

A PERFORMANCE EVALUATION OF SUPPLY CHAIN MANAGEMENT OF EQUIPMENT MAINTENANCE MATERIAL BASED ON FUSSY COMPREHENSIVE EVALUATION

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Abstract

Along with the recent high-tech local wars, the new military revolution cored of information technique has come to light, with the clarity of battlefield becoming stronger and stronger and the technique content of weapon material higher and higher, thus the status of Equipment guarantee has also become more and more outstanding. This article has deeply analyzed the basic factors of the performance evaluation of supply chain management of equipment maintenance material, under the normal function of the equipment maintenance material supply institution and mechanism, and evaluated the performance evaluation of supply chain management of equipment maintenance material by means of establishing mathematics model using Fussy Comprehensive Evaluation.

Keywords: The equipment maintenance; the material supply; the supply chain management; the performance evaluation

1 Introduction

The information-based war still emphasizes on technique and equipment. Driving ability of equipment technique guarantee is not only the important premise of insuring high technique weapon a material exertive the biggest effect, but the core and key of recovering and keeping troops fighting strength. As the material foundation of the equipment technique guarantee, the function, level, ability and quality of the equipment maintenance material guarantee will directly affect the war course and result. The study on the performance evaluation of supply chain management of equipment maintenance material will find out the characteristics and regulation of the guarantee of the equipment maintenance material supply, and grasp the key link of the equipment maintenance material supply, which is the significant path insuring equipment credibility and intact rate and raising the quality of the material guarantee and troops fighting strength.

2 Maintain Material of Equipments and Management of Supply Chain of Maintain Material of Equipments

The maintains Material of equipments usually include various of materials and spare parts needed in the

maintenance of weapon equipments, original materials and basic supplies to guarantee the implement of equipment technique, including maintain devices^[1]. Generally, the supply chain refers to a net-shaped mode that core business enterprises turn primary materials into secondary and final products through the control of information flow, material flow and cash flow, then send these products to consumer through the distribution nets. That is a net-shaped mode which links manufactories, suppliers, retail companies, dealers, and final customers together^[2]. Supply chain of maintain Material of equipments is the conclusion of supplies of the maintain Material of equipments in the field of military equipments. The net made up by of equipments business enterprises, types of maintain Material suppliers and maintaining enterprises, validly plan, moderate and control the information flow, material flow and cash flow in the collect, produce, pack, transport, store, deploy, troops using, and retire of maintain Material of equipments ,through reformation and integrated business process^[3]. In conclusion, the management of supply chain of maintain Material of equipments means planning, moderating and controlling the information flow, material flow and cash flow validly by basic principles and scientific methods of management in the collecting, producing, packing, transporting, store, deploying, troops using, and retire of maintain Material of equipments, to make the best coordination and match among various activities in supply of maintain Material of equipments. Although the management of supply chain of maintain Material of equipments does not participate into maintaining of equip directly , the level of the management of supply chain of maintain Material of equipments restricts the quality of guarantee of equipments maintaining ,it also influences the strength of troops.

The study on the management benefits of supply chain of maintain Material of equipments aims at supervising and controlling the supplying process of maintain Material of equipments more validly, providing basis for the optimizing of system of supply chain of maintain Material of equipments, obtaining the best military and economic performance at price of less consume of resources and faster reaction. Therefore, when studying on the management of supply chain of maintain material of equipments, we can not only study

on the managing and supplying process of maintain material of equipments ,we should also concentrate on the consume of resources and guarantee performance in management of supply chain of maintain material of equipments.

3 Analysis on the management benefits of supply chain of maintain devices of equipments

The management of supply chain of maintain devices of equipments aims at controlling quantity of stock maintain devices of equipments , raising recycle rate of stock, lowering cost of transport. The management achievements of supply chain of maintain devices of equipments reflect the comprehensive management quality and effect in the management of supply chain of maintain devices of equipments .Considering recent resources performance, management achievements of supply chain of maintain devices of equipments should consider not only the function optimizing , moderating guarantee quality and respond speed, but also using of resources. The management achievements of supply chain of maintain devices of equipments include comprehensive achievements and dividing achievements.

