and assessment mechanism".

It is expected that in the whole life of the ship, complete and sound equipment management methods can be used from beginning to end to ensure that the newly installed equipment quickly forms combat effectiveness and shorten the transition period.

2.2 Based on AHP certification assessment mechanism.

The analytic hierarchy process, abbreviated as AHP, refers to the method of qualitatively and quantitatively analyzing the factors related to the final decision, and applying multi-objective comprehensive evaluation to obtain the optimal decision. Ship equipment management is closely related to the operating level of the crew. Therefore, theory, practice, and systems are used as the judgment layer. Through the establishment of a hierarchical structure model, a comparison matrix is established to determine the assessment of ship equipment operation procedures, the content of the safety operation manual, and the identification of safety warning signs. After the final weights, the most reasonable assessment mechanism for evaluating crews is obtained.

3. Design of ship equipment management factors

3.1 Equipment operation process standardization.

Based on the existing training materials, sum up a set of sound and standardized equipment operation procedures. The operation flow is required to be concise, and the specific operation methods and conditions of each step are directly clarified. The operation steps are rationalized and standardized to form the final authoritative basis.

The standardized equipment operation process is the guidance basis for equipment operation, and requires the readability and standard description of the process guidance document. According to the investigation, the characteristics of the teaching materials provided by the current training units are as follows: the content is complicated and complicated, obscure and difficult to understand, and the underlying principles and internal implementation are comprehensively listed. For operators, such a complex textbook is not friendly. From a practical perspective, a concise and focused textbook is needed. The operation flowchart is the most intuitive and effective textbook. Edit and integrate complex information, principles and procedures, and use professional diagrams, tables, symbols, etc. for visual processing to improve its readability, so that operators can understand and respond quickly in actual operations.

Collect related equipment system operation instructions and guide tutorials, compile key operation procedures into flowcharts, and remind operators of the procedures that need to be paid attention to in red, see Fig.1 and Fig.2.

3.2 Standardization of Safety Operation Manual.

The ship safety operation manual is a key guidance document for the crew to operate the equipment safely. Ship safety risk points are relatively scattered and hidden. Through work, the entire ship‘s equipment system related to safety risk points are sorted out one by one, and specific countermeasures are determined, compiled into a manual, and distributed by the entire ship, department, shift, and station. To every crew member.

The safety operation manual generally contains three parts: equipment operation procedures, job responsibilities and equipment management common sense. According to the establishment of positions and the establishment of a book for the positions, each position shall prepare a set of equipment safety operation manuals matching the position. Different positions in each department have different duties and equipment. The crew must fully grasp the relevant operation procedures of the equipment they are responsible for, clearly understand the initial state and ready status of the equipment, and compile the operation steps of the equipment into a written operation procedure.

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Table 1. XXX ship position setting table (example)

Department	Post
Aviation Department	Nautical squad leader, navigator
	Signal squad leader, signal soldier
Electrical and Mechanical Department	Electrician squad leader, electrician
	Engineer squad leader, engineer
Ship department	Cooking squad leader, cooking soldier
	Cable squad leader, cable anti-chemical soldiers
...	...

3.3 Standardization of safety warning signs.

Use warning means to prevent misoperation during use. On the basis of the existing set of warning signs, we will systematically sort out, check for deficiencies, and improve the types and ranges of warning signs to warn operators of relevant precautions and ensure misoperations when operating equipment.

