Research on intelligent scheduling method of power mate rial supply chain based on entropy fuzzy matter-element model

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Abstract. Under the new situation of the vigorous development of power Internet of Things, the information blockage exposed by the traditional power grid material supply can be solved by digital technology. Firstly, the profit function of the participants in the direct electricity trading supply chain is constructed, and then the profit distribution model of the direct electricity trading supply chain is constructed by using the blockchain intelligent contract, and the interests are automatically matched and settled according to the distribution factors, so as to realize the optimization of the interests of each enterprise in the direct electricity trading supply chain and ensure the optimization of the interests of the whole supply chain, and a power material supplier evaluation model based on entropy weight analysis model and fuzzy matter-element model is proposed. It is verified that the model can effectively optimize and provide a new method for the selection of power material suppliers.

Keywords: Direct fuzzy element model, material supply chain, and scheduling method

1 Introduction

At present, the supply chain has become an important organizational form of industrial form, and the existence of the supply chain needs to maintain the stability of the whole chain, which makes the issue of how to accurately and objectively distribute benefits among supply chain members particularly important. As a new network technology, blockchain technology takes distributed computability as its main technical feature, and intelligent contracts based on blockchain architecture as version 2.0 of blockchain, with its characteristics of low cost, full automation and avoiding human interference, can bring fair and equitable transactions to all parties to the contract[1].

In the application of big data in the whole supply chain management of power grid materials, we should first analyze its data information source, structure and characteristics, and understand the current situation of data information application. Therefore,

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the planning of big data application is discussed from a macro perspective, management objectives with different priorities are set and mathematical analysis models of each module are constructed, so as to realize the effective application of big data in the whole supply chain of power grid materials[2].

The operation of the whole supply chain of power grid materials mainly includes the nodes of material production enterprises, logistics and warehousing. The daily operation of these key nodes should focus on the needs of power grid construction and operation, sign purchase contracts with suppliers according to the production plan, ensure the safety and efficiency of power material transportation and control reasonable inventory. Electric power enterprises are the management core of the whole supply chain, and the operation efficiency of their management system will not only directly affect their own economic benefits, but also have an impact on the daily management and operation of material supply and logistics enterprises[3]. Therefore, electric power enterprises play a decisive role in the formulation and implementation of production plan, business contract management and total inventory control of each node in the whole supply chain of materials[4].

In the operation and management of the whole supply chain of power grid, the data sources are not only traditional structural data, but also non-structural information related to material production and supply and logistics enterprises, such as the credit status of enterprises, the changes of relevant policies and regulations in the industry market and the competitive situation. These information are of great strategic reference value to the operation and management of the whole supply chain of power grid materials, and are the decision-making basis for power enterprises to adjust their procurement, warehousing and transportation schemes[5]. At present, besides the business data between enterprises and the inventory management data of materials, there are also the basic financial information and management accounting information of power enterprises themselves. These traditional structural data come from different nodes and related business processes in the whole material supply chain and are stored in the information management system equipment of related enterprises and departments. Its application is basically confined to the interior of various enterprises and departments, so the relevance and potential application value of data information have not been fully tapped[6].

In the aspect of data information analysis and application technology, based on the Internet and computer technology, the data generated in the daily production and management process of the whole supply chain of electric power enterprises can be deeply processed, which can realize in-depth analysis of business processes based on specific management objectives and explore effective ways to optimize enterprise management and operation[7]. At present, due to the information management of the whole supply chain of power grid materials, the data generated has brought challenges to the traditional information system in both quantity and quality. First, the generation of various structured data has the characteristics of continuous dynamic change, and in order to obtain valuable and relevant unstructured information, the information system is required to collect and process information in many fields. Therefore, the amount of information is increasing all the time, and the traditional storage equipment and information processing ability of the system can no longer meet the management requirements of the whole supply chain of power grid materials[8].

