Data Analysis of Equipment Support During the Age of Big Data

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Abstract

Firstly, this paper try to discuss the factors related to equipment state (new, to be used, to be repaired and to be scrapped) through partial correlation analysis method to and illustrate the degree of correlation; Then it infer the rationality of the equipment reserve scale under the background of efficiency of equipment reserve. This article is intended to explain whether the existing warehouse equipment reserve situation can meet the requirements of the army.

Keywords

Big data; equipment support; partial correlation analysis; equipment reserve scale.

1. Introduction

With the rapid development of Internet technology, mankind has entered the era of big data analysis. Not only does big data have a profound impact on world economy and social development, but also it has changed the people's work, life style and thinking method. Its profound effect has been applied in the military field by scholars. The understanding of big data should not just be confined to the literal meaning, and a foreign research institution defined that: data is an information resource to process mass of data with a very strong ability of decision-making and insight [1]. Now, it has become an important research direction in the military field that using large data analysis methods to study and solve the practical problems of military decision making and equipment management etc.

Modern warfare troops are faced with ability challenges of rapid maneuver, all-time and all-weather in space war. With the accelerated process of war, destructive power gradually increased and the war reserves was largely consumed, which develop the characteristics of mass information, wide varieties and emergent time in supporting the materials. Under this circumstance, the traditional model of equipment support is very difficult to be adapted to modern warfare requirement. The big data technology provides vigor and vitality to equipment data, which accelerates the expansion of military in information technology, data mining technology and the artificial intelligence technology. And it has a great impact on decision-making ability and way of military logistics management department.

Due to the large amount of data, traditional excel tool cannot meet the demand of statistics. In this paper, the statistical software SPSS statistics and Access are employed for data collating. First, classifying the data that is more than 0.16 million groups through software Access, and discussing the related factors of equipment state (new, to be used, to be repaired and to be scrapped) by partial correlation analysis method to illustrate the degree of correlation; Then analyzing the rationality of warehouse equipment reserve scale by inferring and modeling to explain whether the existing warehouse equipment reserve situation can meet the requirements of the army.

2. Research on equipment state

2.1 Data sources and analysis

With the advance of information construction, military establishment, the types of equipment and equipment state have been digitized, which makes statistical methods possible to research equipment support [4]. Through a deep research in troops as well as analysis and data processing, it obtained the unit level code, equipment level code, astronomical time and equipment number of 160000 groups (see Appendix 1 to 5) which are connected to equipment status code. The equipment status code are

01,02,03,04, which are respectively on behalf of the equipment of the new, to be used, to be repaired and to be scrapped; Force level code is determined by the corresponding longitude, latitude and elevation; Equipment level code should contain the corresponding number of preparation, existing, available and the number intended to add; and the unit level code and equipment level code have its corresponding amount of reserves and consumption.

2.2 Partial correlation analysis

Generally, simple correlation coefficient is used to study the degree of the linear correlation between the two variables. But when it turns to multiple variables, it is inaccurate to use just simple correlation coefficient. Because the relationship between them is complex, and the simple correlation coefficient only measures the interaction between the two variables, ignoring the influence of other variables on these two variables. In the multiple linear regression models, when independent variables and dependent variables interact with each other, the interaction between independent variables is mixed at the same time. Partial correlation coefficient refers to the relevance degree of the two variables in control of the effects of other variables. Partial correlation analysis method would be more accurate and truer to reflect the degree of correlation between variables [3].

Assuming that a set of independent variables $x_1, x_2, \cdots, x_n$ is to calculate the partial correlation coefficient of x_i and x_j $(i, j = 1, 2, \cdots, n)$. First, calculating the correlation matrix composed of simple correlation coefficient r_{ij} :

$$R = (r_{ij})_{n\times n} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nn} \end{bmatrix} \quad (1)$$

Then calculating the inverse matrix of the R :

$$R^{-1} = \begin{bmatrix} \lambda_{11} & \lambda_{12} & \cdots & \lambda_{1n} \\ \lambda_{21} & \lambda_{22} & \cdots & \lambda_{2n} \\ \vdots & \vdots & & \vdots \\ \lambda_{n1} & \lambda_{n2} & \cdots & \lambda_{nn} \end{bmatrix} \quad (2)$$

At last, the partial correlation coefficient between x_i and x_j is defined as: $c_{ij} = \frac{-\lambda_{ij}}{\sqrt{\lambda_{ii}\lambda_{jj}}}$.

