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Application of multi-attribute decision-making methods based on normal random variables in supply chain risk management

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Abstract

For the multi-criteria group decision-making problem where the criterion value is a normal interval number and the weight information is incomplete, the normal interval number and its compromise expected value, compromise mean square error, algorithm, weighted arithmetic average of normal interval number (ININWAA) Operator, the ordered weighted average (ININOWA) operator of normal interval numbers and the mixed weighted average (ININHA) operator of normal interval numbers, and a multi-criteria group with incomplete information based on normal interval numbers is proposed. Decision-making methods. This method uses ININWAA operator and INNHA operator to integrate criterion values, uses the compromise mean square error of criterion values, establishes an optimisation model to solve the optimal criterion weights and uses the expectation variance criterion to determine the order of the schemes. The case analysis shows the effectiveness and feasibility of this method.

Keywords: group decision making, normal interval number, ensemble operator**AMS 2010 codes:** 34A34

1 Introduction

Multiple attribute decision is limited, and programs relating to the selection of multiple properties are reported. In reality, due to the complexity and uncertainty of multi-attribute decision-making problems, the results of measurement or evaluation of the property value may be in the form of random variables, where property values obedience or approximately normally distributed random variables are the most common form. For example,

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the life of the product, batch pass rate products, customer or market demand, and sometimes that is normally distributed. how to solve the normal random variable with multi-attribute decision has important significance. Currently, for a multi-attribute decision problem with a property value normal to the random variable, a targeted decision analysis method is not much of use but can see some of the random multi-attribute decision-making methods, such as stochastic dominance based, SMAA method, etc. It should be noted that the use of methods to solve stochastic dominance based on random normal random variables with a multi-attribute decision-making problem can only qualitatively determine the part of the two dominant relationships between the two programs but cannot determine the dominant degree; SMAA using methods is calculated based on the Monte Carlo simulation program to sort the results; obtained results are sorted in a certain sense of confidence based on the above analysis; a multi-attribute decision proposed a solution for having a normal random variable. Methods which use probabilistic knowledge of the normal random variable had two advantages when compared with the two programs of the matrix; on this basis, PROMET HEE method is used to sort programs [1].

In the actual decision-making process, due to the complexity of ambiguity, uncertainty and the human mind objective things, it is often difficult to give a specific numerical guideline value and representing it by the number of intervals is more convenient and more suitable. In the multi-criteria decision-making problems, guideline values of the interval number and people with the guideline value as a random variable fall within a certain range of numbers. Therefore, this article defines the normal range and the number of related concepts, gives some integrated operator normal interval number information and proposes guidelines for interval numbers, and the weight information is not complete; multi-criteria group decision-making is normal and methods and examples are analysed [2].

2 Normal interval numbers and related definitions

Definition 1. Let $[a, b]$ be the interval number that has been normalised. (according to the knowledge of data normalization processing, it can be assumed that the interval numbers are all non-negative interval numbers), if the criterion value $r \in [a, b]$ obeys the normal distribution $N(\eta, \sigma^2)$, then $[a, b]$ is called normal. The number of distribution intervals is denoted as $\tilde{\alpha} = \{\eta, \sigma\}$, where, according to the 3σ principle of normal distribution, that is, $p(r \in [a, b]) = 0.9974$, the expected value η and the mean square error σ are determined by the following formula:

$$\eta = \frac{1}{2}(a + b) \quad (1)$$

$$\sigma = \frac{1}{6}(b - a) \quad (2)$$

Definition 2. Let $\tilde{\alpha}_1 = \{\eta_1, \sigma_1\}$ and $\tilde{\alpha}_2 = \{\eta_2, \sigma_2\}$ be any two normal distribution interval numbers, then the following equations are obtained:

1. $\tilde{\alpha}_1 \oplus \tilde{\alpha}_2 = \{\eta_1 + \eta_2, \sqrt{\sigma_1^2 + \sigma_2^2}\};$
2. $\lambda \tilde{\alpha}_1 = \{\lambda \eta_1, \lambda \sigma_1\}, \lambda \geq 0.$

Definition 3. Suppose X is a given universe and $\{\eta(x), \sigma(x)\} \in \Omega$ When $\mu_A(x) = 1, v_A(x) = 0$ the normal interval number set degenerates to the normal distribution interval number set.

