Application of Fuzzy TOPSIS Group Decision Method in Location Selection of Emergency Rescue Facility

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Abstract: In order to ensure the rationality of group decision-making in the problem of deciding the location of emergency rescue facilities, it is essential to fully consider the uncertainty of post-disaster uncertainties, the multiple attribute group decision making problem with mixed evaluation value, introduce fuzzy set theory, extend the improved TOPSIS method to the fuzzy environment and propose a group decision-making method for emergency rescue facility location based on fuzzy TOPSIS. Since for emergency multi-attribute decision making problem, the accurate value is too fuzzy to simulate real life situations. Therefore, the triangular fuzzy number and linguistic variables are used to make the evaluation decision. In addition, the general weights of decision makers and the attributes of alternatives are obtained respectively based on deviation measurement method. Finally, the feasibility and effectiveness of the proposed method are verified by a specific example. The results show that the proposed method is in line with the actual decision-making mechanism.

1. Introduction

In the post-disaster rescue operations, a large number of response facilities are needed to be put into emergency rescue at the same time. While, the location of emergency rescue facilities is the premise and key to rescue needs. Facing the severe disaster situation, it is necessary to allocate various emergency rescue facilities effectively and rationally to improve the emergency rescue capacity after disaster, and to ensure that emergency rescue facilities can provide decision-making guidance for the location of emergency rescue facilities after emergencies. Therefore, the study of emergency facility location has important practical significance in reducing losses and improving rescue effect.

At present, domestic and foreign scholars have done in-depth research on facility location. Sun Qingzhen et al. have established a facility location model based on multi-objective programming method, which makes use of linear weighting method to solve the model [1]. Ding Xuefeng et al. have built a multi-objective programming decision-making model, which uses the general model of simulated plant growth algorithm and proposed a problem solving method based on simulated plant growth ideas [2]. Gaoleifu established an emergency facility location model under uncertain circumstances in 2015, in which artificial bee colony algorithm is used to obtain the optimal location scheme under uncertain demand [3]. Xiao Junhua et al. proposed a multi-objective and multi-coverage attenuation location model for emergency facilities, and solved the model by intelligent algorithm [4]. After disaster occurs, different decision makers will have different risk preferences and risk avoidance behavior. Therefore, different evaluation forms will be used to evaluate the evaluation index, which consists of qualitative and quantitative values [5-8]. since the environment after disaster will become uncertain, Song Yinghua and others have set up a multi-stage and multi-objective emergency logistics location model in uncertain information environment, which is solved by Epsilon constraint method [9]. However, the existing studies mostly consider the minimum distance or time to reach the emergency site, but neglect the selection and quantitative analysis of evaluation indicators in the decision-making process of post-disaster facility location. Moreover, in the existing research, there is a single decision-making. However, a single decision-maker may not have all the experience and wisdom needed in the emergency

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decision-making process, and it is difficult to make a decision to minimize the loss of emergencies in the shortest time.

Based on the above analysis, considering the uncertainty and fuzziness of the post-disaster environment, the author introduces the fuzzy set theory [10-11], considers the combination of the fuzzy set theory and TOPSIS method in the group decision-making environment, calculates the weights of each evaluation index and each decision-maker by the combination weighting method, establishes different decision matrix for each evaluation index and scheme, in which the evaluation value is introduced into the linguistic evaluation index [12-13] and triangular fuzzy number, solve these matrix according to the steps of fuzzy TOPSIS method, and lastly the schemes are sorted and optimized.

2. Problem Description

In many emergency rescue facility location decision-making, the decision-maker's decision-making problem is often affected by some inaccurate constraints, objectives and consequences in the real world. The evaluation index of each scheme can not give an exact value except a fuzzy value. Therefore, this paper uses triangular fuzzy number and uncertain linguistic variable [13] to evaluate each index. When dealing the value of a scheme, the linguistic variables are represented by triangular fuzzy numbers, and the subjective judgment of decision makers is quantitatively described. Finally, the fuzzy TOPSIS method is applied to aggregate and process the decision information, and the corresponding decision-making steps and methods are given and the alternatives are ranked.

