

Research Article **The Cost Management on the Quantification of Responsibility**

Wenwen Zhou ^(b),¹ Yuchen Li,¹ Hao Liu ^(b),² and Xiaobo Song³

¹School of Economics and Management, Beijing University of Technology, No. 100 Pingpark, Chaoyang District, Beijing 100124, China ²School of Economics and Management, Beihang University, No. 37 Xueyuan Road, Haidian District, Beijing 100191, China ³Research Institute of Coal Strategy and Planning, China Coal Research Institute, Beijing 100013, China

Correspondence should be addressed to Wenwen Zhou; zhouwenwen@bjut.edu.cn

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Cost management is an important part of enterprise management and can enhance the competitiveness of enterprises and improve the sustainability of enterprise development. Responsibility management can maximize the enthusiasm and initiative of employees and effectively improves the efficiency of cost management. Quantitative responsibility is the premise of realizing responsibility management. Aiming at the problem of unclear responsibility for costs within the enterprise, a method for responsible quantification based on intuitionistic trapezoidal fuzzy numbers and genetic algorithms is proposed in this paper. This paper first expounds on a cost management structure model, uses the method of intuitionistic fuzzy mathematics to determine the initial value of the responsibility based the structure model, then constructs the quantitative model for the coefficient of responsibility, and finally uses a specific enterprise as an example of quantitative calculations to solve the responsibility problem.

1. Introduction

1.1. Background. With the proposal of Germany "Industry 4.0," America "Industry Internet," and China "Made in China 2025," a new industrial revolution, marked by highly digitized production, networks, and information, is sweeping across the globe. In the new industrial revolution, the deepening development of information makes enterprise managers face massive, multisource, heterogeneous, fragmented and sparse cost data, which provides a possibility for the introduction of new information technology. At the same time, enterprise information planning is in great demand and brings new challenges for enterprise management, especially for enterprise cost management. The traditional enterprise development mode will encounter revolutionary change; the internal logic of cost accounting during the information era should adapt to the change in enterprise environment. Under this new economic normal, accounting systems based on big data and information systems need to be reconstructed; cost management will play a more important role as a tool of promoting economic transition. As an important process of cost management, cost management of responsibility must clarify the body and size of cost responsibility in the enterprise management process, so that the enterprise cost management can be controlled effectively.

Since the "13th five-year plan," China, influenced by changes in domestic and foreign economic environments, started to emphasize enterprise cost management and promote the cost-decreasing development strategy of "cutting overcapacity, destocking, deleveraging, reducing corporate costs, and shoring up weak spots." Controlling the enterprise cost effectively is an important issue that needs to be solved urgently to confirm responsibility of cost and select a proper mode to supervise the cost responsibility body. However, the cognitive level of governors is limited, and there are many factors that restrict enterprise development, which causes problems in the current enterprise cost responsibility management.

From the perspective of the enterprise cost responsibility relationship, there lacks a scientific cost responsibility traceability and quantification method. In the new industrial revolution, intelligent planning and design in factories involve many enterprise departments, but traditional enterprise cost accounting methods cannot truly reflect the internal logic between cost and the liability body, and they cannot restore the occurrence time, space, and logical attributes of cost, making it difficult to implement cost management of responsibility into each process of production and management and to implement it into related subject departments. At present, most enterprises take departmental production costs as a responsibility body subjectively, which causes unclear ownership of enterprise cost responsibility. From the perspective of enterprise cost information, there lacks effective information display methods. In the new industrial revolution, cost information has demand for multimodal interaction, but at the moment, enterprise cost information "grows thickly." The amount of cost management information is massive, and enterprise cost management has problems with this massive amount of information, the single information display mode, and the low efficiency in attaining information for managers.

1.2. The Necessity Analysis of the Quantification of Responsibility. The quantification of responsibility is an important part of cost responsibility management. It is the basis of cost assessment, analysis, and system formulation, which is crucial in enterprise management. A reasonable responsibility coefficient can improve the performance management level, mobilize employees' enthusiasm, exert the potential of each employee, realize cost control, and, finally, achieve the goal of increasing profit. In contrast, an unreasonable cost responsibility coefficient not only frustrates employees' enthusiasm but also affects the production efficiency of enterprises. It has become the key to solve many problems in the cost management of enterprises by quantifying the responsibility of each liability body, guiding the behavior of the responsible body, and improving the operability of responsible management.

Indeed, the fundamental goal of enterprise operation and production is to maximize their interests. Due to the enterprise's internal and external environmental conditions, including huge market pressures, a single enterprise cannot control the market, and they are a recipient within the market. Thus, effectively reducing costs and improving cost efficiency become inevitable choices of every enterprise to improve their efficiency. It is an effective means of cost management to cooperate with each other and implement responsible management. The quantitative method of responsibility is a way to realize this, which can promote the active and effective cost management of the individual responsibility bodies and improve the efficiency of enterprises.