For convenience, we call $\tilde{\beta} = \langle \{\eta, \sigma\}, \mu, v \rangle$ the normal interval number, where $\{\eta, \sigma\}$ is the normal distribution interval number, $\mu \in [0, 1], v \in [0, 1], \mu + v \leq 1$, and let Θ be the set of all normal interval numbers.

Normal interval numbers have more advantages than fuzzy numbers and normal distribution interval numbers. Compared with the fuzzy number, an evaluation value is added to the normal interval number, namely the normal distribution interval number $\{\eta, \sigma\}$, so that the membership degree μ and the non-membership degree v are opposite to a specific evaluation value and relative to the normal distribution interval number evaluation

value. The degree of non-membership ν and the degree of hesitation π are added to the normal interval number, which can reflect the degree of non-membership of the evaluation value of the interval number of the normal distribution and the degree of hesitation of the decision maker. Therefore, the normal interval number is more accurate and reasonable in reflecting decision information [3]. As can be seen from the normal interval number $\tilde{\beta} = \langle \{0.82, 0.13\}, 0.75, 0.20 \rangle$, the decision maker believes that the degree of evaluation object belonging to $\{0.82, 0.13\}$ is 0.75, while the degree of not belonging to $\{0.82, 0.13\}$ is 0.20, and the degree of hesitation that cannot be determined whether it belongs to $\{0.82, 0.13\}$ is 0.05 [4].

Definition 4. Let $\tilde{\beta}_1 = \langle \{\eta_1, \sigma_1\}, \mu_1, \nu_1 \rangle$ and $\tilde{\beta}_2 = \langle \{\eta_2, \sigma_2\}, \mu_2, \nu_2 \rangle$ be any two normal interval numbers, then the following equations are obtained:

1. $\tilde{\beta}_1 \oplus \tilde{\beta}_2 = \left\langle \left\{ \eta_1 + \eta_2, \sqrt{\sigma_1^2 + \sigma_2^2} \right\}, \frac{\eta_1 \mu_1 + \eta_2 \mu_2}{\eta_1 + \eta_2}, \frac{\eta_1 \nu_1 + \eta_2 \nu_2}{\eta_1 + \eta_2} \right\rangle;$
2. $\lambda \tilde{\beta}_1 = \langle \{\lambda \eta_1, \lambda \sigma_1\}, \lambda \mu_1, \lambda \nu_1 \rangle, \lambda \geq 0.$

It is easy to know that all the operation results in definition 4 are still normal interval numbers and satisfy the following:

1. $\tilde{\beta}_1 \oplus \tilde{\beta}_2 = \tilde{\beta}_2 \oplus \tilde{\beta}_1;$
2. $(\tilde{\beta}_1 \oplus \tilde{\beta}_2) \oplus \tilde{\beta}_3 = \tilde{\beta}_1 \oplus (\tilde{\beta}_2 \oplus \tilde{\beta}_3);$
3. $\lambda (\tilde{\beta}_1 \oplus \tilde{\beta}_2) = \lambda \tilde{\beta}_1 \oplus \lambda \tilde{\beta}_2, \lambda \geq 0;$
4. $\lambda_1 \tilde{\beta}_1 \oplus \lambda_2 \tilde{\beta}_1 = (\lambda_1 + \lambda_2) \tilde{\beta}_1, \lambda_1, \lambda_2 \geq 0.$

Using the expectation-variance criterion, this paper defines a comparison and ranking method of normal interval numbers.