2.3 Partial correlation research of equipment state

It analyzes respectively the correlation between the army level code and unit level code level code, equipment level code, astronomical time and quantity through partial correlation analysis in SPSS software, to obtain the correlation coefficient (Table 1).

Correlation degree refers to the collection of case correlation and significance, of which the higher correlation is, the smaller significance is and the more associated they are. Generally, the correlation coefficient in the 0.1-0.3 is weakly correlated, 0.3-0.5 for medium and 0.5-1.0 for strongly correlated. By data calculation, equipment state is strongly associated with the astronomical time, the equipment level code and quantity. And a low association with unit level code. In the next step, its influence on the equipment status could be neglected when analyzing rationality of equipment reserve scale.

Table 1 Partial correlation coefficient and significance

Equipment status code	Equipment level code	Quality	Unit level code	Astronomical time
Partial correlation coefficient	0.790	0.760	0.002	0.810
Significance	0.000	0.000	0.645	0.000

3. Research on rationality of equipment reserve scale

In the early days of the war, the demand is the main basis to determine the equipment reserve scale [6]. Therefore, the first principle to determine the equipment reserve scale F_1 is that the equipment reserve scale must meet the demand of military struggle F_0, so: $F_1 \geq F_0$. Only when the scale of equipment reserve meets the demand of military struggle, then the scale is appropriate, and when equipment reserve scale is beyond the requirement of military struggle, it is low efficiency. Supposing that F_1 represents equipment reserve scale; and F_0, the initial wartime needs, is the equipment scale ensuring the full load of combat troops. Z represents the reserve equipment efficiency, then there is: $Z = F_1 / F_0$. Military struggle preparation decides equipment reserve scale. Also, the objection and scale of military struggle preparation also restrict the equipment reserve scale, namely, future outbreaks scale determines the initial demand of equipment. Types of war also determine the equipment reserve categories. Based on this hypopaper, further reasoning will focus on rationality of equipment reserve scale.

3.1 Equipment reserve scale F_1 is not less than the initial demand for war F_0

Supposing F_0 is fixed. Due to the consumption of military struggle and war, F_1 will decrease and (F_1 - F_0) will be the reduced volume of equipment reserve, written as S. λ is used as the consumption rate of equipment, that is consumption volume of equipment dividing the total, $\lambda = \vartriangle F_1 / F_1$. Thus, consumption volume of equipment $\vartriangle F_1$ is the product of consumption rate and equipment reserve volume, that is $\vartriangle F_1 = \lambda F_1$. The factors influencing λ includes aging caused by science and technology progress, organic combination of human and equipment. In order to ensure the balance, we must continue to make up for the reduced. Offset the decrease of F_1 is to reproduce new equipment P through the war mobilization, to make up for the consumption of war, to avoid $F_0 \geq F_1$. Thus, during the military struggle, the actual scale of equipment will remain $(F_1 - \lambda F_1 + P)$, and must qualified with the inequation $F_1 - \lambda F_1 + P \geq F_0$.

3.2 Equipment reserve scale F_1 is proportional to the equipment consumption rate λ

If λ and F_0 are determined, then the bigger P is, the smaller the formula $F_1 = (F_0 - P) / (1 - \lambda)$ is. Amount of reproduction P's size is connected to the scale and efficiency of mobilization. Namely, the enterprise scale in the wartime mobilization of producing weapons and equipment ensures the scale of mobilization. And the timeliness of mobilization ensures the timely supplement levels of consumption by equipment recycling volume. Supposing V_i is regeneration variable, among which:

$t \geq i \geq 0$, t means reproduction time, then there is $P_i = V_i * t$ and $F_{1\min} = {(F_0 - P)} / {(1-\lambda)} = {(F_0 - V_i * t)} / {(1-\lambda)}$.