In order to quantify the cost of responsibility, the relationships among different responsibility bodies and the factors (subject and object) that influence the responsibility bodies shall be taken in to account. (1) Liability bodies contain the sum of all project costs for which they are responsible. The management of cost in operations often requires the joint participation of different responsibility bodies. (2) Different objective factors such as the level of education of the responsibility bodies, their technical level, and their own quality can lead to many aspects such as differences between subjects of observations, information collection, and handling methods. This leads to different preferences, which ultimately affect the input and effort of each responsibility body, thus making cost management uncertain.

This paper proposes the quantification responsibility of cost on the basis of cost management structure model, thus achieving the purpose of the responsible management of cost. The responsible management of cost is the right, responsibility and distribution of each responsible subject, and the cost management structure model will be elaborated upon in Section 3. The cost management structure model is proposed so that cost management information can be effectively displayed. Compared with traditional methods, it is more intuitive and efficient and also extends the responsibility of cost management to cost information, knowledge content, and related relationships. We quantify the responsibility of cost, define the responsibility size of each responsible subject, realize the scientific allocation of labor, and improve the efficiency of work. The optimization of the responsibility coefficient can improve the internal competitiveness of enterprises and improve the sustainability of enterprise development. Notations are used throughout the paper.

2. Literature Review

Cost management is an important measure for enterprises to gain competitive advantage. For all aspects of cost management, domestic and foreign scholars have done a lot of systematic research, such as the methods of cost management, cost management in the forecasting, and cost management responsibility.

In terms of cost management methods, the activity-based costing management has been gradually extended to supply chain cost management, strategic cost management, and information cost management [1]. Chunhui and Jinchang [2] and other scholars put forward the humanism cost accounting method. In this method, the actor's "responsibility" and "contribution" can be clearly defined, which will enable people to achieve self-behavior management and realize the organic integration of cost management and cost accounting at the behavioral level. Guenther and Gaebler [3] studied the application of strategic cost management in enterprises. Jung and Park [4] analyzed and elaborated the role of information methods on reducing cost through studying the relationship between cost management and information management. In the aspect of cost management forecasting, Mittas et al. [5] and other scholars have constructed the error recognition and evaluation model and applied it to the cost budget. Li and Mohanram [6] and other scholars proposed an alternative plan of cross-sectional prediction model to carry out the cost prediction. This method effectively overcomes the calculation limitation of hidden cost and improved the accuracy of prediction. Onyango et al. [7] and other scholars have optimized and analyzed the cost and budget of effective pavement in urban arterial roads. Elfaki et al. [8] used intelligent technology to estimate the cost of the construction industry, and the method has been proposed as the standard for construction cost estimation.

In terms of cost management responsibility, Hong and Andersen [9] and other scholars studied how corporate responsibility affects costs. This lays a foundation for research on factors affecting manufacturing cost. Cao [10] studied how to use information means to improve the management level of corporate responsibility cost. This effectively eliminates the enterprise's internal information island and information asymmetry and enables the enterprise to form the scientific standard management mode. El Ghoul et al. [11] and other scholars have discussed the impact of corporate environmental responsibility on the cost of equity capital of manufacturing enterprises. They believed that improving environmental responsibility will reduce the cost of equity financing for enterprises, while the negative correlation between CER and financing cost is playing a role in the global scope. Xin et al. [12] and other scholars studied the performance of responsibility cost control of construction projects. They believed that the information rent and game conflict had a negative impact on the annual cost responsibility performance of the project department.

It can be identified from the literature summary that, for the cost management research, the scholars have done much work, but most of the research works mainly focus on cost management methods, and how to apply the methods to cost forecasting. However, there are few researches on cost management responsibility, especially on the quantification of enterprise cost responsibility. Based on this, this paper provides research on the quantification of cost responsibility. Firstly, this paper adopts an intuitionistic fuzzy correlation method to conduct quantitative research on the enterprise responsibility of cost. Then, we build an optimization model in which the cost of each responsibility unit is treated as the objective and each responsibility body is treated as a constraint. The construction of a quantitative model of enterprise cost responsibility is of vital significance for optimizing the responsibility coefficient and improving the level of enterprise cost management.

3. Brief Introduction of the Cost Management Structure Model

In this section, we develop a new cost management structure model. The cost management structure model is based on activity-based costing, and according to a certain hierarchical structure, it is effective in organizing cost information according to the process of cost and the subject of responsibility. In the process of enterprise production and operation, cost can be divided into several "Area Costs" according to its time and space attribute. In addition, we can divide it into "Block Costs" based on the "Area Costs." Moreover, then "Block Costs" can be further divided into "Unit Costs." Those that cannot be easily classified as "Area Costs," "Block Costs," "Unit Costs," and auxiliary production costs are defined as "Line Costs." Then we can call the cost management structure model "LUBA." It is formed by connecting the first letter of the "Line," "Unit," "Block," and "Area" [13], as shown in Figure 1.