3.1 Comprehensive performance of management of supply chain of maintain devices of equipments

Comprehensive performance of management of supply chain of maintain devices of equipments reflects comprehensive characteristic of management benefits of supply chain of maintain devices of equipments. It includes time efficiency, satisfaction and economic performance.

Time efficiency refers to organizing capability of activity directly related to the nodes. It can be reflected by time, consisting of up-going time and down-going time. Up-going time begins when the supply chain management nodes receive requirement of maintain clients, and it ends when the nodes ask suppliers of maintain devices of equipments for requirement. Down - going time refers to the time while supply chain management nodes receive messages or objects from suppliers of maintain devices of equipments and move them to maintain clients .

Satisfaction refers to the satisfaction of maintain clients. The satisfaction of maintain clients means approve of service which supply chain management nodes provide for equipments maintain clients . It can be denoted by flexibility and rate of punctual delivery. Flexibility includes quantity flexibility, time flexibility, product flexibility. They respectively reflect the degree of satisfaction of supply chain management nodes on additional requirement in quantity, time and product. Quantity flexibility can be denoted by the rate of additional enough quantity and planned quantity. Time flexibility can be denoted by the rate of additional delivery time and delivery time. Product flexibility can be denoted by the rate of quantity of substituted products in plan and quantity of products in plan. Rate of punctual

delivery can be denoted by the rate of times of punctual delivery and total times of delivery.

Economic performance is test of total cost and total income of supply chain of maintain devices in a period. The total cost includes cost of management, transport, purchasing, stock, etc. These evident cost can be checked in the finance department. The total income includes the income of military and economic.

3.2 The sub-tache performance of supply chain management of equipment maintenance material

3.2.1 The production and the purchase management performance of supply chain of equipment maintenance material

The production and the purchase performance is the basic paths that the troops collects equipment maintenance material. The production and the purchase management of supply chain management of equipment maintenance material is to control the production and the purchase of the supply chain of equipment maintenance material, whose management performance mainly contains the science of producing plan , the rationality of purchasing plan and the standardization of purchasing acceptance.

The scientificness of producing plan firstly embodies on the demand forecast, which makes the production of material and that of corresponding maintenance material synchronously carry out, and prevent from the material amount with corresponding maintenance material amount becoming disjointed, that is, lack leads to not enough while overabundance results in waste. Secondly, pay attention to the general use and standardization of maintenance material design and production, unify the maintenance material with homologous or close function to a same model number as far as possible and compress the category of maintenance material scientifically.

The rationality of purchasing plan firstly embodies on the completeness of the purchase plan. The purchase plan can cover all respects such as the product quality, time of delivery, purchase expenses etc. Secondly, it is the agility of the purchasing plan. There needs to be a variety of expect ideas, which can quickly execute corresponding remedy purchasing plan avoiding the lack of maintenance material because of purchase the problem.

The standardization of purchasing acceptance embodies on the scientific acceptance system. There needs to be various purchasing acceptance system to ensure the acceptance quality. It also embodies on the strict acceptance procedure, which requires carrying on an examination of product quality and technique according to the demand of purchasing contract during the course of purchasing acceptance, as well as the entrance pass of maintenance material.

3.2.2 The storage management performance of supply chain of equipment maintenance material

The process that the equipment maintenance material stores in the warehouse isn't the process of a simple heap but the store and manages process of homologous storage accordingly. It mainly embodies on the perfect degree of regulation system, the store manager's ability character and the automation level of store management.

The perfect and standardized store regulation system is the premise qualification to ensure the storage quality of maintenance material, such as the sealing up and dealing regulation of putting the maintenance material into warehouse, the classification regulation of putting maintenance material, the environment regulation, the system of staff member on duty and handing over and the checking system of the warehouse etc. are all important aspects of store management.

The ability character of management staff is a significant factor influencing the storage of equipment maintenance material, which can directly affect the storage quality of maintenance material, such as the character of using advanced management, acquainting with the technician capability of the maintenance material and science and technology character of storage request, as well as the character of organization ability character in work etc.

Automatic storage management is the basic requirement of implementing equipment maintenance grantee under information-based condition. It can realize the "stock is clear" of the maintenance material through the information system of warehouse storage management. Combined with the equipment manage and command information system, it also can master the situation of warehouse storage of supply chain of equipment maintenance material in the whole system.