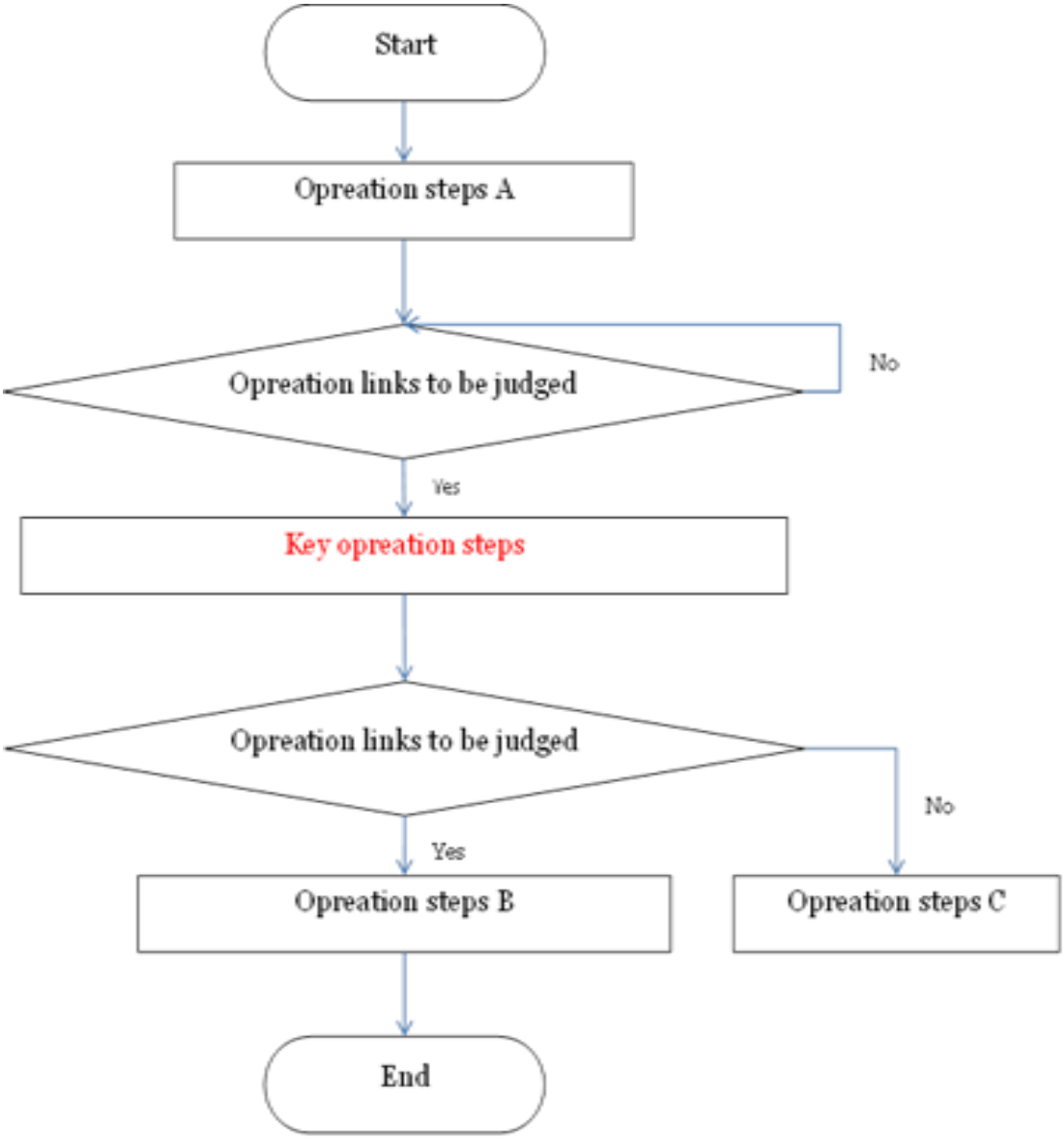

Fig. 1 Basic flow chart

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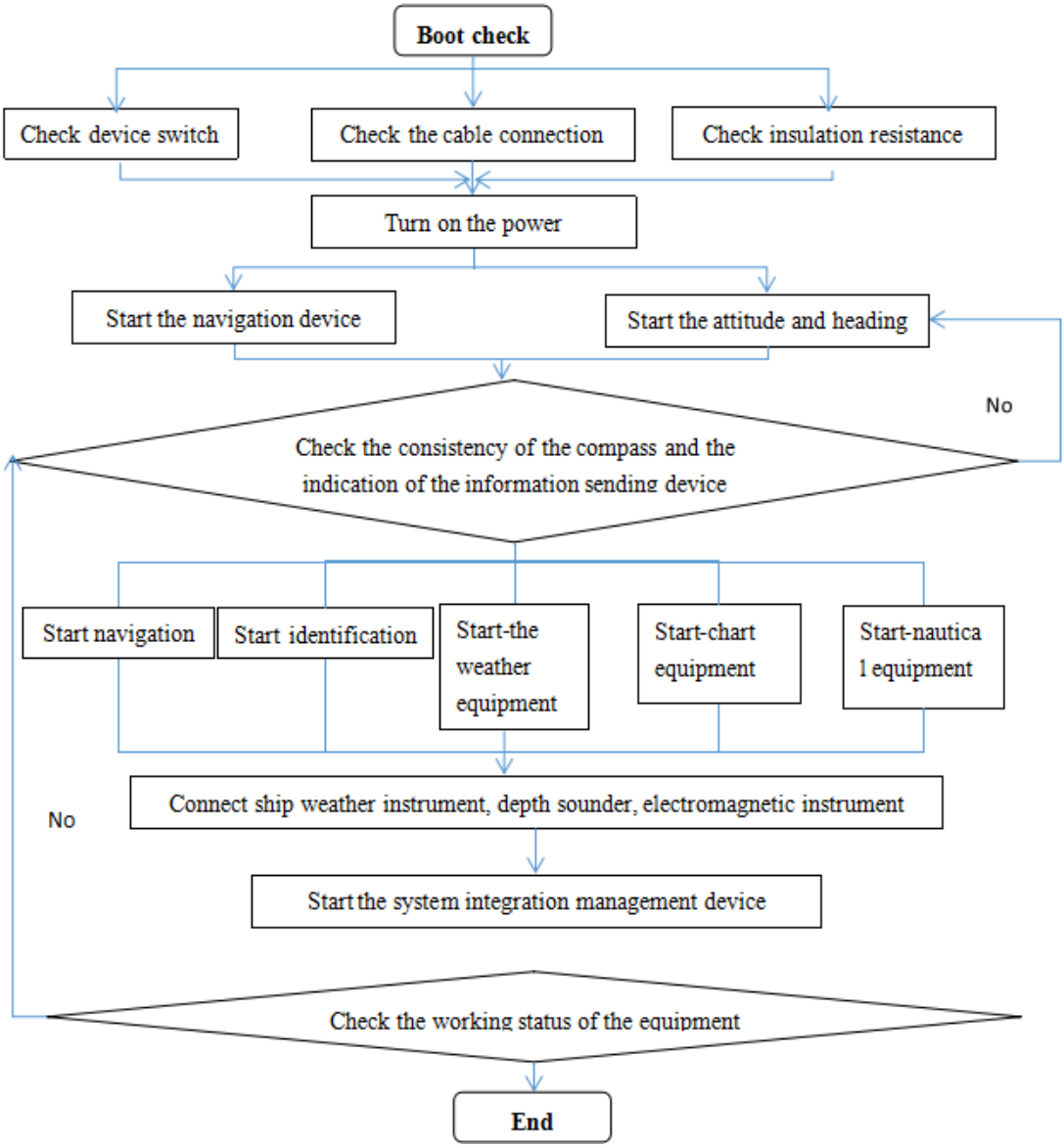

Fig. 2 XXX equipment operation flow chart (example)

Safety signs can remind the crew to prevent danger and effectively reduce the probability of accidents; when a dangerous situation occurs, it can instruct the crew to escape or take corrective measures to contain the hazards. In order to achieve the correct and correct warning purpose, it is required that the type of safety signs should be consistent with the warning content, and the setting position should be correct and reasonable.

Classified according to the information conveyed by the signs, the safety warning signs are:

(1) Prohibition signs—indicating that certain behaviors of people are not allowed or prohibited; the geometric figure of the prohibition signs is a circle with a slash, in which the circle is connected with the slash, in red; the graphic symbol is black, and the background is white .

(2) Warning signs-to make people pay attention to possible hazards; the geometric figures of the warning signs are black equilateral triangles, black symbols and yellow background.

(3) Instruction signs-indicate that they must be followed, and are used to force or restrict people's behavior; the geometric figures of the order signs are circles, blue backgrounds, and white graphic symbols.

(4) Prompt signs-indicate the target location or direction. The geometric figure of the reminder sign is square, green and red background, white graphic symbols and text.