Based on this, this paper describes the problem of fuzzy multi-attribute group decision-making as follows. In $D=(d_1,d_2,\ldots,d_h)$, h denotes decision makers, d_k denotes decision makers ranked k, $\gamma=(\gamma_1,\gamma_2,\ldots,\gamma_h)$ means the weight of decision makers, γ_k refers to the weight of decision maker ranked k, $\bar{\gamma}=(\bar{\gamma}_1,\bar{\gamma}_2,\ldots,\bar{\gamma}_h)$means the subjective weight of decision makers, and $\tilde{\gamma}=(\tilde{\gamma}_1,\tilde{\gamma}_2,\ldots,\tilde{\gamma}_h)$ is denoted as the objective weight of decision makers. $A=(a_1,a_2,\ldots,a_n)$denotes the set of N feasible decision schemes, in which a_i refers the decision scheme ranked j is denoted. C= (c1, c2,... Cm) denotes the set of M evaluation indicators, in which c_i denotes the index ranked i, and I_1,I_2 are respectively the income index set and the profitability index set. W= (w1, w2,... Wm) represents the evaluation value of the index, in which w_i represents the evaluation value of the evaluation index ranked i. $\lambda=(\lambda_1,\lambda_2,\ldots,\lambda_m)$denotes the weight of the evaluation index. Λ_i denotes the weight of the evaluation index ranked i. In addition, the subjective weight of the evaluation index is denoted as $\bar{\lambda}=(\bar{\lambda}_1,\bar{\lambda}_2,\ldots,\bar{\lambda}_m)$while the objective weight of the evaluation index is represented by $\tilde{\lambda}=(\tilde{\lambda}_1,\tilde{\lambda}_2,\ldots,\tilde{\lambda}_m)$. In the fuzzy decision matrix $\widetilde{D}_k=(d_{ij}^k)_{m\times n}, d_{ij}^k$ which is given by the decision-maker d_k means the evaluation value of the decision-making scheme a_i given by the decision-maker ranked k under the evaluation index c_i.

3. Solution Method and Decision-making Step Based on the Fuzzy TOPSIS

3.1 Determination of Decision-makers' Weight

For the determination of the weights of decision makers, the combination weighting method not only integrates the advantages of single subjective or objective weighting method, but also avoids their respective shortcomings to a certain extent. The subjective weights of each decision-maker are discussed collectively by the decision-makers and given according to the experience of location decision-making in the past. The calculation process is described as follows:

(1) The modified fuzzy decision matrix $\widetilde{D}'=(d_{ij}^k)_{m\times n}$ is weighted averaging and the group decision matrix $R=(r_{ij})_{m\times n}$ is obtained.

$$r_{ij} = (d_{ij}^1 \oplus d_{ij}^2 \oplus \ldots \oplus d_{ij}^{\mathrm{h}}) / h \quad (1)$$

(2) The deviation between the evaluation value of decision expert d and the group decision matrix R is calculated. The distance of $d(d_{ij}^k, r_{ij})$ is calculated by the method of reference [14].

$$D_k = \frac{1}{mnh} \sum_{i=1}^{m} \sum_{j=1}^{n} d(d_{ij}^k, r_{ij}) \quad (2)$$

(3) Calculate the objective weight of each decision maker according to the deviation D_k. If the bigger the deviation of the decision-maker, the more deviation the decision-maker's evaluation results from the group decision-making results and the smaller the decision-making weight should be given. On the contrary, the more deviation the decision-maker's evaluation results coincide with the group decision-making results, the higher the weight should be given. Then the final objective weight $\tilde{\gamma}_k$ is obtained by normalization of $\dot{\gamma}_k$.

$$\dot{\gamma}_k = \frac{1}{D_k} \sum_{k=1}^{h} D_k \ , \qquad \tilde{\gamma}_k = \dot{\gamma}_k / \sum_{k=1}^{h} \dot{\gamma}_k \quad (3)$$

(4) Determine the comprehensive weight of decision-makers γ_k

$$\gamma_k = \alpha \bar{\gamma}_k + (1-\alpha) \tilde{\gamma}_k \quad (4)$$

In the formula, the compromise coefficient of the subjective weight of decision-maker is used. The decision-maker can set parameters according to the specific situation to adjust the degree of difference among decision-makers. The bigger the difference is, the greater the influence of subjective weights on comprehensive weights is. While the smaller the difference is, the smaller the influence of objective weights on comprehensive weights is. In this paper, we take 0.5.