3.2.3 The replenishment management performance of supply chain of equipment maintenance material

In the course of maintenance material guarantee, to deliver the maintenance material needed to the maintenance personnel on time and accurately is the important insurance of successful maintenance job. The replenishment management performance of supply chain of equipment maintenance material mainly contains the four aspects: applying and receiving system, delivering management system, transporting management system and take-over system.

Scientific and strict receiving system of maintenance material is the essential guarantee of carrying out the receiving activity. The receiving number is usually calculated based on the scientific evaluation of the maintenance mission according to the guarantee relationship and needs to be simplified, scientifically and easy to operate in receiving procedure.

During the delivering management of maintenance material, it requires being timely and accurate, or the maintenance work will be pulled down. If the equipments are rationally packaged and registered, the delivering speed can be improved. Meanwhile, strictly executing the delivering procedure can ensure the accuracy of this job.

The transporting management of maintenance material requires coordinating all transporting energy and choosing rational replenishment method to complete the transporting mission in cost of least transporting resources, such as reducing the middle links, making use of quick replenishment and saving transporting cost meaner etc. Moreover, it includes package processing, transporting tool management and transporting safety management in the transport process etc.

The take-over system of maintenance material is mainly to settle down the take-over job of maintenance material accordingly, for example, checking the amount, quality and relating files of the received maintenance material, and transact the hand-over procedure, as well as the temporary keeping and storing the received maintenance material. The regular take-over system can maintain a personnel to smoothly use the maintenance material.

3.2.4 The usage and the recovery management performance of supply chain of equipment maintenance material

The usage and the recovery management performance of supply chain of equipment maintenance material are related together. The usage of maintenance material is to make the damaged material recover its technique function as soon as possible, while the recovery is a link of the equipment retire to recycle, which can economize the maintenance resources and raise the usage efficiency that the material maintains a device. The usage and the recovery management performance of supply chain of equipment maintenance material mainly include usage management and recovery management.

The usage management of maintenance material aims to the specific maintaining task. It carries on a precise statistics and log off of the maintenance material, makes an item appropriation particularly in the usage process and works in accordance to maintaining system.

The recovery management of maintains materials is the important path to economize maintaining resources. Before the arrival of lately maintaining devices, we can't abandon the old device, but recycle the old materials after using new materials. Through the classification of damaged materials, such as usable, dis-usable, fixable and unfixable, the damaged materials are recycled according to correspond methods, which is benefit to the recycle and second usage damage of the damaged materials.

4 The management performance evaluation model of supply chain of equipment maintenance material

4.1 Building the index system on the management performance evaluation of supply chain of equipment maintenance material

We can build the evaluation index system according to the related factors of the management performance of

