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Evaluation of emergency rescue capability for general aviation based on cone analytic network process

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Abstract In order to improve the efficiency of general aviation emergency rescue in emergency accidents, reduce accident losses, identify the risk factors of general aviation emergency process, and construct the index system of general aviation emergency rescue ability, based on the general structure of Cone network analysis (Cone-ANP), a general aviation company was taken as an example to establish the evaluation model of general aviation emergency rescue ability. The weight of each index factor was calculated. Combined with the fuzzy comprehensive evaluation method, the overall rescue ability of the airline is comprehensively evaluated, and finally the improvement measures are put forward. The results showed that the emergency rescue ability of the general aviation company was good as a whole, but there were still many aspects to be improved. In the whole process of navigation emergency rescue capabilities, the weights of early warning facilities, operation command, post-disaster recovery, daily construction, accident site treatment, and emergency team rescue capabilities were relatively large, indicating that they were particularly important in responding to sudden accidents and should be strengthened in the construction of navigation emergency system.

Keywords Cone-ANP; Fuzzy; General aviation; Emergency rescue capability

1. Introduction

Public safety incidents and disasters occur frequently, which seriously affect people's life, health and property safety. Emergency rescue of disasters and accidents requires rapid response and flexible action. Traditional rescue methods are limited by the geographical location and environmental conditions of the disaster site, which not only cannot carry out rescue and relief activities, but also face the situation of expanding the impact of disasters. General aviation emergency rescue plays an important role in medical rescue and disaster relief due to its high mobility, rapidity and flexibility. However, compared with other countries, China's navigation emergency rescue system and mechanism are not perfect enough to meet the needs of emergency rescue. Therefore, it is of great practical significance to study and establish an effective evaluation method for the emergency rescue capability of general navigation, focusing on improving the weak links in the rescue and strengthening the management level.

Due to the late start of general aviation emergency rescue work in China, there are few related researches in China. In the earthquake relief of 5.12 earthquake, general aviation played an important role and was widely recognized and valued. General aviation began to become an important force in emergency rescue. With the opening of low-altitude airspace, navigation has opened up a new development, and the emergency rescue system of navigation has been gradually established. However, it faces many problems at the same time: poor operating environment, wide operating sites, and incomplete support measures; The aviation emergency rescue system is not perfect and the construction of rescue mechanism is lacking, and the professional skills and efficiency of the team are insufficient.

Guo Xinyao et al. [1] analyzed the influencing factors of general aviation emergency rescue ability, adopted the decision laboratory analysis method, constructed the correlation matrix of influencing factors, calculated the centrality and cause degree of influencing factors, revealed the influencing mechanism that limited China's general aviation emergency rescue ability, and clarified the path to improve the emergency rescue ability. Gao Jinmin et al. [2] constructed a comprehensive evaluation index system from five aspects of emergency management, emergency objectives, emergency process, emergency information and emergency resources, and used interval analytic hierarchy process and multi-level fuzzy comprehensive evaluation to evaluate the cooperation degree of regional general aviation emergency rescue, which could provide decision-making basis for cross-regional emergency rescue activities. Jin Huibin et al. [3] in analyzed 102 commuter flight incidents in the United States, proposed an event incentive analysis method based on average causal effect and Bayesian network, and established an incentive analysis model for commuter flight incidents. He Xin et al. [4] evaluated the current situation of the general aviation emergency rescue system from the aspects of one case and three systems. Li Yanhua et al. [5] combined "man-machine-loop-pipe" to construct China's aviation emergency response standard system from four dimensions. These studies mainly focus on material scheduling, rescue point setting, rescue regional coordination, and evaluation of general aviation emergency rescue system and overall development, but seldom consider the dynamic process from beginning to end of general aviation emergency rescue. The risk factors in the process of general aviation emergency rescue are more complex, and there is a coupling relationship between early warning, preparation, processing and recovery. The judgment of relative importance of each index factor is particularly important.