3.2 Method of Determining the Weight of Evaluation Index

This paper calculates the attribute index of evaluation index based on distance measure.

(1) Determine the positive and negative ideal solutions w^* 和 w^- of the evaluation index ranked i in the revised fuzzy decision matrix, and obtain:

$$w_i^* = \begin{cases} \max\limits_k(w_{ki}), i \in I_1 \\ \min\limits_k(w_{ki}), i \in I_2 \end{cases} \quad w_i^- = \begin{cases} \min\limits_k(w_{ki}), i \in I_1 \\ \max\limits_k(w_{ki}), i \in I_2 \end{cases} \quad (5)$$

(2) Formulas (1) and (2) are used to calculate the distance between the evaluation value of index ranked i and the positive and negative ideal solutions of index i. The distance $d(\tilde{s}_1^t, \tilde{s}_2^t)$ between two uncertain linguistic variables is calculated by the reference method [15].

$$d_i^+ = \sum_{k=1}^{h} d(w_{ki}, w_i^*), \ d_i^- = \sum_{k=1}^{h} d(w_{ki}, w_i^-) \quad (6)$$

(3) Calculate the posting schedule ζ_i of the evaluation index ranked i as well as the objective weight $\tilde{\lambda}_i$:

$$\zeta_i = d_i^+ / (d_i^+ + d_i^-), \qquad \tilde{\lambda}_i = \zeta_i / \sum_{i=1}^{m} \zeta_i \quad (7)$$

(4) Determine the subjective weight of the evaluation index, and give the subjective positive and negative ideal solutions $\bar{w}^*$ and $\bar{w}^-$ of each evaluation index by the decision-maker. The subjective

weight of the evaluation index is calculated by formula (13), (14). The subjective weight of evaluation index $\overline{\lambda}_i$ can be calculated by formula (13), (14).

(5) Determine the comprehensive weight value λ_i of each evaluation index.

$$\lambda_i = \beta\overline{\lambda}_i + (1-\beta)\tilde{\lambda}_i \quad (8)$$

In the formula, β is the attribute index coefficient. The decision maker is able to set the parameter β according to the actual decision environment and adjust the difference between the weights among the evaluation index. The larger the β, the greater the influence of subjective weights on the comprehensive weights. While the smaller the β, the more objective the comprehensive weights are. In this paper, β is 0.5.

3.3 Decision-making Steps and Methods of the Fuzzy TOPSIS

Fuzzy TOPSIS [14] was first proposed by Chen and Hwang in 1992. In this paper, based on Chen and Hwang's method, the fuzzy TOPSIS under the definition of fuzzy set is proposed in combination with relevant literature. Fuzzy TOPSIS is a sort method according to the approaching degree of a limited number of evaluation objects and idealized objectives, and it is a relative evaluation of the existing objects. Ideal solution has two goals, one is positive or optimal ideal solution and the other is negative or worst ideal solution. If the evaluation object is the closest to the optimal solution and the farthest away from the worst solution, then it is the best, otherwise the worst. Each index value of the optimal solution reaches the optimal value of each evaluation index while each index value of the worst solution achieves the worst value of each evaluation index. The decision-making steps of the fuzzy TOPSIS method are as follows:

