Research on the Optimization Allocation Method of Equipment Based on Readiness Rate

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Abstract: If the equipment optimization allocation in aviation stations is carried out, the benefit of military economy could be improved. Through dividing the aviation stations into some kinds, confidence values models based on readiness rate of the equipment in aviation stations is established, using probability theory and mathematical statistics. Then the optimization allocation method of equipment in aviation stations is determined. Applicability of the method is given by way of a numerical example.

1. Introduction

Many scholars have conducted in-depth research on the optimization of equipment configuration methods. Li Xinon the basis of the analysis of the transfer material group board system and the group board equipment system, with reference to the idea of multi-objective planning, the optimization of the three target relations such as the efficiency of the group board, the group board equipment, and the number of workers, the material group board equipment configuration model based on multi-objective planning was established [1]. The improved simplex method is used to solve the model, and the optimal configuration scheme of the panel equipment is obtained. Chenye The inspection and support work of plugins is abstracted into free operation in the workshop, and the optimization method of equipment configuration is given[2]. According to the time required to protect constraints and various tasks, the configuration scheme of the equipment is calculated, the representation of the sorting problem is simplified with a triple set, the guarantee process is adjusted and intuitively displayed with a Gantt diagram, and the optimized configuration scheme is tested. Houlin using rough theory to describe uncertain decision factors influenced by environmental complexity and subjective experience, and making full use of DEA model to quickly evaluate the relative validity of multi-input and output decisions, an optimal model of communication jamming equipment configuration scheme based on rough DEA is established[3]. Finally, the relative validity of the configuration scheme is analyzed by an example. Through the analysis of the literature in this field, it can be found that from the point of view of the equipment integrity rate, it is rare to study the paper on the optimal equipment configuration method of formed units.

Based on the analysis of the above problems, the paper establishes the model from the point of view of the integrity confidence of the equipment, and determines the optimal configuration method of the formed unit equipment under the condition of satisfying the integrity confidence of the equipment.

2. Model Building

At Availability refers to the degree to which the device is in a working or usable state at any time[4]. The average availability of individual equipment can be expressed as:

$$A = \frac{T_1}{T_1 + T_2 + (1-p)T_3}$$

The overall equipment integrity requirement for individual formed units with formed unit spare parts is determined by the type of unit.

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If the number of certain types of equipment deployed by the first formed unit is, the total number of certain types of equipment deployed by the units of the formed unit is

$$N = \sum_{k=1}^{n} N_k$$

The critical value of the quantity of a certain type of equipment deployed by the first formed unit that meets the requirements of the integrity rate is

$$N_k' = \lceil \eta_k N_k \rceil$$

The critical value of the quantity of equipment assigned to individual formed units under formed unit spare parts that meets the overall integrity requirement is

$$N' = \left\lceil \eta \sum_{k=1}^{n} N_k \right\rceil$$

Since the device integrity rate is a percentage of the equipment that measures the integrity of the device group at a certain point in time, but the integrity rate is also changing over time, it is necessary to further introduce the concept of confidence[5]. To measure the likelihood that the device's integrity rate will meet the specified standards at any time.

The confidence function of a certain type of equipment that is configured by the first formed unit to achieve the perfect rate standard is

$$\alpha_k = \sum_{x=N_k'}^{N_k} \mathrm{C}_{N_k}^{x} A^x \left(1-A\right)^{N_k - x}$$

The confidence function of a certain type of equipment deployed by the formed unit under the spare parts of the formed unit to achieve the overall integrity rate standard is

$$\alpha = \sum_{x=N'}^{N} \mathrm{C}_{N}^{x} A^x \left(1-A\right)^{N - x}$$

The confidence level of a certain type of equipment deployed by the individual units under the spare parts of the formed units to achieve the overall integrity rate standard is the specified value and the confidence level of a certain type of equipment deployed by the first formed unit to achieve the integrity rate standard is as follows: In order to enable the equipment to complete the most basic assurance tasks, the limit of the number of equipment deployed by each formed unit is.