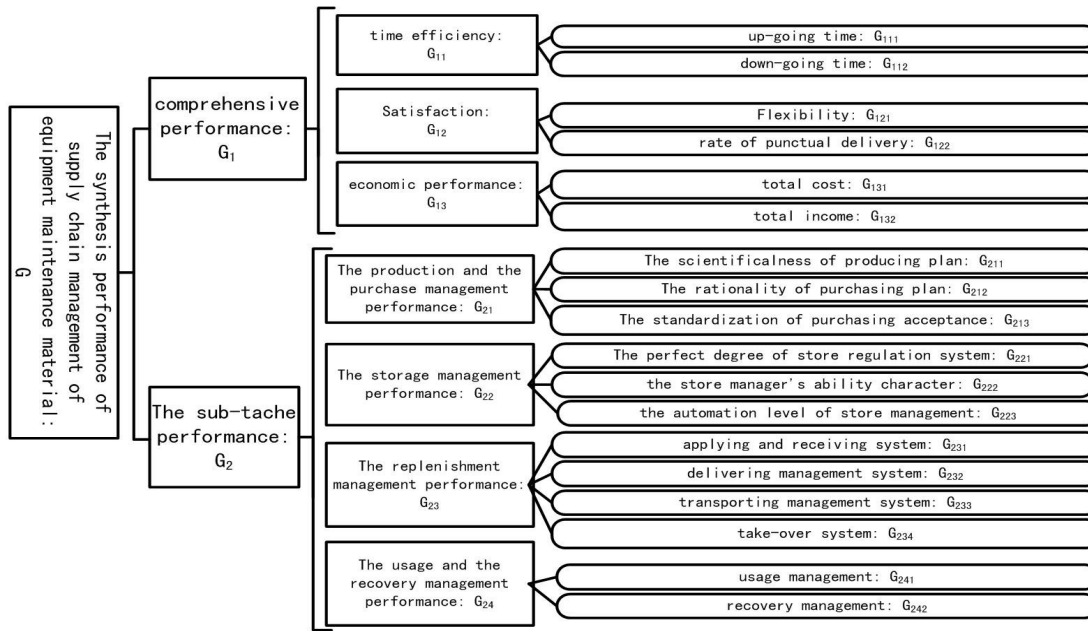


Fig. 1 Sketch of the index system on the management performance evaluation of supply chain of equipment maintenance material

supply chain of equipment maintenance material, showed in Fig.1.

This index system adopts three levels index. Utilizing this index system can realize the elaboration and quantization of the index on the management performance evaluation of supply chain of equipment maintenance material, in which the index are replaced by corresponding symbols, for example, G111 denotes the Up -going time index of time efficiency of the management comprehensive performance evaluation of supply chain of equipment maintenance material. According to this multilevel construction model in the evaluation index system, the evaluation objects can be divided into firstlevel factor aggregate $G=\{G_1,G_2\}$, secondlevel factor aggregate $G_i=\{G_{i1},G_{i2}\}$ ($i=1,2$) and thirdlevel factor aggregate G_{ij} , such as $G_{11}=\{G_{111},G_{112}\}$, $G_{23}=\{G_{231},G_{232},G_{233},G_{234}\}$, etc.

4.2 Fuzzification arithmetic of the index

4.2.1 Definition of evaluation aggregate

In the evaluation course, the evaluation levels of the index usually are set four levels as excellent, good, moderation and inferior, or three levels as excellent, good and inferior, which are used to measure the good and bad degree and differences of the evaluated factors on the index. In this article, the former is adapted for convenience, named as evaluation aggregate $V=\{v_1,v_2,v_3,v_4\}$, where the v_i ($i=1,2,3,4$) denotes the evaluation comment, not numerical value.

4.2.2 Fuzzification arithmetic of the index

Usually, several specialists give a qualitative level evaluation of the first index of the thirdlevel index factor aggregate according to the related requirement and regulation. It requires that the specialists firstly investigate and acknowledge the index, according to the

demands on equipment maintenance guarantee and related work and administrative provisions on equipment maintenance supply, as well as their own professional knowledge and experiences, and then make evaluation conclusion independently choosing one from v_1, v_2, v_3, v_4 .

Take G_{ijk} for example, the membership grade on fuzzy evaluation levels is obtained by fuzzy probability using the formula as follows:

$$r_{ijk} = \frac{\text{The numebrs of specialists giving comment } v_i}{\text{The numbers of all specialists}} \dots\dots (1)$$

Thus, the membership grade of G_{ijk} to fuzzy evaluation aggregate V is r_{ijk} :

$$r_{ijk} = (r_{ijk1}, r_{ijk2}, r_{ijk3}, r_{ijk4}) \dots\dots (2)$$

4.3 Definition of weight vector

The weights denote the relative importance of each index. The specialists sort the index importance according to the management and guarantee requirements of supply chain of equipment maintenance material, and determine the relative importance, then use AHP to obtain the weights of each index, and verify their consistency, finally acquire the weight aggregate of all level factors. (taken from Ref. [6])

$$A=(a_1,a_2);$$

$$A_1=(a_{11}, a_{12},a_{13}); A_2=(a_{21},a_{22},a_{23},a_{24});$$

$$A_{11}=(a_{111},a_{112}); A_{12}=(a_{121},a_{122}); A_{13}=(a_{131},a_{132});$$

$$A_{21}=(a_{211},a_{212},a_{213}); A_{22}=(a_{221},a_{222},a_{223});$$

$$A_{23}=(a_{231},a_{232},a_{233},a_{234}); A_{24}=(a_{241},a_{242});$$

Here, A is firstlevel factor weight aggregate, and $a_i(i=1,2)$ denotes the weight value of index G_i in factor aggregate $G=\{G_1,G_2\}$; A_1 and A_2 are secondlevel factor weight aggregate, $a_{ij}(i=1,2)$ denotes the weight value of index G_{ij} in secondlevel factor weight aggregate $G_i=\{G_{i1},G_{i2}\}$; $A_{11}, A_{12}, A_{13}, A_{21}, A_{22}, A_{23}, A_{24}$ are all thirdlevel factor weight aggregate, a_{ijk} denotes the weight value of index G_{ijk} in thirdlevel factor weight aggregate G_{ij} .