3.3 Equipment reserve scale is inversely proportional to the mobilization scale and speed

The size of equipment reserve scale is inversely proportional to the wartime equipment reproduction quantity scale. And reproduction depends on equipment mobilization scale and speed. Therefore, equipment reserve scale is inversely proportional to the mobilization scale and speed. Once the war broke out, people turn army "on a larger scale and faster speed" which could meet the war demand for equipment continuously, then the usual equipment reserve scale is not big. On the contrary, it must hold large-scale equipment reserve to prepare well for any eventuality [6].

4. Data fitting of equipment reserve

In accordance with the equipment level code, it will integrate the number of inventory reserve and consumption through the Access. There are 376 types of equipment and the difference will be listed. The inventory, consumption and the difference are produced into a line Figure.

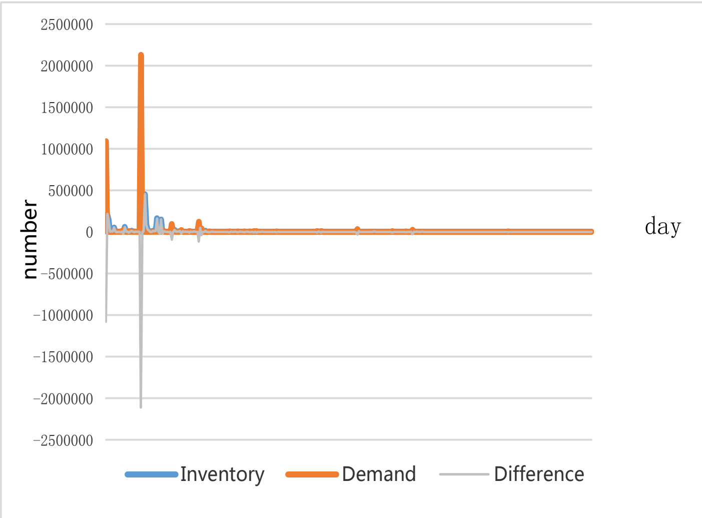

Figure 1 Force equipment reserve and consumption balance Figure

Excepting for a few salient points, the difference line remains relatively stable. It suggests the reasonable relationship between supply and demand in the army inventory, and warehouse reserve can meet the security requirements for an army to some degree. It also can be found in several prominent points, to negative axis of Y , indicating that there is still nearly 20% equipment in extreme shortage or stock (such as shown in Figure 1).

5. Conclusion

Through analysis and fitting of data, using partial correlation analysis and Access, this paper draws the following conclusion: there are strong correlation between equipment and astronomical time, equipment level code and quantity; and supply and demand relationship in the army inventory is relatively reasonable, with 80% warehouse reserve meeting the security needs of troops. But there is still nearly 20% of the equipment extremely in shortage or accumulation. The results of the study correctly analyze the support status of the current force, providing a certain reference for troops and equipment support and management.

References

[1] Deng Wei. Opportunities and challenges faced in the era of big data [J].Expert forum, 2013：49-51.
[2] Li Lin. Introduction to military equipment [M]. Beijing: Academy of Equipment Command and Technology, 2001.248-250.
[3] Wang Huiwen. Partial least squares regression method and application [M]. Beijing: National Defense Industry Press, 1999
[4] Dai Dongsheng. Equipment support data integration model based on the grid technology [J]. Automation, 2007,26 (8):27.
[5] Peng Shengfeng. Research of equipment support data integration based on multi database system technology [J]. National Defense Science and Technology, 2008,29 (4):1-5.
[6] Du Qian, Xue Yong, Jiang Xiaofeng. Study on the determination and optimization of equipment reserve scale [J]. Journal of the Academy of Equipment Command & Technology, 2008,29 (4):1-5.