LUBA cost management adopts a hierarchical structure to express the cost of responsible unit and stresses the internal structure of cost incurred, which can restore the space, time, responsibility, and other attributes of cost, and it is the basis management for cost responsibility. Distinguished from the other cost management models, LUBA has several advantages: (1) LUBA can reflect the inner relationship between different cost bodies; (2) the time, space, and responsibility attributes of the cost bodies in LUBA are well tractable; (3) LUBA can help the enterprise to perform feed-forward and concurrent control from the perspective of total management.

4. Quantifying Responsibility of Cost

The key to the quantification of the responsibility coefficient is to construct a quantitative model that is proper and scientific. In the process of cost management, each responsibility body pursues their own interests, assuming that each is rational. The purpose of cost management is to make the cost benefit optimal for the corresponding liability unit. Therefore, we quantified the responsibility coefficient by an established model in which optimal efficiency of each cost control unit and the benefit of the responsibility body are established. Due to the uncertainty of the environment and the objective of the process of enterprise cost management, the problem of responsibility has its own fuzzy nature, so we have to determine the initial responsibility coefficient by the method of fuzzy mathematics. This method is based on the intuitionistic trapezoidal fuzzy number, expanding the fuzzy set into the intuitionistic fuzzy set. It considers membership degree, nonmembership degree, and hesitation based on fuzzy sets. This method has more flexibility in the distribution of responsibility and can fully consider the interaction between the cost project and the responsibility body. Therefore, the initial value of responsibility is determined by using an intuitionbased fuzzy number method, and then the responsibility quantification model is constructed.

4.1. Initial Value Determination of Responsibility Based on Intuitionistic Trapezoidal Fuzzy Mathematics. Assume that one unit cost U in one enterprise has m_1 "Unit Cost" items and m_2 "Line Cost" (consists of "Area Line Cost" and "Block Line Cost") items. Let $m = m_1 + m_2$, and C_1, C_2, \ldots, C_m is then the cost items of this unit. Assume this unit has n responsibility bodies set as D_1, D_2, \ldots, D_n . Take the cost item as a row element and take the responsibility subject as a column element to construct Table 1. The cross position is the responsibility correlation coefficient of C_j and D_i recorded as r_{ij} , as shown in Table 1.

The RB represents responsibility body; r_{ij} is intuitionistic trapezoidal fuzzy number. The matrix with *n* columns and *m* rows composed of responsibility correlation coefficients is called the responsibility correlation matrix. It is expressed as $D = (r_{ij})_{nm}$. The first m_1 columns are fuzzy responsibility coefficients of "Unit Costs" items, and later, m_2 columns are "Line Costs" corresponding to the fuzzy responsibility coefficients of each "Area Cost" and "Block Cost" divided into this "Unit Costs":

$$r_{ij} = \left(\left[h_{1j}(D_i), h_{2j}(D_i), h_{3j}(D_i), h_{4j}(D_i) \right]; \mu_j(D_i), \\ \vartheta_j(D_i) \right).$$
(1)



FIGURE 1: LUBA structure.

TABLE 1: The relationship between the cost item and the responsibility body.

ם תת		Cost i	tem C_i	
$\operatorname{KB} D_i$	C_1	C_2		C_m
D_1	<i>r</i> ₁₁	<i>r</i> ₁₂		r_{1m}
D_2	r_{21}	<i>r</i> ₂₂		r_{2m}
:	:	:	·	:
D_n	r_{n1}	<i>r</i> _{n2}	•••	r _{nm}

The intuitionistic trapezoidal fuzzy number of related responsibility body D_i under cost item C_j can be attained through an investigation questionnaire and statistical analysis, in which $\mu_j(D_i)$ indicates that the responsibility coefficient of the responsibility body for each cost item belongs to the degree of the intuitionistic trapezoidal fuzzy number $[h_{1j}(D_i), h_{2j}(D_i), h_{3j}(D_i), h_{4j}(D_i)]; \vartheta_j(D_i)$ indicates that the responsibility coefficient of responsibility body D_i corresponding to cost item C_j does not belong to the degree of intuitionistic trapezoidal fuzzy number $[h_{1j}(D_i), h_{2j}(D_i),$ $h_{3j}(D_i), h_{4j}(D_i)], 0 \le \mu_j(D_i) \le 1, 0 \le \vartheta_j(D_i) \le 1$, and $0 \le \mu_i(D_i) + \vartheta_j(D_i) \le 1$ [14].

In the following, we make preliminary quantifications for responsibility coefficients of each responsibility body for cost control unit *U*. Set the corresponding weight vectors of cost items as $\overline{\omega} = (\overline{\omega}_1, \overline{\omega}_2, \dots, \overline{\omega}_n)$ and $\omega_i \in [0, 1], \sum_{i=1}^n \overline{\omega}_i = 1$.