Definition 5. Suppose $\tilde{\beta} = \langle \{\eta, \sigma\}, \mu, \nu \rangle$ is the number of normal intervals. From Definition 3, it can be known that its confidence in the number $\{\eta, \sigma\}$ of the normal distribution interval is the interval C $[\mu, 1 - \nu]$, then $E^L(\tilde{\beta}) = \eta \mu$ is the minimum expected value of $\tilde{\beta}$, $E^R(\tilde{\beta}) = \eta (1 - \nu)$ is the maximum expected value of $\tilde{\beta}$ and $[E^L(\tilde{\beta}), E^R(\tilde{\beta})]$ is the expected value interval of $\tilde{\beta}$. Thus, the expected compromise value of $\tilde{\beta}$ is as follows:

$$E(\tilde{\beta}) = \frac{\eta(\mu + 1 - \nu)}{2} \quad (3)$$

Definition 6. Let $\tilde{\beta} = \langle \{\eta, \sigma\}, \mu, \nu \rangle$ be the number of normal intervals, call $D^L(\tilde{\beta}) = \sigma \mu$ the minimum mean square error of $\tilde{\beta}$, $D^R(\tilde{\beta}) = \sigma (1 - \nu)$ be the maximum mean square error of $\tilde{\beta}$ and $[D^L(\tilde{\beta}), D^R(\tilde{\beta})]$ be the mean square error interval of $\tilde{\beta}$. Thus, the compromise means square error of $\tilde{\beta}$ is given as follows:

$$D(\tilde{\beta}) = \frac{\sigma(\mu + 1 - \nu)}{2} \quad (4)$$

3 Supply chain risk theory and modelling

3.1 Theoretical analysis of supply chain

We can get the definition from ‘Logistics Terminology’: Supply chain refers to the entire process of production and circulation, which includes all corporate activities from upstream to downstream and includes every node in the network structure. This definition understands the supply chain as a network structure model formed

by the interconnection of related enterprises. The supply chain includes all the enterprises that pass through in the commodity circulation link. However, Ma Shihua and others believe that the supply chain is the sum of information flow, capital flow and logistics. They revolve around core enterprises, from raw materials to final products, and deliver them to the final consumers, bringing retailers, suppliers and distributors together, a network chain that connects manufacturers and end users. The supply chain is not a simple information chain, material chain or capital chain. It is also a value-added chain. After the product passes through circulation, assembly and intermediate processing links, until it is transformed into the final product, every link will have value. Chinese enterprises can also obtain certain benefits from this and integrate downstream consumers with upstream suppliers. Therefore, it can be concluded that the supply chain is a network composed of core enterprises and all enterprises involved in providing products or services to end users, including capital flow, logistics, information flow and their value-added chain. According to the understanding of the supply chain, its basic model can be represented by the following figure:

Fig. 1 The basic structure model of the supply chain.

The following four aspects are the specific understanding of supply chain management. (1) Supply chain management can organise, coordinate, plan and control all participants in the chain. (2) The object of supply chain management is the entire system, and it is planned, organised, coordinated and controlled. Its purpose is to make the whole more efficient, with integrated and holistic thinking. (3) From the most upstream supplier to the most downstream end user all belong to the scope of supply chain management. Supply chain management not only interferes with corporate nodes but also controls corporate behaviour and the establishment and maintenance of information platforms. (4) Modern computer network technology is the main tool used by supply chain management. The advent of the information age has made supply chain management more convenient and faster. The nodes on the chain can obtain the required information accurately and instantly, allowing suppliers to have a more global view and complete their production tasks more efficiently. Figure 2 shows the basic structure of supply chain management [5]:

Fig. 2 The basic structure of supply chain management.

3.2 Supply chain risk

The concept of supply chain risk has not been put forward soon; so, there is still no clear definition of its concept. Since the supply chain involves many aspects, the description of supply chain risk is different from different perspectives. The following is what people agree with and there are several theories: (1) Supply chain risk comes from the negligence or failure of supervision. It is an event beyond the scope of normal planning. (2) Supply chain risk, in other words, is the probability that the supply chain may not operate normally or the supply chain will be interrupted. (3) Supply chain risks can be lurking in any link of the supply chain and have a destructive effect on the overall interests. Especially in the fragile links of the supply chain, the possibility of supply chain risks is greater. (4) Supply chain risks are accompanied by accidents, which are mixed with many uncertain factors. In order to reduce the influence of uncertain factors, it is necessary to increase the technical cost input, and the corresponding income will be reduced. Due to the existence of supply chain risks, the company's set goals cannot be achieved, and even more serious, the entire supply chain will be broken. (5) Supply chain risk refers to the possibility of a crisis in the supply chain, which is caused by uncertain factors. Due to the contingency of uncertain factors, risks in the manufacturing process and the circulation of goods often affect the expected effects and benefits, and the entire supply chain will be affected to varying degrees.

