Multi Stage Distribution Method of Production Emergency Materials Based on Blockchain Technology

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Abstract. At present, the multi-stage distribution matrix of production emergency supplies is mostly one-way processing, and there are many distribution constraints, leading to the reduction of the optimal distribution coefficient. Therefore, the design and verification analysis of multi-stage distribution method of production emergency supplies based on blockchain technology is proposed. According to the actual distribution demand and standard, describe the production material distribution problem, set the basic distribution goal, adopt a multi-stage approach, build a distribution system, break the distribution constraints, establish a multi-stage distribution matrix, build a multi-stage production material distribution model of the blockchain, and use block oriented optimization to achieve multi-stage distribution. The test results show that, with the assistance and support of blockchain technology, the optimal distribution coefficient can reach more than 6. 5, which indicates that this multi-stage distribution method for production emergency materials is relatively variable, highly targeted, more efficient for the distribution of materials, and the distribution error is controllable, which has practical application value.

Keywords: Blockchain technology · Production emergency · Emergency materials · Multi-stage distribution · Distribution method · Material dispatching

1 Introduction

The occurrence and extension of production line emergencies will cause incalculable property losses to the greatest extent, leading to increased production costs. In order to improve the actual operation quality and efficiency of the production line, a large number of emergency supplies need to be provided in a short time. Under normal circumstances, emergency supplies need to be produced and distributed one by one in stages according to the actual abnormal conditions, and their quantity is also limited. Reasonable and effective distribution of production emergency supplies is an urgent problem to be solved at present [1–3]. The distribution of production emergency materials can be divided into the following aspects: materials, equipment and materials. Therefore, during the production process, the materials to be distributed need to be classified and summarized in advance. Especially for emergency production materials, it is more necessary to design a

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specific production distribution plan. In fact, the premise of reducing emergency losses is mainly the distribution of emergency materials, and the effect of emergency handling is determined by the distribution of emergency materials. The current production line emergency material distribution mode has the problems of high response time and high emergency cost, so it is necessary to analyze and study the emergency material distribution model. Therefore, the design and verification analysis of multi-stage distribution method of production emergency materials based on blockchain technology are proposed.

2 Design and Produce Multi-stage Blockchain Distribution Method for Emergency Materials

2.1 Description of Production Material Allocation Problems

The production emergency material allocation problem can be divided into two categories according to the number of objective functions. One is a single objective planning allocation unit with only one objective function, and the other is a multi-objective planning allocation unit with multiple objective functions [4–6]. The mathematical planning unit form and initial distribution model of production emergency materials distribution are shown in formula (1) and (2):

$$\min_{x} F_{1(x,y)}, F_{2(x,y)}, \ldots, F_{n(x,y)} \tag{1}$$

$$\begin{aligned} F(x, y) &\leq 0 \\ h_i(x, y) &\leq 0 \end{aligned} \tag{2}$$

Formulas (1) and (2): x and y represents the objective function, n indicates the number of allocations, h_i indicates a valid constraint [7–9]. Set the numerical standards obtained above in the initial allocation model to lay the foundation for the implementation of subsequent associated allocation work.

2.2 Setting Basic Allocation Objectives

After the description of production material distribution problem is completed, the basic distribution goal is set by integrating the actual distribution requirements and standards, considering the material production capacity of the company, the standard value of response time for production material allocation is calculated as shown in formula (3):

$$T_j = \min \left[\frac{a + \sum_{e=1} ge + v_2}{v_1} \times (1 - a) \right] + gv_1 \tag{3}$$

In formula (3): a represents the total controllable emergency duration, g represents the unit transportation distance, e indicates the number of times of transportation, v_1 and v_2 it represents the initial transportation volume and actual transportation volume respectively. Based on the above determination, the standard value of response time for production material allocation is calculated and set in the initial allocation model.