Firstly, apply the related calculation formula of the canonical fuzzy decision matrix to transfer matrix $T = (t_{ij})_{nm}$, $t_{ij} = [h_{1j}(D_i), h_{2j}(D_i), h_{3j}(D_i), h_{4j}(D_i)]$ composed of the intuitionistic trapezoidal fuzzy number in related responsibility matrix $D = (r_{ij})_{nm}$ into normalized matrix, $M = (m_{ij})_{nm}$; here, $m_{ij} = [m_{ij}^1, m_{ij}^2, m_{ij}^3, m_{ij}^4]$ in which $m_{ij} = \max_j (h_{4j}(D_i) - h_{kj}(D_i))/\max_j (h_{4j}(D_i) - \min_j (h_{1j}(D_i)))$, k = 1, 2, 3, 4. Then, set the normalized matrix as $D' = (r'_{ij})_{n \times m}$. Find the positive ideal solution of each cost item in normalized matrix G_j^+ , $G_j^+ = ([\max(m_{ij}^1), \max(m_{ij}^2), \max(m_{ij}^3), \max(m_{ij}^4); 1, 0])$ and the negative ideal solution $G_j^-, G_j^- = ([\min(m_{ij}^1), \min(m_{ij}^2), \min(m_{ij}^2); 0, 1])$ [15–17].

Secondly, calculate the distances of the responsibility correlation coefficient, the positive ideal solution, and the negative ideal solution through a related formula and record them as d_{ij}^+, d_{ij}^- ; here, $d_{ij}^+ = d(a_{ij}, G_{ij}^+) = \sum_{j=1}^m \overline{\omega}_j d(r'_{ij}, G_{ij}^+)$, and $d_{ij}^- = d(a_{ij}, G_{ij}^-) = \sum_{j=1}^m \overline{\omega}_j d(r'_{ij}, G_{ij}^-)$.

Thirdly, solve the maximum distance difference d_{\max}^+ , d_{\max}^- and minimum distance difference d_{\min}^+ , d_{\min}^- of d_{ij}^+ , d_{ij}^- , $d_{\max}^+ = \frac{\max}{ij} d_{ij}^+$, $d_{\min}^+ = \frac{\min}{ij} d_{ij}^+$, $d_{\max}^- = \frac{\max}{ij} d_{ij}^-$, $d_{\min}^- = \frac{\min}{ij} d_{ij}^-$.

Fourthly, calculate the correlation coefficient $\varepsilon_{ij}^+, \varepsilon_{ij}^$ between each responsibility correlation coefficient and positive and negative ideal solution d_{ij}^+, d_{ij}^- , and then transfer the responsibility correlation matrix into the correlation coefficient matrix $P_1 = (\varepsilon_{ij}^+)_{m \times n}$, $P_2 = (\varepsilon_{ij}^-)_{m \times n}$, in which the formula of the correlation coefficient is

$$\varepsilon_{ij}^{+} = \frac{d_{\min}^{+} + \delta d_{\max}^{+}}{d_{ij}^{+} + \delta d_{\max}^{+}}$$

$$\varepsilon_{ij}^{-} = \frac{d_{\min}^{-} + \delta d_{\max}^{-}}{d_{ij}^{-} + \delta d_{\max}^{-}}$$
(2)

in which δ is the resolution coefficient with a value of 0.5.

Fifthly, calculate the correlation coefficient between each responsibility body and positive and negative ideal solutions.

$$\varepsilon_{i}^{+} = \sum_{j=1}^{n} \overline{\omega}_{j} \varepsilon_{ij}^{+},$$

$$\varepsilon_{j}^{-} = \sum_{i=1}^{n} \overline{\omega}_{j} \varepsilon_{ij}^{-}.$$
(3)

Set up the following antecedent planning model to solve the weight vector of the cost item:

min
$$P_2 = \min \sum_{i=1}^{m} \sum_{j=1}^{n} \overline{\omega}_j \left(\varepsilon_{ij}^+ - \varepsilon_{ij}^- \right)$$

s.t $\overline{\omega}_j \in \overline{\omega}, \quad j = 1, 2, 3, \dots, n$ (4)
 $\sum_{j=1}^{n} \overline{\omega}_j = 1, \quad \overline{\omega}_j \ge 0.$

This linear planning model can be solved with MATLAB, and then the weight vector $\overline{\omega} = (\overline{\omega}_1, \overline{\omega}_2, \dots, \overline{\omega}_n)^T$ can be attained.

Finally, calculate the relative correlation degree of each responsibility body for positive ideal solution and record it as $\varepsilon_i = \varepsilon_i^+ / (\varepsilon_i^+ + \varepsilon_i^-)$. Take ε_i as the related responsibility coefficient and set its responsibility coefficient as $(r_1^U, r_2^U, \dots, r_n^U)$.

4.2. Constructing the Quantification Model of Responsibility. The determination of the responsibility coefficient can improve the degree of effort of the responsibility body. We adopt the methods for determining the responsibility coefficient, which is proposed by Jiang and Zhu and the other scholars [18]. The key factor of cost control lies in the effort level of each responsibility body. Each responsibility body interacts with the others and finally promotes the decrease of each unit cost and the increase of its net income, which is an important presentation of the core ability of the responsibility subject. Set the increased income function of unit U as $Z_U(K, e)$. Here, K is the influencing factor of other comprehensive factors, and e is the effort level of responsibility body in unit U. When each responsibility correlation body in unit U manages cost, the net income of unit U as well as the net income of responsibility body will increase. Set r_i as the responsibility allocation coefficient of unit U [19], and the increased income for responsibility body D_i due to effort supervision is $r_i Z_1(K, e)$.