Step 1, to establish the Initial Fuzzy Decision Matrix

When confronted with multi-objective optimization problems, there are usually n evaluation objects, and each evaluation object has m evaluation indexes. Firstly, the relevant experts are invited to give the fuzzy decision matrix of the scheme $\tilde{D} = (d_{ij}^k)_{m\times n}$ and the fuzzy decision matrix $\tilde{W} = (\tilde{w}_1, \tilde{w}_2, \ldots \tilde{w}_m)$ of the evaluation index respectively, and to transform the linguistic indexes into triangular fuzzy numbers and standardize the different language granularity, so as to get the revised fuzzy decision matrix $\tilde{D}' = (d_{ij}^k)_{m\times n}$ and $\tilde{W}' = (\tilde{w}'_1, \tilde{w}'_2, \ldots \tilde{w}'_m)$.

Step 2, to compute the comprehensive fuzzy evaluation value of various schemes

According to formula (1) ~ (4), the comprehensive weight of each decision-maker $\gamma = (\gamma_1, \gamma_2, \ldots \gamma_h)$ is determined, in which $\tilde{d}_{ij}^k = (a_{ij}^k, b_{ij}^k, c_{ij}^k)$ indicates the evaluation value of decision-maker K made to the scheme under ranked j under the index ranked i. Therefore, the comprehensive fuzzy evaluation value of the scheme $\tilde{d}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ under each index is as follows:

$$a_{ij} = \min_h \{\gamma_k a_{ij}^k\}, \quad b_{ij} = \frac{1}{h}\sum_{k=1}^{h} \gamma_k b_{ij}^k, \quad c_{ij} = \max_h \{\gamma_k c_{ij}^k\} \quad (9)$$

According to formula (5) ~ (8), the comprehensive weight of each evaluation index $\lambda = (\lambda_1, \lambda_2, \ldots, \lambda_m)$ is determined.

Step 3, to normalize decision-making fuzzy decision matrix.

In the problem of fuzzy multi-attribute decision making, because the dimensions of each evaluation index are different and the evaluation criteria are different, it is impossible to use the initial attribute index values to compare and rank them. Before the comprehensive ranking of schemes, the attribute criteria should be transformed into comparable criteria. The normalized fuzzy decision matrix is recorded as follows:

$$\tilde{R} = [\tilde{d}_{ij}]_{m\times n} \quad i=1,2,\ldots,m;j=1,2,\ldots,n \quad (10)$$

in which

$$\tilde{d}_{ij} = \begin{cases} (\frac{a_i^-}{c_{ij}}, \frac{a_i^-}{b_{ij}}, \frac{a_i^-}{a_{ij}}) & a_i^- = \min_j \{a_{ij}\} \quad i \in I_2 \\ (\frac{a_{ij}}{c_i^*}, \frac{b_{ij}}{c_i^*}, \frac{c_{ij}}{c_i^*}) & c_i^* = \max_j \{c_{ij}\} \quad i \in I_1 \end{cases} \quad (11)$$

Step 4, to calculate weighted normalized decision matrix.

$$\tilde{V} = [\tilde{d}_{ij} \otimes \lambda_i] \quad i=1,2,\ldots,m;j=1,2,\ldots,n \quad (12)$$

Step 5, to obtain (FPIS) A^* and (FNIS) A^-.

A^* and A^- are defined as follows:

$$A^* = (\tilde{V}_1^*, \tilde{V}_2^*, \ldots, \tilde{V}_m^*) \quad \tilde{V}_i^* = \max_j \{v_{ij3}\} \quad i=1,2,\ldots,m;j=1,2,\ldots,n \quad (13)$$

$$A^- = (\tilde{V}_1^-, \tilde{V}_2^-, \ldots, \tilde{V}_m^-) \quad \tilde{V}_i^- = \min_j \{v_{ij1}\} \quad i=1,2,\ldots,m;j=1,2,\ldots,n \quad (14)$$

Step 6, to calculate distance scale.