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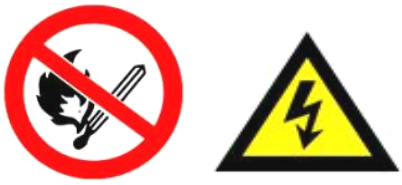

Fig. 3 Safety warning signs (example)

4. Model establishment based on AHP method certification and assessment mechanism

4.1 Ship crew certification assessment mechanism.

The goal of studying the standardization of the certification and assessment mechanism: establish a mechanism for crew members to take up their posts with a certificate to ensure that each post can meet the requirements of the "Four Meetings" after passing the training, and lay the foundation for subsequent practical operations. Based on the principle of improving the combat effectiveness of the troops, the theory is based on the crew as the center(B1), practice(B2), system(B3) evaluate from three perspectives, apply AHP method to evaluate the operation process of ship equipment(C1), safety warning label identification (C2) , safety operation manual content (C3) Perform comprehensive analysis and sorting, and get the optimal decision of crew certification and assessment mechanism.

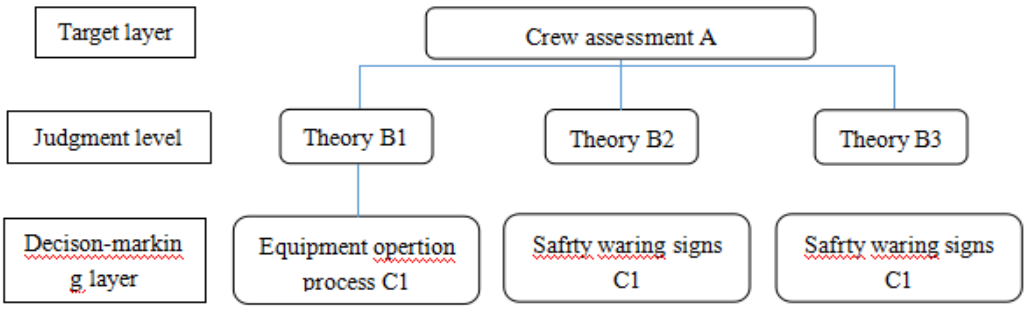

Fig. 4 Hierarchical structure diagram of crew assessment

4.2 Assessment scale and description.

In order to facilitate the theory(B1), practical operation(B2), system(B3)For comparison and judgment, the 1-9 ratio scale method is introduced. It is stipulated that 1, 3, 5, 7, and 9 are respectively used to represent the judgment based on experience. Compared with the element j: equally important, slightly important, stronger important, and strongly important, Is absolutely important, and 2, 4, 6, 8 represent the compromise value between the above two judgment levels.

Table 2. Ratio scale

Scaling	Definition (comparison factors i and j)
1	Factors i and j are equally important
3	Factors i and j are slightly more important
5	Factors i and j are stronger and more important
7	Factors i and j are strongly important
9	Factors i and j are absolutely important
2,4,6,8	The median value of two adjacent judgment factors

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Judgement matrix a_{ij} is obtained by comparing element i with element j, then the judgment of element i compared with element j isa_{ji}=1/a_{ij}, and there is the following relationship:

$$a_{ij} = \frac{1}{a_{ji}}; a_{ii} = 1; i, j = 1,2, \dots, n \quad (1)$$

Obviously, the greater the ratio, the higher the importance of element i.

4.3 Build a judgment matrix.

The basic information of the judgment matrix AHP method is also an important basis for weight calculation. Taking the crew evaluation as the target layer, the elements in Figure 4 are judged and compared in pairs to construct a judgment matrix:

(1) The judgment matrix $A - B$(that is, the comparison of the relative importance of the elements of the judgment layer relative to the overall goal of the crew assessment), as shown in Table 3;

Table 3. Judgment matrix $\mathbf{A - B}$

A	B1	B2	B3
B1	1	1/3	2
B2	3	1	5
B3	1/2	1/5	1

(2) The judgment matrix $B_1 - C$(Compared with the theory, the relative importance of each element of the decision-making level), as shown in Table 4;

Table 4. Judgment matrix $\mathbf{B_1 - C}$

B_1	C1	C2	C3
C1	1	1/3	1/5
C2	3	1	1/3
C3	5	3	1

(3) The judgment matrix $B_2 - C$(Compared with the actual operation, the relative importance of each element at the decision-making level), as shown in Table 5;