The cost C_i of responsibility body is composed of two parts, including daily productive cost C_{pi} and cost C_{Gi} , increased by effort supervision, which is $C_i = C_{pi} + C_{Gi}$. Here, we only consider the role of effort in the supervision of the responsibility body; therefore, define C_{pi} as the constant and C_{Gi} as the function of e_i . Thus, the increased cost of the responsibility body is C_{Gi} . The increased cost C_U of unit U is the sum of the effort cost of each responsibility body $\sum_{i=1}^{n} C_{Gi}$, which is $C_{U_1} = \sum_{i=1}^{n} C_{Gi}$, and then the increased net income of unit U is

$$P_U = Z_U(K, e) - C_U.$$
⁽⁵⁾

The increased net income of responsibility body D_i is

$$P_{D_i} = r_i Z_U(K, e) - C_{Gi} \tag{6}$$

in which $C_{Gi} = C_G(k_i e_i)$, and k_i is the effort cost coefficient of the responsibility body. It can be seen from formula (6) that the amount of income received by the responsibility body determines how much responsibility it should bear. The formula of net income for the responsibility body presents the principle of mutual unification among rights, responsibility, and profit. Assume that P_U is the strictly increasing concave function of e; then:

$$\begin{aligned} \frac{\partial P_U}{\partial e_i} &> 0, \\ \frac{\partial^2 P_U}{\partial^2 e_i} &< 0, \\ \frac{\partial^2 P_U}{\partial e_i \partial e_j} &> 0 \\ & (i \neq j; \ i, j = 1, 2, \dots, n). \end{aligned}$$

$$(7)$$

It can be seen from formula (7) that the optimized responsibility coefficient solution has been transferred into a responsibility coefficient allocation problem, which meets the maximization of increased net income of responsibility body as well as increased net income of related units; the following optimization model is used to solve the problem:

$$\begin{array}{ll} \max & P_U \\ \text{S.T.} & \max P_{D_i} & (i = 1, 2, \dots, n) \\ & r_i > 0 & (i = 1, 2, \dots, n) \\ & e_i > 0 & (i = 1, 2, \dots, n) \,. \end{array}$$

5. A Numerical Example

To further analyze the confirmation issue of the responsibility coefficient from a visualized management perspective, we take the cost of "Recovery Block" in "Underground Production Area" of a coal enterprise as an example and adopt the responsibility coefficient confirmation method in the paper to confirm the responsibility coefficient of cost. In the cost of the "Recovery Block," five units of "Supporting Unit," "Coal Mining Unit," "Coal Loading Unit," "Coal Handling Unit," and "Coal Management Unit" have been divided. We take each "Coal Mining Unit" as an example and confirm the responsibility coefficient of the "Coal Unit" cost.

Firstly, the cost responsibility bodies of each "Coal Mining Unit" include two different parts, individual and department. This paper takes department responsibility bodies as an example, which mainly include the human resources team, supply team, operation team, production technology department, safety supervision department, dispatch team, coal team, tunneling team, transport team, ventilation team, and electromechanical team. The human resources team, supply department, and operation team belong to the operation management department. The production technology department, safety supervision department, and dispatch team belong to the ground production department. The coal team, transportation team, ventilation team, and electromechanical team belong to the underground production departments.

Secondly, within the cost of each "Coal Mining Unit," we clarify cost generating items, which mainly include staff salary cost, special tool cost, the cost of product components, oil emulsion cost, and other costs, as well as depreciation expense, electricity expense, and others which belong to "Line Cost." As the fixed cost in a coal enterprise accounts for a major ratio in the production and management process, so we should study the influence of depreciation of fixed cost, so we include depreciation in the LUBA cost management model by way of "Line Cost" and allocate it to specific units. Managers may then understand and track the useful condition of heavy equipment and timely and effectively improve the useful efficiency of equipment, while ensuring the machine remains in service.

Thirdly, we sent out investigation questionnaires. We focused on sending questionnaires to coal mines, as well as to institutions studying the coal economy. There were 100 copies of questionnaires sent out in total, and 98 effective questionnaires have been collected. Through sorting out all the collected effective questionnaires, we clarify the interval corresponding to the intuitionistic trapezoidal fuzzy number, and at the same time, we study the membership degree and nonmembership degree of each responsibility body based on the distribution results of data statistics and confirm the fuzzy correlation matrix of cost responsibility, as shown in Table 2.