3.3 Supply chain risk modelling

Based on the above mentioned normal interval number algorithm, in order to facilitate the integration of normal interval number information, three integration operators for normal interval numbers are given below, namely the weighted arithmetic average (ININWAA) operator of normal interval numbers, the ordered weighted average (ININOWA) operator of normal interval numbers and the mixed weighted average (ININHA) operator of normal interval numbers [6]. For a multi-criteria decision-making problem where the criterion value is a normal interval number and the criterion weight information is not completely determined, let $A_2, \dots, A_m$ be the set of plans, $I = \{I_1, I_2, \dots, I_n\}$ be the set of criteria and $D = \{d_1, d_2, \dots, d_t\}$ be the set of decision makers. Suppose the decision maker d_k gives the criterion value $\tilde{\beta}_{ij}^{(k)}$ under criterion I_j for scheme A_i , the resulting decision matrix is denoted as $R_k = (\tilde{\beta}_{ij}^{(k)})_{m \times n} (i = 1, 2, \dots, m, j = 1, 2, \dots, n, k = 1, 2, \dots, t)$, where $\tilde{\beta}_{ij}^{(k)} = \langle \{\eta_{ij}^{(k)}, \sigma_{ij}^{(k)}\}, \mu_{ij}^{(k)}, \nu_{ij}^{(k)} \rangle$ is the normal interval number and $\{\eta_{ij}^{(k)}, \sigma_{ij}^{(k)}\}$ is the method used in [7]

1. $\{w : Bw \geq b, w > 0, b \geq 0\};$
2. $\{w : Bw \leq b, w > 0, b \geq 0\};$
3. $\{w : Bw = b, w > 0, b \geq 0\}.$

4 Case analysis

Supply chain management emphasises the establishment of strategic partnerships between companies in the supply chain to reduce supply chain costs, reduce inventory levels, enhance information sharing, improve mutual communication and generate stronger competitive advantages. There are many factors affecting supply chain collaboration; so, the choice of partnership is a very complex issue. In particular, when selecting partner companies, core companies in the supply chain must weigh various factors in many ways, comprehensively examine potential partner companies and make the best choice. Among the factors that affect the decision of supply chain partners, response time (delivery time) and supply capability (y_1), quality and technical level (y_2), price and cost (y_3) and service level (y_4) are the key factors for success. Three experts $d_k (k = 1, 2, 3)$ (the expert weight vector is $w = (0.35, 0.35, 0.30)^T$) are now required to evaluate the above four factors through a questionnaire survey. Experts compare these factors in pairs and construct the following three interval judgement

matrices:

$$\tilde{C}_1 = \begin{bmatrix} ([0.5, 0.5], [0.5, 0.5]) & ([0.6, 0.7], [0.1, 0.2]) & ([0.5, 0.6], [0.2, 0.3]) & ([0.3, 0.5], [0.2, 0.4]) \\ ([0.1, 0.2], [0.6, 0.7]) & ([0.5, 0.5], [0.5, 0.5]) & ([0.4, 0.6], [0.1, 0.2]) & ([0.6, 0.7], [0.1, 0.3]) \\ ([0.2, 0.3], [0.5, 0.6]) & ([0.1, 0.2], [0.4, 0.6]) & ([0.5, 0.5], [0.5, 0.5]) & ([0.3, 0.4], [0.5, 0.6]) \\ ([0.2, 0.4], [0.3, 0.5]) & ([0.1, 0.3], [0.6, 0.7]) & ([0.5, 0.6], [0.3, 0.4]) & ([0.5, 0.5], [0.5, 0.5]) \end{bmatrix}$$