Table 5. Judgment matrix $\mathbf{B_2 - C}$

B_2	C1	C2	C3
C1	1	2	7
C2	1/2	1	5
C3	1/7	1/5	1

(4) The judgment matrix $B_3 - C$(Compared with the system, the relative importance of each element at the decision-making level), as shown in Table 6;

Table 6. Judgment matrix $\mathbf{B_3 - C}$

B3	C1	C2	C3
C1	1	3	1/7
C2	1/3	1	1/9
C3	7	9	1

4.4 Calculate the characteristic root, characteristic vector and consistency test of the judgment matrix.

Use the root finding method to calculate the eigenvalues of the judgment matrix:

(1) Calculate the nth root of the product of elements in each row of the judgment matrix A,

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$$\overline{w_i} = \sqrt[n]{\prod_{j=1}^{n} a_{ij}} \ (\mathrm{i} = 1,2,\dots,\mathrm{n}) \tag{2}$$

(2) Normalize $\overline{w_i}$ to obtain $w_i = \frac{\overline{w_i}}{\sum_{i=1}^{n}\overline{w_i}}$,$\mathrm{W} = (w_1, w_2, \dots, w_n)^T$, which is the approximate value of the eigenvector of A;

(3) Calculate the largest characteristic root of the judgment matrix: $\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i}$

(4) Consistency test: In actual evaluation, the evaluator can only make a rough judgment on A, which will cause logical inconsistency, so consistency test is required. According to the principle of the AHP method, the consistency is checked by the difference between the maximum theoretical eigenvalue $\lambda_{\max}$ and n of A, and the consistency index CI: $\mathrm{CI} = \frac{\lambda_{\max}-\mathrm{n}}{n-1} < 0.1, CR = \frac{CI}{RI} < 0.1$ is calculated. Then the consistency of the judgment matrix is considered acceptable, otherwise the pairwise comparison is performed again.

After calculation, the eigenvector of matrix A-B is $\mathrm{W} = [0.230, 0.648, 0.122]^T$, the largest characteristic root is $\lambda_{\max} = 3.004$, consistency check $CR = 0.003 < 0.1$;

After calculation, the eigenvector of matrix B_1-C is $\mathrm{W} = [0.105, 0.258, 0.637]^T$, the largest characteristic root is $\lambda_{\max} = 3.039$, consistency check $CR = 0.033 < 0.1$;

After calculation, the eigenvector of matrix B_2-C is $\mathrm{W} = [0.592, 0.333, 0.075]^T$, the largest characteristic root is $\lambda_{\max} = 3.014$, consistency check $CR = 0.012 < 0.1$;

After calculation, the eigenvector of matrix B_3-C is $\mathrm{W} = [0.149, 0.066, 0.785]^T$, the largest characteristic root is $\lambda_{\max} = 3.08$, consistency check $CR = 0.069 < 0.1$;

4.5 Weight calculation result.

After obtaining the relative importance of the elements at the same level, the overall importance of the elements at all levels to the overall level can be determined from top to bottom. Calculate the operational process assessment of ship equipment (C1), safety warning label identification (C2), Safety operation manual content (C3) The weight distribution results are shown in Table 7:

Table 7. Weight distribution results

level	B1	B2	B 3	Level C weight total ranking
	0.230	0.648	0.122	
C1	0.105	0.592	0.149	0.426
C2	0.258	0.333	0.066	0.283
C3	0.637	0.075	0.785	0.291

It can be seen from Table 7 that the weight (C1) of the ship equipment operation process is 0.426, the weight of the safety warning label identification (C2)is 0.283, and the weight of the safety operation manual content (C3) is 0.291.

5. Conclusion

By combining the ship equipment management training and crew certification assessment mechanisminto a ship equipment management system, a positive feedback mechanism is formed. There are corresponding management measures in the ship construction phase, the ship receiving phase, and the use phase. During the entire life of the ship, a complete and sound equipment management method can be used from the beginning to the end to ensure that the newly installed equipment quickly forms combat effectiveness and shorten the transition period. The implementation of the ship equipment management system can effectively enhance combat effectiveness and enhance equipment support. Regardless of the military and civilian fields, the management methods of the ship equipment management system are of great significance.

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