Under the above constraints, the configuration scheme corresponding to the minimum number of equipment deployed by the individual units of the formed unit spare parts is the optimal scheme.

Therefore, the objective function for solving the optimal scheme is

$$\min \sum_{k=1}^{n} N_k$$

$$s.t. \begin{cases} \sum_{x=N_k'}^{N_k} \mathrm{C}_{N_k}^{x} A^x \left(1-A\right)^{N_k - x} \geq \gamma \quad k = 1, 2, \cdots, n \\ \sum_{x=N'}^{N} \mathrm{C}_{N}^{x} A^x \left(1-A\right)^{N - x} \geq \gamma \\ N_k \geq N_0 \quad k = 1, 2, \cdots, n \\ N_k \in N \quad k = 1, 2, \cdots, n \end{cases}$$

According to formulas, the optimal configuration quantity of a certain type of equipment for each formed unit can be determined, and the optimal configuration quantity of a certain type of equipment for all formed units under the spare parts of the formed unit can be further obtained.

3. Example Analysis

The A certain unit spare parts are pre-equipped with a certain type of equipment. The average downtime of the equipment is 4350 hours, the average repair time after the equipment failure is 550 hours, and the average maintenance spare parts protection level is 0.95. The duration of emergency procurement owing to the shortage of spare parts for maintenance and repair was 320 hours, while the overall equipment integrity rate for the six units attached to the formed units was set at the established value. The categories and equipment integrity rate for each formed unit are shown in table 1. The level of confidence of the equipment to reach the integrity standard is determined by the lower limit of the number of equipment of this type deployed by each formed unit is 3 units. The optimal configuration scheme of the equipment is given.

Table 1 Level of integrity of formed unit categories and equipment

Formed unit	Kind	Level of integrity of standard
1	One	95%
2	One	95%
3	Two	90%
4	Two	90%
5	Two	90%
6	Three	85%

The average availability of a single device is

$$A = \frac{4350}{4350 + 550 + (1 - 0.95) \times 320} = 0.885$$

Build the objective function of the optimal scheme based on the sound rate standard data.

Using the software programming calculation of LINGO, the optimal configuration scheme of a certain type of equipment in each formed unit is obtained as shown in Table 2.

Table 2 Optimized configuration of certain types of equipment

Formed unit	Kind	Level of integrity of standard	Number
1	One	95%	12
2	One	95%	12
3	Two	90%	9
4	Two	90%	9
5	Two	90%	9
6	Three	85%	4

According to table 2, the optimal number of equipment for a certain type of equipment in 6 units under the spare parts of the formed units is calculated as 55 units.

4. Conclusion

Based on the average availability of equipment, this paper first establishes the confidence model of the equipment of the organizational unit configuration, considers the various factors that affect the equipment configuration, and establishes the optimization model of the organizational unit configuration equipment. The example proves that the optimal scheme model is scientific and suitable. This model can improve the military economic benefits of equipment support by further promoting and applying the model in the optimization of equipment configuration.

References

[1] Li Xin, Zhangjun. Research on the Configuration Model of Aviation Board Equipment Based on Multi-Target Planning [J]. Journal of the School of Military Transportation, 2017, 19(1): 59-63.

[2] Houlin, Liuxiangwei, Heman. Optimization of Communication Interference Equipment Configuration Scheme Based on Rough DEA [J]. Fire and Command Control, 2013, 38(6): 81-84.

[3] Yanglibo. Research on the targets of water traffic safety supervision and rescue equipment allocation [J]. China Maritime, 2017, (1):20 -23.

[4] Baoqinglong, Chenzhiying, Zhangzhuo. Application of queuing theory to safeguard equipment configuration method research [J]. China Science and Technology Information, 2011,(1) :95 -97.

[5] Shengzhou, Xie Shiqian, Panchengyi. Probability Theory and Mathematical Statistics [M]. Beijing: Higher Education Press, 2008.