The positive ideal and the negative ideal are, respectively:

$$G^{+} = (([5, 6, 7, 8]; 1, 0) ([6, 7, 8, 9]; 1, 0) ([6, 7, 8, 9]; 1, 0) ([5, 6, 7, 8]; 1, 0) ([4, 5, 6, 7]; 1, 0) ([4, 5, 6, 7]; 1, 0))$$

$$G^{-} = (([1, 2, 3, 4]; 0, 1) ([1, 2, 3, 4]; 0, 1) ([1, 2, 3, 4]; 0, 1) ([1, 2, 3, 4]; 0, 1) ([1, 2, 3, 4]; 0, 1) ([1, 2, 3, 4]; 0, 1)) ([1, 2, 3, 4]; 0, 1) ([1, 2, 3, 4]; 0, 1) ([1, 2, 3, 4]; 0, 1))$$
(9)

The function of linear programming is solved by MAT-LAB to determine the weight coefficient of each cost project in the "Coal Mining Unit":

$$\overline{\omega}_{1} = 0.3$$

$$\overline{\omega}_{2} = 0.1$$

$$\overline{\omega}_{3} = 0.2,$$

$$\overline{\omega}_{4} = 0.2,$$

$$\overline{\omega}_{5} = 0.085,$$

$$\overline{\omega}_{6} = 0.03,$$

$$\overline{\omega}_{7} = 0.085.$$
(10)

According to the calculation procedure described in this paper, the initial liability coefficient of the responsible body of the "Coal Unit" after normalization is shown in Table 3.

Table 3 shows the tunneling team, supply team, HR team, and operation teams, and so on; these departments, which were supposed to have little responsibility, actually need to take on some responsibility, reflecting the correlation between the subjects.

The contribution level of the individual responsibility body is set as $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_{11}$; among them, $0 < \varepsilon_i < 1$, and the cost of strengthening regulation is $C_{G1}, C_{G2}, \ldots, C_{G11}$. The net income of the "Coal Mining Unit" U and the individual liability subject in the unit can be expressed as

$$P_{U} = Ke_{1}^{\epsilon_{1}}e_{2}^{\epsilon_{2}}\cdots e_{1}^{\epsilon_{11}} - \left(\frac{1}{2}k_{1}e_{1}^{2} + C_{G1_{0}}\right)$$

$$-\left(\frac{1}{2}k_{2}e_{2}^{2} + C_{G2_{0}}\right) - \cdots - \left(\frac{1}{2}k_{11}e_{11}^{2} + C_{G1_{0}}\right)$$

$$P_{D_{1}} = r_{1}\left(Ke_{1}^{\epsilon_{1}}e_{2}^{\epsilon_{2}}\cdots e_{1}^{\epsilon_{11}}\right) - \left[\frac{1}{2}k_{1}e_{1}^{2} + C_{G1_{0}}\right]$$

$$P_{D_{2}} = r_{2}\left(Ke_{1}^{\epsilon_{1}}e_{2}^{\epsilon_{2}}\cdots e_{1}^{\epsilon_{11}}\right) - \left[\frac{1}{2}k_{2}e_{2}^{2} + C_{G2_{0}}\right]$$

$$\vdots$$

$$P_{D_{11}} = r_{2}\left(Ke_{1}^{\epsilon_{1}}e_{2}^{\epsilon_{2}}\cdots e_{1}^{\epsilon_{11}}\right) - \left[\frac{1}{2}k_{2}e_{2}^{2} + C_{G2_{0}}\right].$$
(11)

The value of the other comprehensive factors of K is 300. The values of the contribution level of the individual responsibility body $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_{11}$, the cost of strengthening regulation $C_{G1}, C_{G2}, \ldots, C_{G11}$, and the effort cost coefficient are shown in Table 4.