Calculate the distance of each scheme from FPIS to FNIS. Note the distance from the scheme to FPIS A^* as S^*, and the distance from FNIS A^- as S^-.

$$S_j^* = \sum_{i=1}^m d_v(\tilde{V}_{ij}, \tilde{V}_i^*) \quad j=1,2,\ldots,n \quad (15)$$

$$S_j^- = \sum_{i=1}^m d_v(\tilde{V}_{ij}, \tilde{V}_i^-) \quad j=1,2,\ldots,n \quad (16)$$

Step 7, to calculate the posting schedule of various schemes and ideal solutions C^*.

$$C_j^* = S_j^- / (S_j^* + S_j^-) \quad j=1,2,\ldots,n \quad (17)$$

Step 8, to sort the schemes.

According to the C_j^* of posting schedule, the schemes are sorted in order from small to large. The bigger the value C_j^*, the better the scheme and the biggest is the optimal selection goal C_j^*.

4. Example Analysis

In order to verify the validity and rationality of the methods mentioned above, an earthquake in a mountainous area is taken as an example. The local emergency management department needs to select an optimal emergency rescue facility from several candidate sites as soon as possible. This paper assumes that three decision makers {d1, d2, d3} jointly select the best facility point from three candidate emergency facility points {x1, x2, x3} and consider the following indicators. c1 is the maximum time of passage (the maximum time of passage from the emergency rescue facility point to the farthest disaster point in the worst case). c2 is the supply capacity (the number of emergency rescue facility facilities that can be provided at the location of the emergency facility point). c3 is the cost (cost produced from emergency facility point to disaster site). c4 is safety (safety of emergency rescue facility point). c5 is traffic condition (unimpeded condition of road from emergency facility point to disaster site). c6 means environmental impact (impact of emergency facility point on surrounding environment). c1, c3, c6 are profit and loss indicators, in which the smaller the better. c2, c4, c5 are profitability indicators, in which the larger the better.

In this case, three decision makers d1, d2 and d3 choose different language evaluation sets according to their preferences. When evaluating the evaluation indexes, they use 7, 9 and 11 granularity non-uniform language evaluation scales in which $s^{(4)}=\{s_{-3}^{4}$=very poor (VP), $s_{-4/3}^{4}$=poor(P), $s_{-1/2}^{4}$= more poor (MP), s_{0}^{4}=normal(F), $s_{1/2}^{4}$=better (MG), $s_{4/3}^{4}$=good (G), s_{3}^{4}=very good (VG)}, $s^{(5)}=\{s_{5}^{-4}$ =extremely low, s_{-2}^{5}=very low, s_{-1}^{5}=low, $s_{-2/5}^{5}$=lower, s_{0}^{5}=average, $s_{2/5}^{5}$=higher, s_{1}^{5}=high, s_{2}^{5}=very high, s_{4}^{5} =extremely high}, $s^{(6)}=\{s_{-5}^{6}$=extremely low, s_{-2}^{6}=very low, $s_{-3/2}^{6}$=fairly low, $s_{-4/5}^{6}$=low, $s_{-1/3}^{6}$=lower, s_{0}^{6} =average, $s_{1/3}^{6}$=higher, $s_{4/5}^{6}$=high, $s_{3/2}^{6}$=quite high, s_{2}^{6}=very high, s_{5}^{6}=extremely high};

The specific decision-making steps are as follows:

(1) Decision-making experts use different language evaluation scales to evaluate each evaluation index, and use 7-granularity non-uniform language evaluation scales to evaluate the evaluation values of each scheme. The decision matrix of each evaluation index is shown in Table 1, and the decision matrix of each scheme is shown in Table 2.

Table.1 Decision Matrix of Each Evaluation Index

Attribute index	Decision maker			Subjective Positive Ideal Solution $\vec{w}^*$	Subjective Negative Ideal Solution $\vec{w}^-$
	d1	d2	d3		
c1	30	30	30	24	30
c2	$[s_{1/2},s_{4/3}]$	$[s_1,s_2]$	$[s_{3/2},s_2]$	$[s_2,s_4]$	$[s_{-4},s_{-2}]$
c3	[805,843,856]	[808,840,855]	[807,841,857]	[805,835,850]	[807,840,855]
c4	$[s_{4/3},s_3]$	$[s_1,s_2]$	$[s_0,s_{4/5}]$	$[s_2,s_4]$	$[s_{-4},s_{-2}]$
c5	$[s_0,s_{4/3}]$	$[s_0,s_2]$	$[s_{4/5},s_{3/2}]$	$[s_2,s_4]$	$[s_{-4},s_{-2}]$
c6	$[s_{-4/3},s_0]$	$[s_{-1},s_0]$	$[s_{-2},s_{-5/4}]$	$[s_{-4},s_{-2}]$	$[s_2,s_4]$

