Contribution Rate Evaluation of Army Air Defence Brigade Equipment System Based on Vector Model

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Abstract. In view of the complexity of the evaluation process of the contribution rate of the current equipment system and the inconspicuous analysis of the system indicators, it is not possible to meet the special issues of contribution rate assessment and index analysis of the Army air defense brigade equipment system, and proposes a method for evaluating the contribution rate of the Army air defense brigade equipment system based on the vector model. This method analyzes the combination of various indicators and vector theory in the Army Air Defense Brigade system and derives the links between various equipment (elements) to achieve accurate positioning and quantification of various equipment (elements). This is an equipment for the Army air defense brigade. The analysis of system indicators and the evaluation of contribution rates provide reliable support. The case shows that this method is simple and convenient, with relatively high accuracy and strong practicality. It can provide an effective method for the analysis of the Army air defense brigade equipment system and the assessment of the contribution rate of the Army air defense brigade equipment system.

1. Introduction

In this paper, based on the evaluation of the contribution rate of the Army Air Defense Brigade Equipment System, a vector model evaluation method is proposed, which can provide theoretical support for the rapid and accurate assessment of the contribution rate of the Army Air Defense Brigade Equipment System [1][2].

2. Vector Model of Army Air Defense Brigade Equipment System

Equipment is often associated with other equipment in performing tasks. There is a certain degree of principal and related parties between the equipment and the associated equipment. The main related parties are used as the action points. The two are connected in a straight line and the direction is pointed to the related party. Therefore, a set of vectors with size, direction, and action points is formed. The linear length of the straight line represents the contribution of one equipment to another. The vector size of a single equipment represents the effectiveness of the equipment in the system, and the size of the direction indicates the degree of dependence of the related party on the related party. The greater the deviation in the direction, the weaker the degree of dependence. It shows that the related party plays a small role in the effectiveness of the equipment played by the related party, and vice versa. Assuming that the vector model of the system contains T vectors, the set of vectors in the model is T.
The above vector representing the equipment characteristics is introduced into the coordinate system of the assignment. The set $Z$, set $H$, set $F$, set $M$, set $A$, vector, and coordinate system together form a vector model representing the Army's air defense brigade equipment system. The model diagram is shown in Figure 1:

![Figure 1. Vector Model of Army Air Defense Brigade Equipment System.](image)

3. A vector model calculation method for the equipment system of army air defense brigade

3.1. Element coordinate positioning
The positioning of the elements in the coordinates is the basis for determining the weight value of the elements in the system. The use of weights and assignments is mainly based on the expert evaluation scoring method, the AD method, and the SEA method. Each has its own advantages and disadvantages. Since the SEA method can more objectively reflect the characteristics of the equipment, the weight assignment of the system uses the SEA as the main idea. The flow chart of its procedures is shown in Figure 2:
3.2. Vector formula generation \[^{[8][9]}\]

There are some differences in the performance and combat capabilities of the equipment in different tasks and use environments. According to the element coordinate positioning program, coordinate points are generated by the natural environment influencing factors. This type of element can be represented by set \(A\). The vector calculation of the influence ability of this element set is:

\[
\overline{OA} = \sum_{x=1}^{n} \overline{OA}_x
\]  

(1)

In addition to the collection \(M\) in Figure 1, the remaining coordinate points constitute the operational performance of the entire Army Air Defense Brigade equipment system. Therefore, the combat capability of the system is:

\[
\overline{OG} = \sum_{a=1}^{n} \overline{OZ}_a + \sum_{\beta=1}^{m} \overline{OH}_\beta + \sum_{\gamma=1}^{p} \overline{OF}_\gamma
\]  

(2)

Among them, \(G\) represents the combat capability coordinate point of the entire equipment system of the Army Air Defense Brigade, and \(OG\) represents the combat capability vector expression of the equipment system.

According to the definition of the \(M\) set, the ability of the target to affect the combat performance of the Army Air Defense Brigade is:
Since the resistance of the defensive target and the combat capability of the Army's air defense brigade are mutually antagonistic, the direction of OM projection on the axis of OG is generally opposite to that of OG.

### 3.3. Computation and Analysis of Equipment Association Degree

In the vector model of Figure 1, the end of the vector represents the main equipment, and the beginning of the vector represents the auxiliary equipment. Assuming that $Y_y$ is any point in the vector coordinate system (excluding the $M$ set), the coordinate points associated with $Y_1, Y_2, \ldots, Y_j$ and $Y_y$, $Y = \{Y_1Y_y, Y_2Y_y, Y_3Y_y, \ldots, Y_jY_y\}$ is the set of vectors associated with the $OY_y$ generated by the main equipment, so the correlation between the main equipment and the auxiliary equipment set is:

$$
\Gamma_y = \left[ \frac{OY_y \cdot \sum_{j=1}^{u} Y_jY_y}{|OY_y|} \Bigg/ \left( \frac{|OY_y|}{|OY_y|} + \frac{OY_y \cdot \sum_{j=1}^{u} Y_jY_y}{|OY_y|} \right) \right] \times 100\%
$$

(4)

The value of $u$ is equal to the number of elements in the set $Y$, and $Y_j$ represents the $j$ element in the set $Y$; The degree of association between the main equipment and a single auxiliary equipment is:

$$
\Gamma_j = \left[ \frac{OY_y \cdot Y_jY_y}{|OY_y|} \Bigg/ \left( \frac{|OY_y|}{|OY_y|} + \frac{OY_y \cdot Y_jY_y}{|OY_y|} \right) \right] \times 100\%
$$

(5)

### 3.4. Analysis and Calculation of Dynamic Contribution Rate of Equipment System

Assuming that $X$ and $Y$ are the new (improved) dynamic combat capabilities of the Army's air defense brigade system before and after a certain equipment, and $Z$ is the contribution rate of the new (improved) equipment to the system, then:

$$
D_\tau = |OA + OG + OM| (\tau = 1, 2)
$$

(6)

$$
\psi = \frac{D_2 - D_1}{D_2} \times 100\%
$$

(7)

### 4. Conclusions

In this paper, a method of calculating and analyzing the contribution rate of Army Air Defense Brigade Equipment System based on vector model is presented. The method of calculating and analyzing the correlation between the air defense brigade equipment and auxiliary equipment and the individual auxiliary equipment is designed. Based on the model, the fast calculation and intuitive analysis method of the contribution rate of the Army Air Defense Brigade Equipment System is derived. In order to make the contribution rate theory of the equipment system practical, the next step focuses on the application of this method in the optimization of the Army Air Defense Brigade architecture.
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