To sum up, scholars have done in-depth research on supply chain benefit distribution and blockchain smart contract, but the research on applying blockchain smart contract technology to supply chain benefit distribution is rarely involved. This paper attempts to apply smart contract to the design of the benefit distribution mechanism of all parties in the power direct trading supply chain in order to avoid mutual distrust caused by human intervention and ensure the lasting cooperation of all parties involved in the power direct trading supply chain[9]. The direct trading supply chain, which consists of the production, transmission, distribution and use of electric power, can only seek long-term and stable common development through mutual benefit. To formulate the profit distribution scheme of enterprises in the direct trading supply chain of electric power, we must first design a scientific cooperative profit distribution model, and at the same time, supplement it with effective implementation means to ensure it. Therefore, the benefit distribution mechanism of the supply chain of direct electricity trading based on blockchain smart contract proposed in this paper has extremely high theoretical significance and practical value[10].

2 Intelligent scheduling platform demand analysis

The intelligent scheduling platform covers functional modules such as job scheduling, production management, production monitoring, production business analysis, etc. of the provincial metering center, receives all kinds of production work orders issued by the marketing business application system, and schedules the data interaction and work flow of the automatic verification system, intelligent warehousing system and logistics distribution system of the provincial metering center in real time, thus realizing all-round control over all businesses, production links and work quality of the provincial metering center[11]. Its functions mainly include two parts: one is production management, production monitoring and production analysis, which is the basic function that the production scheduling platform of provincial metrology center must have; The other part is production maintenance and management business, which serves the production and management functions of provincial measurement centers. The platform needs to integrate subsystems such as detection system, warehousing and logistics system to realize seamless connection with verification/detection system and warehousing and logistics system, realize the whole process management of planning, procurement, warehousing, verification, distribution, etc. for metering equipment such as single and Three-phase electric power electric energy meters and acquisition terminals, and realize the full life cycle management of electric power materials through close connection with the ERP system marketing business application system[12].

3 Construction of entropy fuzzy matter-element model

3.1 Fuzzy Matter-Element Model

Matter-element analysis mainly describes things through the three elements of "things, characteristics and magnitude". Assuming that there is a thing N and its corresponding characteristic C has a magnitude of V, then the ordered triplet R=(N, C, V) can represent the basic elements of things, which is called matter-element for short. If the characteristic value has fuzzy properties, it is called fuzzy matter element. For the multi-objective selection problem that needs fuzzy decision-making and analysis, that is, there are multiple evaluation indexes and multiple selection schemes, it is necessary to construct a compound fuzzy matter-element model[13].

3.1.1 Define compound fuzzy matter element

Suppose that there are m suppliers of a power material, which are denoted as N1, N2, ..., Nm; Each evaluation sample has n evaluation indexes C1,C2,…, Cn, and the corresponding fuzzy values of these evaluation indexes are u(xij)l≤j≤ n,1≤ j≤ m), then Rnxm is a fuzzy matter element, which is recorded as:

$$\begin{bmatrix} & N_1 & N_2 & \dots & N_m \\ C_1 & u(x_{11}) & u(x_{12}) & \dots & u(x_{1m}) \\ C_2 & u(x_{21}) & u(x_{22}) & \dots & u(x_{2m}) \\ \dots & \dots & \dots & \dots & \dots \\ C_n & u(x_{n1}) & u(x_{n2}) & \dots & u(x_{nm}) \end{bmatrix} \quad (1)$$

3.1.2 Pretreatment of indicators

The membership degree of the evaluation value of the evaluation index to the standard sample index is called the preferential membership degree (generally positive). For an evaluation sample, the evaluation indicators can be divided into the bigger the better (such as management ability, product performance, product qualification rate and other indicators in supplier evaluation of power supply enterprises) and the smaller the better (such as price, delivery period, etc.). In order to meet the principle of preferential membership, the following definitions are made:

The bigger the better indicator:

$$x_{ij}^{*} = \frac{x_{ij} - m_i}{M_i - m_i} \quad (2)$$

Where Mi = max {xij} and mi = min {xij}.