				cost item			
RB	Staff salary	Special tools	Product components	Oil and emulsion	Other expenses	Electricity expense	Depreciation
Conltant	[(4, 5, 6, 7);	[(6, 7, 8, 9);	[(6, 7, 8, 9);	[(6, 7, 8, 9);	[(5, 6, 7, 8);	[(2, 3, 4, 5);	[(1, 2, 3, 4);
	0.7, 0.2]	0.6, 0.2]	0.8, 0.1]	0.9, 0.1]	0.8, 0.2]	0.8, 0.1]	0.9, 0.1]
Tunnaling team	[(4, 5, 6, 7);	[(2, 3, 4, 5);	[(3, 4, 5, 6);	[(2, 3, 4, 5);	[(3, 4, 5, 6);	[(2, 3, 4, 5);	[(1, 2, 3, 4);
	0.8, 0.1]	0.8, 0.2]	0.5, 0.5]	0.7, 0.3]	0,7, 0.3]	0, 6, 0.3]	0.8, 0.2]
Transnort tram	[(3, 4, 5, 6);	[(4, 5, 6, 7);	[(4, 5, 6, 7);	[(5, 6, 7, 8);	[(2, 3, 4, 5);	[(2, 3, 4, 5);	[(1, 2, 3, 4);
11 ausport team	0.8, 0.2]	0.9, 0.1]	0.8, 0.2]	0.8, 0.2]	0.9, 0.1]	0.8, 0.2]	0.7, 0.1]
Wontilation toom	[(3, 4, 5, 6);	[(3, 4, 5, 6);	[(2, 3, 4, 5);	[(4, 5, 6, 7);	[(2, 3, 4, 5);	[(2, 3, 4, 5);	[(1, 2, 3, 4);
	0.8, 0.2]	0.7, 0.3]	0.6, 0.4]	0.8, 0.2]	0.7, 0.3]	0.6, 0.4]	0.7, 0.3]
Electromechanical	[(3, 4, 5, 6);	[(5, 6, 7, 8);	[(6, 7, 8, 9);	[(5, 6, 7, 8);	[(3, 4, 5, 6);	[(4, 5, 6, 7);	[(4, 5, 6, 7);
team	0.8, 0.2]	0.7, 0.3]	0.6, 0.3]	0.8, 0.1]	0.6, 0.3]	0.8, 0.1]	0.8, 0.2]
Droduction toom	[(2, 3, 4, 5);	[(2, 3, 4, 5);	[(2, 3, 4, 5);	[(3, 4, 5, 6);	[(2, 3, 4, 5);	[(1, 2, 3, 4);	[(2, 3, 4, 5);
ETUUULU LEATT	0.8, 0.2]	0.8, 0.2]	0.6, 0, 4]	0.7, 0.3]	0.7, 0.3]	0.8, 0.2]	0.7, 0.3]
Safety supervision	[(2, 3, 4, 5);	[(2, 3, 4, 5);	[(2, 2.5, 3, 4);	[(3, 4, 5, 6);	[(1, 2, 3, 4);	[(1, 2, 3, 4);	[(1, 2, 3, 4);
team	0.8, 0.2)]	0.8, 0.2]	0.6, 0.3]	0.8, 0.2]	0.7, 0.3]	0.7, 0.3]	0.7, 0.3]
Dispatch	[(2, 3, 4, 5);	[(2, 3, 4, 5);	[(1, 2, 3, 4);	[(1, 2, 3, 4);	[(1, 2, 3, 4);	[(2, 3, 4, 5);	[(1, 2, 3, 4);
team	0.8, 0.2]	0.7, 0.3]	0.8, 0.2]	0.8, 0.2]	0.8, 0.2]	0.8, 0.2]	0.7, 0.3]
HD team	[(5, 6, 7, 8);	[(1, 2, 3, 4);	[(1, 2, 3, 4);	[(1, 2, 3, 4);	[(2, 3, 4, 5);	[(1, 2, 3, 4);	[(1, 2, 3, 4);
TTIN REGITT	0.7, 0.2]	0.7, 0.2]	0.8, 0.2]	0.9, 0.1]	0.8, 0.1]	0.7, 0.3]	0.6, 0.3]
Supply team	[(1, 2, 3, 4);	[(5, 6, 7, 8);	[(6, 7, 8, 9);	[(5, 6, 7, 8);	[(2, 3, 4, 5);	[(1, 2, 3, 4);	[(1, 2, 3, 4);
ouppry ream	0.8, 0.2]	0.8, 0.2]	0.7, 0.2]	0.8, 0.2]	0.8, 0.2)	0.7, 0.2]	0.8, 0.2]
Oneration team	[(2, 3, 4, 5);	[(3, 4, 5, 6);	[(2, 3, 4, 5);	[(2, 3, 4, 5);	[(3, 4, 5, 6);	[(1, 2, 3, 4);	[(1, 2, 3, 4);
	0.6, 0.3]	0,7, 0.2]	0.8, 0.2]	0.7, 0.3]	0.8, 0.2]	(0.8, 0.2)	(0.7, 0.2)]

Operation team	0.0778	
Supply team	0.095	
HR team	0.0831	
Dispatch team	0.0716	
Safety supervision team	0.0756	
Production team	0.0764	
Electro mechanical team	0.1128	
Ventilation team H	0.0878	
Transport team	0.1050	
Tunneling team	0.0883	
Coal team	0.1230	

coefficient.
correlation
g liability
orresponding
TABLE 3: C

	ε ₉	70.0	k_9	27	$C_{G_{9_0}}$	20
	ε_{10}	0.63	k_{10}	28	C_{G10_0}	22
	ε ₁₁	0.60	k_{11}	32	C_{G11_0}	25
	83 1	0.45	k_8	32	C_{G8_0}	28
alues.	ε ₇ 0.10	0.49	k_7	29	C_{G7_0}	24
ble 4: Parameter v	ε6 0 π0	06.0	k_6	28	C_{G6_0}	20
TA	ε ₂	0./0	k_2	23	C_{G2_0}	22
	ε ₅	cc.0	k_5	30	C_{G5_0}	25
	e S S	C0.U	k_3	28	C_{G3_0}	26
	ε4 4	96.0	k_4	26	C_{G4_0}	25
	ε ₁	0.60	k_1	25	C_{G1_0}	20

Then, through MATLAB programming, the genetic algorithm [20, 21] is adopted to encode the optional liability coefficient. Then, the selection, hybridization and variation are performed to calculate the fitness value of various liability coefficients. Finally, the coefficient of liability of the "Coal Mining Unit" after optimization is shown in Table 5.