Table. 2 Decision Matrix of Various Programs

Attribute index	Schemes to be selected	Decision maker		
		d1	d2	d3
c1	A1	G	G	MG
	A2	MG	G	MG
	A3	MG	G	G
c2	A1	VG	G	VG
	A2	G	VG	G
	A3	G	VG	VG
c3	A1	G	MG	G
	A2	G	MG	MG
	A3	G	P	G
c4	A1	MG	G	MG
	A2	MG	MG	MG
	A3	MG	G	G
c5	A1	G	VG	VG
	A2	MG	MP	MP
	A3	P	VP	VP
c6	A1	G	MG	P
	A2	MP	MG	G
	A3	G	MP	G

(2) In the decision matrix of each evaluation index, the linguistic indicators with 7 and 11 granularity need to be standardized. According to references [15], the linguistic indicators with 9 granularity should be transformed into linguistic indicators with 9 granularity. The positive and negative ideal solutions of evaluation indicators are given and 9 granularity linguistic indicators are applied which can be seen in Table 1. The comprehensive weight values λ=(0.183,0.247,0.09,0.165,0.154,0.161) of evaluation indicators are obtained by formula (5) ~ (8).

(3) For the convenience of calculating the conversion values between triangular fuzzy numbers and linguistic variables, the interval of triangular fuzzy numbers in this paper is 0-10, as shown in

Table 3. The corresponding fuzzy decision matrix is written in Table 2 and Table 3. The subjective weights of each decision maker are known to be

Table.3 Conversion values between linguistic variables and triangular fuzzy numbers

Linguistic variables	Triangular fuzzy numbers
very poor	(0,0,1)
poor	(0,1,3)
more poor	(1,3,5)
normal	(3,5,7)
better	(5,7,6)
good	(7,9,10)
very good	(9,10,10)

Table.4 Comprehensive fuzzy weights for each alternative

Attribute index	Schemes to be selected	Decision maker			Comprehensive fuzzy weight
		d1	d2	d3	
c1	A1	(7,9,10)	(5,7,9)	(7,9,10)	(1.6,2.79,3.8)
	A2	(5,7,9)	(5,7,9)	(7,9,10)	(1.5,2.59,3.8)
	A3	(5,7,9)	(7,9,10)	(7,9,10)	(1.5,2.8,3.8)
c2	A1	(9,10,10)	(9,10,10)	(7,9,10)	(2.66,3.21,3.8)
	A2	(7,9,10)	(7,9,10)	(9,10,10)	(2.1,3.13,3.8)
	A3	(7,9,10)	(9,10,10)	(9,10,10)	(2.1,3.23,3.8)
c3	A1	(7,9,10)	(7,9,10)	(5,7,9)	(1.9,2.74,3.42)
	A2	(7,9,10)	(5,7,9)	(5,7,9)	(1.6,2.53,3.42)
	A3	(7,9,10)	(7,9,10)	(0,1,3)	(0,1.99,3.2)
c4	A1	(5,7,9)	(5,7,9)	(7,9,10)	(1.5,2.59,3.8)
	A2	(5,7,9)	(5,7,9)	(5,7,9)	(1.5,2.33,3.42)
	A3	(5,7,9)	(7,9,10)	(7,9,10)	(1.5,2.8,3.8)
c5	A1	(7,9,10)	(9,10,10)	(9,10,10)	(2.1,3.23,3.8)
	A2	(5,7,9)	(1,3,5)	(1,3,5)	(0.32,1.4,2.7)
	A3	(0,1,3)	(0,0,1)	(0,0,1)	(0,0.1,0.9)
c6	A1	(7,9,10)	(0,1,3)	(5,7,9)	(0,1.89,3.42)
	A2	(1,3,5)	(7,9,10)	(5,7,9)	(0.3,2.15,3.42)
	A3	(7,9,10)	(7,9,10)	(1,3,5)	(0.38,2.24,3.2)