4.4 Construction of fuzzy evaluation matrix

Firstly, the membership grade R_{ij} of G_{ijk} to fuzzy evaluation aggregate V is obtained, and combined with formula (2) to construct four single factor evaluation matrix, that is:

$$\begin{aligned} R_{11} &= (r_{111}, r_{112})^T; & R_{12} &= (r_{121}, r_{122})^T; \\ R_{13} &= (r_{131}, r_{132})^T; & R_{21} &= (r_{211}, r_{212}, r_{213})^T; \\ R_{22} &= (r_{221}, r_{222}, r_{223})^T; \\ R_{23} &= (r_{231}, r_{232}, r_{233}, r_{234})^T; & R_{24} &= (r_{241}, r_{242})^T; \end{aligned}$$

4.5 Calculate synthesis membership grade

The fuzzy value $B_{11}, B_{12}, B_{13}, B_{21}, B_{22}, B_{23}, B_{24}$ of $G_{11}, G_{12}, G_{13}, G_{21}, G_{22}, G_{23}, G_{24}$ can be achieved by threellevel comprehensive evaluation as:

$$\begin{aligned} B_{11} &= A_{11} \circ R_{11}; & B_{12} &= A_{12} \circ R_{12}; \\ B_{21} &= A_{21} \circ R_{21}; & B_{22} &= A_{22} \circ R_{22}; \end{aligned}$$

Here, “ \circ ” is fussy operators(using Richard arithmetic operators, taken from Ref. [7]).

The single factor evaluation matrix of secondlevel index aggregate $G_1=\{G_{11},G_{12},G_{13}\}$ & $G_2=\{G_{21},G_{22},G_{23},G_{24}\}$ of management performance of supply chain of equipment maintenance material is:

$$\begin{aligned} R_1 &= (B_{11}, B_{12}, B_{13})^T; \\ R_2 &= (B_{21}, B_{22}, B_{23}, B_{24})^T; \end{aligned}$$

The fuzzy value B_1, B_2 of subset G_1, G_2 can be obtained by secondlevel comprehensive evaluation:

$$\begin{aligned} B_1 &= A_1 \circ R_1 \\ B_2 &= A_2 \circ R_2 \end{aligned}$$

And the single factor evaluation matrix of management performance of supply chain of equipment maintenance material is:

$$R = (B_1, B_2)^T;$$

Further, the fuzzy value B of G can be gotten by means of firstlevel comprehensive evaluation, and normalized to define its grade of subitem of B according to maximum membership grade principle.

The concrete computational instance and computational process are not given here. For example, in a certain management performance evaluation result of supply chain of equipment maintenance material, we

get the fuzzy value $B=(0.32,0.55,0.13,0)$, and its management performance level of supply chain of equipment maintenance material is assessed as “good” according to maximum membership grade principle, and its membership grade is 0.87, falling into “upper good”(comprise of “good” and “excellent”).

5 Tag

Under the information-based war condition, the military equipment have been consumed greatly, and the need of equipment maintain guarantee has been a diversification, stereoscopic trend. The guarantee of equipment maintenance material has given more important position and guarantee mission. By evaluating the performance of supply chain management of equipment maintenance material, it can improve upon the level of supply chain management of equipment maintenance material, and it also can ensure and serve the warfare better. Utilizing the parse on the performance factor of supply chain management of equipment maintenance material, by building and using the mathematical model on performance evaluation, we can evaluate the performance of supply chain management of equipment maintenance material preliminarily. However, the work is very professional, covers a wide range. Looking forward to an evaluation method which is widespread applied and scientific, a deeper study is needed.

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