$$\tilde{C}_2 = \begin{bmatrix} ([0.5, 0.5], [0.5, 0.5]) & ([0.2, 0.3], [0.5, 0.6]) & ([0.5, 0.7], [0.1, 0.2]) & ([0.2, 0.4], [0.1, 0.3]) \\ ([0.5, 0.6], [0.3, 0.3]) & ([0.5, 0.5], [0.5, 0.5]) & ([0.5, 0.8], [0.1, 0.2]) & ([0.3, 0.6], [0.2, 0.3]) \\ ([0.1, 0.2], [0.5, 0.7]) & ([0.1, 0.2], [0.5, 0.8]) & ([0.5, 0.5], [0.5, 0.5]) & ([0.4, 0.6], [0.1, 0.4]) \\ ([0.1, 0.3], [0.2, 0.4]) & ([0.2, 0.3], [0.3, 0.6]) & ([0.1, 0.4], [0.4, 0.6]) & ([0.5, 0.5], [0.5, 0.5]) \end{bmatrix}$$

$$\tilde{C}_3 = \begin{bmatrix} ([0.5, 0.5], [0.5, 0.5]) & ([0.4, 0.5], [0.2, 0.3]) & ([0.6, 0.7], [0.1, 0.2]) & ([0.5, 0.7], [0.2, 0.3]) \\ ([0.2, 0.3], [0.4, 0.5]) & ([0.5, 0.5], [0.5, 0.5]) & ([0.5, 0.6], [0.2, 0.4]) & ([0.7, 0.8], [0.1, 0.2]) \\ ([0.1, 0.2], [0.6, 0.7]) & ([0.2, 0.4], [0.5, 0.6]) & ([0.5, 0.5], [0.5, 0.5]) & ([0.6, 0.7], [0.1, 0.3]) \\ ([0.2, 0.3], [0.5, 0.7]) & ([0.1, 0.2], [0.7, 0.8]) & ([0.1, 0.3], [0.6, 0.7]) & ([0.5, 0.5], [0.5, 0.5]) \end{bmatrix}$$

Try to determine the most influential factors. First calculate the hesitation matrix of each interval judgement matrix:

$$S_1 = \begin{bmatrix} [0, 0] & [0.1, 0.3] & [0.1, 0.3] & [0.1, 0.5] \\ [0.1, 0.3] & [0, 0] & [0.2, 0.5] & [0, 0.3] \\ [0.1, 0.3] & [0.2, 0.5] & [0, 0] & [0, 0.2] \\ [0.1, 0.5] & [0, 0.3] & [0, 0.2] & [0, 0] \end{bmatrix}$$

$$S_2 = \begin{bmatrix} [0, 0] & [0.1, 0.3] & [0.1, 0.4] & [0.3, 0.7] \\ [0.1, 0.3] & [0, 0] & [0, 0.4] & [0.1, 0.5] \\ [0.1, 0.4] & [0, 0.4] & [0, 0] & [0, 0.5] \\ [0.3, 0.7] & [0.1, 0.5] & [0, 0.5] & [0, 0] \end{bmatrix}$$

$$S_3 = \begin{bmatrix} [0, 0] & [0.2, 0.4] & [0.1, 0.3] & [0, 0.3] \\ [0.2, 0.4] & [0, 0] & [0, 0.3] & [0, 0.2] \\ [0.1, 0.3] & [0, 0.3] & [0, 0] & [0, 0.3] \\ [0, 0.3] & [0, 0.2] & [0, 0.3] & [0, 0] \end{bmatrix}$$

Secondly, combine the original interval judgement matrix and the hesitation matrix to transform it into a score matrix and take $\lambda = \frac{1}{2}$

$$S_1 = \begin{bmatrix} 0.5 & 0.78 & 0.66 & 0.72 \\ 0.18 & 0.5 & 0.675 & 0.7475 \\ 0.30 & 0.2025 & 0.5 & 0.385 \\ 0.39 & 0.23 & 0.605 & 0.5 \end{bmatrix}$$

$$S_2 = \begin{bmatrix} 0.50 & 0.30 & 0.75 & 0.45 \\ 0.66 & 0.50 & 0.78 & 0.585 \\ 0.1875 & 0.18 & 0.50 & 0.625 \\ 0.30 & 0.325 & 0.3125 & 0.50 \end{bmatrix}$$

$$S_3 = \begin{bmatrix} 0.50 & 0.585 & 0.78 & 0.69 \\ 0.325 & 0.50 & 0.6325 & 0.825 \\ 0.18 & 0.345 & 0.50 & 0.7475 \\ 0.2875 & 0.165 & 0.23 & 0.50 \end{bmatrix}$$