According to the external factors affecting the responsibility coefficient, and based on optimization results of the responsibility coefficient, the top five responsibility teams affecting the cost benefit of the "Coal Mining Unit" in the "Recovery Block" have been attained. Findings have been optimized from initial coal team, tunneling team, transportation team, electromechanical team, and supply team to production team, coal team, electromechanical team, transportation team, and tunneling team. The production team provides guidance for production technology, makes investigations on hydrogeological conditions, ensures the quality of hydrogeological conditions, affects the selection of mining technology, prevents the occurrence of safety accidents, and then plays a crucial role in affecting enterprise cost. The quality of production technology determines the rationality of the engineering operation process and cost control, so it takes on a core responsibility. However, the supply department decreases the costs affecting the "Coal Mining Unit" through internal control and decreasing operational expenditures.

The coal team is the department with the most direct cost occurrence, and it is mainly responsible for the processes of coal mining. Whether the material utilized during production is compliant, whether the recovery is timely, and whether the operation is standardized will directly affect the unit cost occurring in this unit.

The electromechanical team is mainly responsible for the inspection, utilization, maintenance, and updating of electromechanical equipment in production process; whether the inspection and maintenance of electromechanical equipment are made timely will have an important influence on staff safety and production operations. The frequency at which equipment is updated will affect the operation cost of the enterprise.

The transportation team is mainly responsible for the stability of the belt, its safe operation, and the transportation of coal products during production. Transportation efficiency and whether the operation situation is stable have a critical influence on the output of coal, and this team should increase its cost management efforts.

The tunneling team is mainly responsible for production, tunneling, supporting, and maintenance, and so on. The quality of support and whether maintenance is made timely will affect the cost of the "Coal Mining Unit." Therefore, the tunneling department takes on an important responsibility in the field of cost.

6. Conclusion

The enterprise cost management is becoming more and more important, under the background of the new normal of economic development in China. This paper provides research on the responsibility quantification problem of cost management. We propose to set up a quantification model after the preliminary determination of the responsibility coefficient with the adoption of intuitionistic fuzzy theory on the basis of a LUBA cost management model. We then confirm the responsibility coefficient through the solution of a genetic algorithm.

After the cost responsibility coefficient is determined, and through the quantitative management of the responsibility of each liability body, including the decomposition of responsibility, reward, punishment, and profit distribution, we can guide the various responsible bodies of enterprises toward the established cost management objectives. In this way, every department and every employee in the enterprise can pay attention to cost and cost consciousness in their daily work. Our methods can gradually change the cost management concept of employees from the passive participation to the active drive and gradually change the work principles and methods of cost responsibility management into the behavior habits of enterprises. These methods can cultivate employees' consciousness of cost control to form an enterprise cost management culture.

The quantification of responsibility based on the LUBA structure can stimulate each responsibility subject to following the given direction, which is good not only for realizing real-time and dynamically responsibility management of cost but also for making the cost management mode more intuitive, concise, and efficient. It can intuitively expose long standing problems existing in the enterprise cost responsibility management program and then decrease cost management expenses, improve the quality of enterprise cost control, and build up a solid foundation for enterprise management and decision-making.

Notations

C_i :	The <i>j</i> th cost item of a unit, $j = 1, 2,, m$
D_i :	The <i>i</i> th responsibility body of a
	unit, $i = 1, 2,, n$
<i>G</i> :	The ideal solution of the normalized
	responsibility matrix M
M:	The normalized responsibility matrix
T:	The intuitionistic trapezoidal fuzzy
	number matrix
P:	The correlation coefficient matrix
K:	Then influencing factor of other
	comprehensive factors
$Z_u(K, e)$:	The increased income function of unit U
d_{ij} :	The distance of responsibility correlation
	coefficient r_{ij}
$h_{kj}(D_i)$:	The intuitionistic trapezoidal fuzzy
,	number of the related responsibility body
	D_i under cost item C_i , $k = 1, 2, 3, 4$
m_1 :	The number of "Unit Cost" items
m_2 :	The number of "Line Cost" items
<i>m</i> :	The total number of cost items
n:	The number of responsibility bodies
r _{ij} :	The responsibility correlation coefficient

r_{ij}

optimization results.
coefficient
TABLE 5: Responsibility

Operation team	0.0552
Supply team	0.0735
HR team	0.0615
Dispatch team	0.0500
Safety supervision team	0.0543
Product team	0.2956
Electromechanical team	0.0913
Ventilation team	0.0662
Transport team	0.0833
Tunneling team	0.0667
Coal team	0.1014

- μ_j : The degree that the responsibility coefficient belongs to the intuitionistic trapezoidal fuzzy number
- ϑ_j : The degree that the responsibility coefficient does not belong to the intuitionistic trapezoidal fuzzy number
- ω_i : Weight vectors of cost item *i*
- ε_{ij} : The correlation coefficient value of related responsibility body D_i under cost item C_j
- e: The effort level of the responsibility body.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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