The smaller the better indicator:

$$x_{ij}^{*} = \frac{M_i - x_{ij}}{M_i - m_i} \tag{3}$$

Among them, Mi and mi have the same meaning.

3.2 Entropy Weight Analysis Model

Entropy weight analysis model is a method to determine the index weight according to the information load of each index[14].

Let the decision matrix be:

$$D = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1m} \\ x_{21} & x_{22} & \dots & x_{2m} \\ \dots & \dots & \dots & \dots \\ x_{n1} & x_{n2} & \dots & x_{nm} \end{bmatrix} \tag{4}$$

Where xij is the index value of the i-th scheme under the j-th index attribute.

The steps to determine the index weight by entropy method are as follows:

Calculate the characteristic proportion or contribution of the ith system under the index j:

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \left(i = 1,2,\dots,n;\ j = 1,2,\dots,m\right) \tag{5}$$

In formula (5), pij represents the contribution degree of the i-th scheme under the attribute of the j-th index.

(2) Calculate the entropy ej of the j-th index, where the entropy ej represents the total contribution of all schemes to the j-th index:

$$e_f = -k\sum_{i=1}^{n} p_{ij} \ln p_{ij} \tag{6}$$

Generally, take $k - \frac{1}{\ln n}$ to ensure that 0≤ ej≤1. When the contribution degree of each scheme under an index attribute tends to be consistent, ej tends to be 1, indicating that the index attribute does not work in decision-making, especially when it is all equal, the weight of the target attribute can be considered as 0 without considering the project attribute[15].

Calculate the difference coefficient gj of the index X, which indicates the degree of inconsistency of the contribution of each scheme under the j-th index, and is determined by Formula (7):

$$g_j = 1 - e_j \tag{7}$$

Obviously, the greater gj, the more attention should be paid to the role of this index.
Calculate the weight wj of the j-th index, which is the normalized weight:

$$w_j = \frac{g_j}{\sum_{i=1}^{m} g_i} \tag{8}$$

3.3 Comprehensive evaluation

According to the composite fuzzy matter-element matrix R and the weight W of each index, the comprehensive evaluation set is calculated:

$$K = W \cdot R = \{K_1, K_2, \ldots, K_m\} \tag{9}$$

According to the comprehensive evaluation result K, the comprehensive evaluation is carried out according to the comprehensive evaluation value.

4 Examples

A certain power supply company needs to purchase a batch of smart energy meters. We are currently selecting 10 suppliers as evaluation objects and selecting the best supplier from them. Based on the established supplier evaluation indicators for power supply enterprises, a professional evaluation team is established, and experts from the evaluation team determine the indicator values of each supplier based on supplier related data. Among them, qualitative indicators are scored by experts on a ten point scale, with a minimum score of 0 and a maximum score of 10; There are two sources of quantitative indicator data: original data and formula calculation. The specific indicator data of the supplier is detailed in Table 1.

Table 1. Initial Data Table of Supplier Indicators

Index	Supplier				
	N1	N2	N3	N4	N5
Management capability (C1)	9	8	7	6	7
Credit rating (C2)	0.7	0.7	0.8	0.76	0.73
Manufacturing Hardware Foundation (C3)	8	7	8	7	6

Product qualification rate (C4)	0.83	0.82	0.8	0.73	0.74
Price (C5)	540	500	408	520	490

In Table 1, the price and delivery time are indicators that are smaller and better, while management ability and credit rating are indicators that are larger and better. The data is normalized according to equations (1) and (2), and a composite fuzzy matter-element matrix is constructed. The entropy weight method is used to determine the weights of each indicator, and the corresponding indicator weights are calculated according to equations (7) and (8), as shown in Table 2. By using the linear weighting method, the evaluation coefficients can be obtained, as shown in Table 3.