Table 1. Standard setting table of multi-stage distribution matrix

Matrix setting allocation stage	Proportion of material reserves	Emergency transmission point (pcs.)	Constraint allocation conditions	Allocation satisfaction rate (%)
Allocation stage 1–1	1.68	12	One-way distribution	45.25
Allocation stage 1–2	1.94	16	One-way distribution	49.51
Allocation stage 2–1	3.05	22	One-way distribution	60.37
Allocation stage 2–2	3.74	24	Targeted allocation	68.54
Allocation stage 3–1	5.24	32	Targeted allocation	89.55
Allocation stage 3–2	6.54	36	Compound distribution	90.27

2.3 Establish Multi-stage Allocation Matrix

Usually, when the production line has abnormal problems, the allocation matrix of the stage is established as the premise of the allocation model design. According to the distribution requirements of production emergency materials, minimize the stage distribution cost of emergency materials as far as possible, and set the distribution standard of the matrix, as shown in Table 1.

According to Table 1, complete the setting and analysis of multi-stage distribution matrix standards. On this basis, the basic framework of the distribution matrix is constructed to form a directional distribution link.

2.4 Building a Multi-stage Production Material Distribution Model of the Blockchain

After completing the establishment of the multi-stage distribution matrix, the next step is to integrate the blockchain technology to build a multi-stage production material distribution model. Set allocation set N, an equivalent independent allocation set composed of n production exception points, and the production exception points can be represented by $i \in N = \{1, 2, \ldots, n\}$. Within the limits of the standard blockchain profit function, describe the total number of production emergency supplies at the production exception points. The specific cooperative game blockchain model structure is shown in Fig. 1.

According to Fig. 1, complete the design and analysis of the cooperative game blockchain production emergency material distribution model structure. Using the above model, calculate the distribution income function at this time, which is used to describe the total amount of transferable utility obtained by the cooperation strategy through coordinating various abnormal points under the cooperation of the alliance distribution

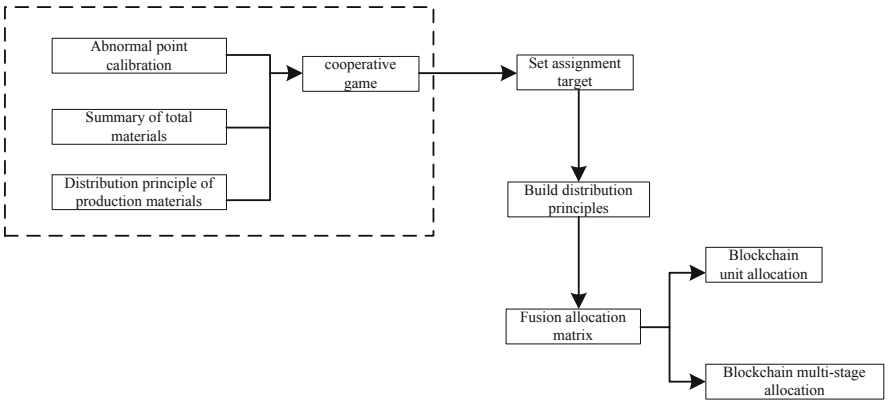

Fig. 1. Structure diagram of emergency material distribution model for cooperative game blockchain production

work, that is, the maximum income corresponding to the alliance distribution [10]. However, it should be noted that the allocation processing of cooperative games usually has super additivity, and it is necessary to control the allocation error of unitarity, as shown in formula (4):

$$g = \theta + \left[\frac{wp}{p - \sum_{w=1} \upsilon w + \theta^2} - 1 \right] + w \tag{4}$$

In formula (4): θ represents the total amount allocated, p represents the independent variable of the income function, υ indicates the number of abnormal points, w indicates the number of blockchain units allocated. Based on the above measurements, the calculation of the unitary distribution error is completed. Next, set it as the actual implementation standard of the corresponding allocation model.

2.5 Block Oriented Optimization for Multi-stage Allocation

After completing the multi-stage production material distribution model of the blockchain, the next step is to integrate the actual distribution needs and standards, and use the block oriented optimization method to achieve multi-stage distribution processing. The optimization threshold value of the distribution result is calculated by using the set material distribution matrix and augmented weighting in combination with the time window and other related constraints, as shown in formula (5):

$$U = \begin{bmatrix} Q_1 \\ Q_2 \\ \vdots \\ Q_n \\ Q^+ \\ Q^- \end{bmatrix} \begin{bmatrix} M_1F_{11} & M_2F_{12} \\ M_1F_{21} & M_2F_{22} \\ \vdots & \vdots \\ M_1F_{n1} & M_2F_{n2} \\ M_1F_{n+1,1} & M_2F_{n+1,2} \\ M_1F_{n+2,1} & M_2F_{n+2,2} \end{bmatrix} \tag{5}$$