(4) The weighted normalized decision matrix is calculated according to formula (10) ~ (12). According to formula (13), (14), (FPIS) A^* and (FNIS) A^- are obtained. The results are shown in Table 5.

Table.5 Standardized alternative weights, FPIS, FNIS

Attribute index	Schemes to be selected			FPIS (A^*)	FNIS (A^-)
	A1	A2	A3		
c1	(0.077,0.105,0.183)	(0.077,0.113,0.195)	(0.077,0.105,0.195)	(0.195,0.195,0.195)	(0.077,0.077,0.077)
c2	(0.173,0.208,0.247)	(0.137,0.203,0.247)	(0.137,0.210,0.247)	(0.247,0.247,0.247)	(0.137,0.137,0.137)
c3	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)
c4	(0.065,0.112,0.165)	(0.065,0.101,0.165)	(0.065,0.101,0.149)	(0,165,0.165,0.165)	(0.065,0.065,0.065)
c5	(0.085,0.131,0.154)	(0.013,0.057,0.109)	(0,0.004,0.036)	(0.154,0.154,0.154)	(0,0,0)
c6	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)

(5) Calculate the distance from each scheme to (FPIS) A^* and (FNIS) A^- according to formula (15) and (16), and record them as S* and S^- respectively. Calculate the posting schedule C* from each scheme to (FPIS) A^* according to formula (17) and sort them. The results are shown in Table 6.

Table.6 Close degree and ranking of the three alternatives

	A1	A2	A3	Rank
S*	0.241	0.322	0.363	A1>A2>A3
S-	0.332	0.279	0.220	
C^*	0.579	0.464	0.377	

According to Table 6, we can see that A1 > A2 > A3 is the best option, so the emergency rescue facilities should be selected in the position where scheme 1 is located.

In the traditional decision making method, when the evaluation value of different criteria is converted to the same comparable standard form, the information will be lost, which will result in a certain error in the decision result. But the fuzzy TOPSIS proposed in this paper can deal with the mixed multi-attribute group decision problem without changing the decision information. At the same time, the weight of each evaluation index in the process of site selection decision is considered. When calculating the evaluation index, it is a decision matrix given by the decision maker, which is calculated separately from the decision matrix of each scheme. It can avoid the influence of decision makers' subjective preference on the decision results. Therefore, the decision model proposed in this paper is reasonable, effective and applicable.

5. Conclusion

After disaster occurs, due to the complexity of time evolution and the ambiguity and uncertainty of environment, decision makers have to make decisions under the pressure of time and great risks. At the same time, in fuzzy environment, the evaluation value of each evaluation index may be a mixed type of exact number, language variable and triangular fuzzy number. Therefore, the fuzzy set theory is introduced to quantify the attribute value in uncertain environment, and a fuzzy TOPSIS based decision making method for emergency rescue facility location group is proposed, which makes the decision reasonable.

In the example analysis, when calculating the weight value of each evaluation index, the standardization of different language granularity is realized according to the non-uniform language evaluation set of different granularity, and the calculation of mixed decision problem is convenient and simplified. In order to avoid the complexity of fuzzy TOPSIS method, the language variables are converted to triangular fuzzy numbers when calculating the comprehensive fuzzy weights of each scheme. This method provides a reasonable new idea for the group decision of emergency rescue facility location after sudden disaster.

When the disaster breaks out, because of the influence of the secondary and derivative disasters, the decision of emergency rescue facility location will become very complicated. The establishment of decision model of dynamic emergency rescue facility location under this influence will be the next research topic.

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