Secondly, use $s_{ij} = \sum_{k=1}^t w_k s_{ij}^{(k)}$, $i, j = 1, 2, \dots, n$ to comprehensively integrate the above score matrix to obtain the following:

$$S = \begin{bmatrix} 0.50 & 0.5535 & 0.7275 & 0.6165 \\ 0.3915 & 0.50 & 0.699 & 0.713875 \\ 0.224625 & 0.237375 & 0.50 & 0.57775 \\ 0.32775 & 0.24375 & 0.390125 & 0.50 \end{bmatrix}$$

Second, calculate the score function value $s(\tilde{c}_i)$ of each scheme

$$\begin{aligned} s(\tilde{c}_1) &= 2.3975, s(\tilde{c}_2) = 2.304375 \\ s(\tilde{c}_3) &= 1.53975, s(\tilde{c}_4) = 1.461625 \end{aligned}$$

Because of $s(\tilde{c}_1) > s(\tilde{c}_2) > s(\tilde{c}_3) > s(\tilde{c}_4)$, the sort order of scheme y_i ($i = 1, 2, 3, 4$) is $y_1 > y_2 > y_3 > y_4$, and the most influential factor is y_1 .

5 Risk control decisions

5.1 Supply chain risk early warning measures

Supply chain risks generally exist in the supply chain. Many experts believe that early warning of supply chain risks is an important way to reduce supply chain losses. When supply chain risks occur, it is necessary to invest a lot of manpower and material resources to manage risks. Therefore, instead of repairing losses, it is better to plan ahead and to do a good job of risk early warning, which is of great significance to the stable development of the supply chain. For the company's risk warning, it should be carried out from the following two aspects.

5.1.1 Strengthen the identification of risk factors

Periodically analyse the factors that cause supply chain risks, establish a company's supply chain risk set based on past experience, conduct questionnaire surveys on the company's senior management or experts in the company and then use the analytic hierarchy process to analyse the data to obtain the weight of each risk factor. The final evaluation result comes from the mathematical model established by the fuzzy evaluation theory, which uses numbers to describe the size of the overall risk, making the result clearer [8]. Because mathematical software is involved in the process of identifying risk factors, the correctness of the calculation does not need to be considered; so, the authority of selecting the questionnaire survey object is an important reason that affects the evaluation result.

5.1.2 Strengthen risk early warning and control

Record all the risks encountered by the company in the risk database, research and set up early warning signals when risks occur. When the early warning signals are sounded, the relevant staff must take immediate measures to reduce the risks and prevent them when the risks have not caused huge losses. Expand further. Risk early warning means that the risk has already occurred to a small extent, and it should be controlled as soon as possible to stop the trend of becoming bigger and minimise the risk loss [9].

5.2 Supply chain risk control measures

From the company's overall risk assessment of 0.4615, it can be seen that the company's risk level is medium. According to the degree of risk, the following control measures are taken for the risks that have occurred.

5.2.1 Risk control on order quantity

The number of orders ranks second in the risk factors, which has a greater impact on the company's profitability. The automotive supply chain generally has a lot of profitability; so, in comparison, the company has more competitors, which requires the company to have a greater competitive advantage. In the forecast of the order quantity, it needs to be more precise to prevent inventory shortages reasonably. When the demand of downstream companies increases, that is, when orders increase, the company will increase inventory, workers and employees must work harder and they can choose to adjust the rest time when appropriate, reduce the off-season working days and increase the production quantity in the peak season or increase bonuses according to the number of orders to increase the enthusiasm of producers. In addition, when orders increase, it is often accompanied by an increase in risk. At this time, the risk warning department should work closely, plan reasonably, maintain information communication with downstream companies and actively respond to sudden order changes. This is to achieve inventory reasonably. Only in this way can it be ensured that the set tasks can be completed in time when the number of orders increases.

5.2.2 Risk control on upstream supplier capabilities

The supply chain is a whole, and the upstream influence is more profound. The lack of overall capability of raw material suppliers is an important reason for supply chain risks. The overall interests of the supply chain override the individual interests of the company, but upstream companies often rely solely on maximising their own economic interests, ignoring the overall interests and causing risks. According to the supplier's ability, there are the following methods to control it.