Table 2. Summary of Test Data

Determine abnormal points	Sudden abnormal area	Delineation of fault degree	Weight ratio	Proportion of distribution
D1	(112.130)	Strong	1.3	19.86
D2	(425,445)	Strong	1.5	11.28
D3	(1250,1650)	Strong	1.7	30.52
D4	(1600,1850)	Centre	1.2	25.61
D5	(90,100)	Centre	1.3	8.16
D6	(95,115)	Weak	1.5	4.57

In formula (5): Q is the weighting coefficient, M indicates the quantity of directional allocation, F represents an allocation unit. Based on the above measurement, the optimization threshold of the distribution result is calculated. Next, the distribution result is verified and proofread according to the standard of the optimization threshold, and the final distribution task is processed.

3 Method Test

In order to verify the practical application effect of the multi-stage allocation method for production emergency supplies based on blockchain technology, Factory G was selected as the main target object for testing, and a comparative analysis was conducted.

3.1 Test Preparation

Relevant personnel have calibrated and classified the fault according to the five levels of strong, strong, medium, weak and weak. According to the formulated processing principles, the reserve materials have been dispatched for multi-dimensional distribution. Assume that the attribute weight is w = {0.2, 0.3, 0.2, 0.3} This paper takes production raw materials as the distribution target of emergency supplies, and builds a specific distribution environment, as shown in Table 2:

3.2 Test Process and Result Analysis

In the above built test environment, the next step is to integrate the blockchain technology and conduct specific test analysis.

At this time, the allocation data of all attributes will be converted into a specific unit of measure, and the allocated attribute value range will be mapped to the same material allocation interval. After standardization, the standardized optimal allocation will be performed by using the allocation standard deviation conversion method, and the final optimal allocation coefficient will be measured, as shown in formula (6):

$$Y = (1 - B)^2 \times \aleph\beta + \frac{Z\beta}{2} \tag{6}$$

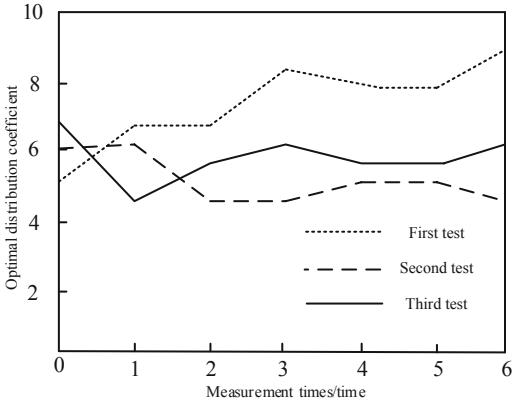

Fig. 2. Comparative analysis of test results

In formula (6): Y represents the optimal distribution coefficient, B represents the total amount of directional allocation, $\aleph$ represents the optimal allocation fixed value, $\aleph$ represents the mapping mean, Z represents the optimal allocation amount. Based on the above measurements, the calculation of the optimal distribution coefficient is completed. Conduct assay analysis as shown in Fig. 2.

According to Fig. 2, with the assistance and support of blockchain technology, the optimal distribution coefficient can reach more than 6.5, which indicates that this multi-stage distribution method of production emergency materials is relatively variable, more targeted, more efficient and faster for the distribution of materials, and the distribution error is controllable, which has practical application value.

4 Conclusion

This paper mainly designs and studies the multi-stage distribution method of production emergency materials based on blockchain technology. The material distribution matrix between abnormal points and characteristic factors is established through analysis, and the algorithm and nature of basic distribution interval value are given. Using blockchain technology, the distribution data and information are normalized, and the standard distribution interval value and relative material demand data under different abnormal conditions at different times are calculated, Further analyze the optimal distribution coefficient between multi-dimensional outliers and characteristic factors. With a targeted allocation ratio, the joint production material process based on the allocation interval is constructed, and the corresponding dynamic allocation model of blockchain emergency resource demand is constructed to improve the feasibility and stability of this allocation method.

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