Table 2. Index indicators

Administrative capacity（W1）	Quality rating（W2）	Production of hardware and software foundation（W3）	Product property（W4）	Product percent of pass（W5）	Price（Yuan）（W6）	Supply period（d）（W7）	Technical support（W8）	Error treatment and timely rate（W9）	Information provision ability（W10）	Environmental protection performance（W11）	Environmental management performance（W12）
0.079	0.089	0.076	0.097	0.129	0.108	0.085	0.071	0.068	0.074	0.064	0.079

Table 3. Evaluation coefficient table

N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
0.347	0.332	0.520	0.359	0.534	0.406	0.808	0.479	0.511	0.920

5 Overall realization of benefit distribution based on blockchain smart contract

5.1 Blockchain smart contract benefit distribution mechanism

Through blockchain technology, low-cost direct communication channels can be established among enterprises participating in power supply chain, so as to realize the rapid completion of interest distribution among enterprises in direct power supply chain, promote the coordination of interests in time, and disperse consensus at the same time. This mechanism can ensure the fairness and security of system distribution[16].

Intelligent contract can optimize the mechanism of benefit distribution, reduce the time cost of benefit distribution, and improve the benefit and efficiency of the whole power direct trading supply chain participating in benefit distribution among enterprises.Therefore, the benefit distribution mechanism of power direct trading supply chain proposed in this paper, which integrates blockchain technology and smart contracts, can help all parties involved in the power direct trading supply chain to establish and complete the benefit distribution quickly, credibly and automatically, protect their own interests, and then ensure the dynamic stability of the whole supply chain.In this mode, the distribution mechanism of power direct transaction supply chain integrating blockchain and smart contract is shown in Figure 1.

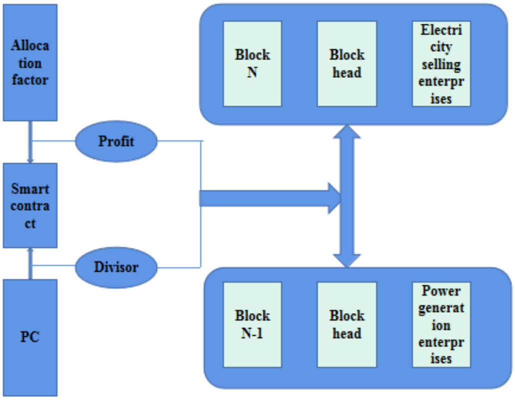

Fig. 1. Benefit distribution mechanism of blockchain intelligent contract

5.2 Smart Contract Formulation Steps

1) The user first registers on the blockchain and receives a public key and private key pair from the blockchain platform.

2) Two or more users agree to the agreement of rights and obligations, if necessary. These rights and obligations are created electronically, and the participants sign with their private keys, confirming the validity of the contract.

3) The signed smart contract is shared on the blockchain network according to the agreed terms.

6 Conclusion

Under the environment of direct electricity trading market, the distribution mode of benefit sharing in power supply chain is proposed based on blockchain smart contract. The quantitative model of benefit distribution in power supply chain and the benefit distribution mechanism based on blockchain smart contract are established, and the intelligent contract execution mechanism is formulated. The mechanism shows that after the transaction is successfully executed, the smart contract can automatically execute the terms of the contract in sequence, and the state of the contract is recorded through the state mechanism, which ensures the fairness and fairness of benefit distribution.

Through the formulation of the benefit distribution of smart contracts, the power generation companies and power sales companies in the direct power trading supply chain can ensure the optimization of the overall interests of the supply chain while pursuing the maximum of their own interests. At the same time, with the help of blockchain smart contracts, the timeliness and non-series modification of the distribution can be guaranteed, and the benefits of the whole direct power trading supply chain can be automatically maximized, so that the whole direct power trading supply chain can maintain a long-term and stable cooperative relationship. As the main trading form in China electricity market, direct electricity trading has many benefits, so it has a good theoretical and practical prospect. This paper only gives the theoretical model and framework, and further research on the quantitative model needs to be carried out.

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