1. Strengthen quality management. Product quality is the lifeblood of a manufacturing company. It is not only for the development of the supply chain but also for its own interests. When a company discovers that there is a problem with the goods of a downstream supplier, it should first isolate the product, negotiate with it and manufacture qualified products as soon as possible. It guarantees that similar problems will not occur and provides upstream suppliers with corrective measures for equipment or personnel to ensure the quality of its own products. If the negotiation is unsuccessful, the cooperation should be terminated as soon as possible, asking the upstream company to compensate for its own economic losses, and then, looking for similar companies, a lot of time will be wasted during this period, which will affect the delivery time between the company and downstream demanders and cause personal reputation problems. This will affect the normal operation of the entire supply chain. Therefore, in the event of unqualified products of upstream enterprises, we should try our best to make rectifications so as not to damage the original supply chain.
2. Strengthen supplier risk control. The upstream raw material suppliers also have the risk of out of stock. The out of stock of upstream suppliers directly affects the company's production. On the one hand, the company and upstream suppliers should ensure smooth communication, keep in touch at all times and allow enough time for risk response. Instil information on the importance of preventing risks to upstream suppliers; on the other hand, the company should ensure safe inventory to prevent accidents, and the company should add more material suppliers to increase the risk of backing space.
3. Strengthen the risk control of supplier management. Due to poor management, suppliers made low-level errors themselves, leading to unfavourable supply of materials and affecting company operations. Therefore, in order to reduce the supply chain management errors of upstream enterprises, the company should strengthen the dissemination of supply chain risk knowledge. On the other hand, the company needs to establish punitive measures, strictly stipulate the deadline for materials and put pressure on upstream companies to make suppliers grow under pressure. Establish an elimination mechanism and give up cooperation with suppliers who cannot complete the expected plan.
4. Strengthen the risk control of supplier personnel flow. After studying the trend of personnel turnover in

recent years, it is found that the personnel turnover of suppliers has a certain cyclical nature. Generally, the personnel turnover is relatively large in July and August. Therefore, the company should increase inventory before then, communicate in advance, formulate reasonable production plans for downstream automobile manufacturers and remind upstream suppliers to prepare safety stocks to reduce risk losses.

5.3 Supply chain risk correction measures

The ultimate goal mentioned above is to avoid risks. Supply chain risks are lurking throughout the supply chain. Managers can only minimise the probability of risks and cannot make the supply chain completely safe. The purpose of the implementation of supply chain risk correction measures is to reduce the impact of risks and to sum up experience and laws from them, improve their own management level and control risk losses. Supply chain risk correction measures can be considered from the following two aspects:

5.3.1 Establish a supply chain risk management department

The company's profit comes from every link. If the company wants to gain a competitive advantage among the peer companies and pay attention to risks, it should set up a dedicated supply chain risk management department to implement emergency measures in time to reduce the reflection time of risks and reduce the loss of risks when risks have occurred. In addition, because M company is a department of the automotive supply chain, the supply chain risk management department should pay attention to the risk situation in the automotive industry, and when it realises that the risk has occurred, notify the department where the risk is located and assist in remediation.

5.3.2 Seek help from cooperative enterprises

The supply chain is a whole, and seeking help from other departments in the supply chain is also an important way to solve risk problems when there is a problem in one link of the supply chain. In today's society, cooperation and competition coexist. In order to obtain the help of other companies, we must first start from ourselves. When we see difficulties with other partners, we should extend a helping hand appropriately. When we encounter difficulties, we will have more enterprises willing to help overcome difficulties together. In addition, risks can be spread, and other companies should be notified as soon as possible when a risk problem occurs so as to prevent risks.

6 Conclusion

This paper defines the normal interval number and its compromise expectation value, compromise mean square error and operation rules and gives several information integration operators for normal interval numbers, namely ININWAA operator, ININOWA operator and INNHA operator, and puts forward a multi-criteria group decision-making method with criterion values of normal interval numbers and incomplete criterion weight information, and its implementation steps are discussed in detail. The method in this paper enriches and develops fuzzy set theory and interval analysis theory, which can be widely used in supply chain selection, investment decision-making, project evaluation and comprehensive evaluation of economic benefits.

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