Cone analytic network process (Cone-ANP) is a new structural analysis method constructed by Li Chunhao et al. [6] on the basis of the network analysis method proposed by Professor Saaty [7], considering the difference of structural characteristics of different elements and the influence of weight on the element set and its internal elements. Zhang Jijun et al. [8] believes that the existing Cone-ANP has great limitations in application, and constructs a general structure by distinguishing the properties of different elements and the dominating relations between multiple element sets, which can calculate the weight of each originating and accepting element. The general structure of Cone-ANP not only reflects the mutual dominant relationship of elements within the system, but also the weight calculation results are more scientific. Chai Qiangfei et al. [9] based on cone network analysis method identified the risk factors existing in each stage of the pipeline life cycle, obtained the weight of pipeline risk evaluation index, and provided ideas for comprehensive and accurate identification of pipeline risk factors. Pan Hua et al. [10] analyzed the emergency capacity of power transmission and transformation engineering in Cone-ANP, identified the relevant risk factors and distinguished the nature of the elements, and proved the rationality of the pointed Cone-ANP in the relevant evaluation of engineering projects according to the analysis of the dominant relationship.

Therefore, based on the information of a general aviation company and the questionnaire data of experts from Henan International Joint Laboratory, this paper uses the sharp-cone network analysis method to establish a general aviation emergency rescue ability evaluation system, enrich the application of sharp-cone network analysis method in the field of general aviation, provide a new idea for the evaluation of general aviation emergency rescue ability, and promote the development of general aviation industry.

2. Identify the risk factors of general aviation emergency rescue

The navigation emergency rescue process corresponds to the accident occurrence process in time, that is, according to the whole development process of the accident, before, during and after the stage characteristics, appropriate measures should be taken for early warning, response processing and recovery. Early warning and emergency preparation should be carried out before the accident, the loss of the accident should be minimized when dealing with the accident, and the social order should be restored in time after the accident. According to the process of emergency rescue for general navigation, the evaluation index is defined. Based on reference to relevant literature [11-17], this study analyzes the factors affecting the emergency rescue ability for general navigation in combination with relevant policies, and takes emergency actions to control emergencies according to the characteristics of sudden and spreading accidents. The emergency rescue capability of general aviation is evaluated from four aspects: early warning support, advance preparation, rescue processing and recovery disposal, as shown in Table 1.

Table 1: General aviation emergency rescue capability indicators

First-level indicators	Secondary indicators	Instructions
Early warning support capability(A)	Information handling(A1)	Predict the accident and start the corresponding rescue response level
	Communication support(A2)	Ensure effective and timely communication systems
	Material support(A3)	Timely delivery of rescue equipment and emergency equipment
	Equipment dependability(A4)	The monitoring equipment was reliable and reasonably configured
Rescue readiness capacity(B)	Daily construction(B1)	Emergency management mechanism construction and organizational system construction
	Emergency plan formulation (B2)	Formulate response plans for all types of accidents
	Emergency training(B3)	To carry out emergency professional training and emergency plan exercises
Rescue handling capacity(C)	Operational command(C1)	Field command, organize and coordinate all parties to carry out response activities
	Rescu and medical care (C2)	Search and Rescue and Medical treatment at the scene of the accident
	Accident site processing C3	Take control measures at the accident site to prevent further expansion and deterioration of the incident
Restoration of disposal capacity(D)	Post-disaster handling D1	Clean up the scene after a disaster and restore order
	Evaluate summaryD2	Summarize the experience and shortcomings

3. Cone analytic network process (Cone-ANP)

3.1 Cone-ANP element set structure

The sharp-cone network elements can be divided into three types, as shown in Table 2. The pointed cone element set composed of any cone top element and any type of cone bottom element is a general point cone element set. The conical network analysis structure composed of two or more sets of conical elements is the general structure of conical network analysis

Table 2: Division of sharp-cone network elements

Classification of elements	explanation
Element of origin	Dominate other elements and not be dominated by other elements
Element of transition	Either dominating other elements or being dominated by other elements
Element of acceptance	Does not dominate other elements and is dominated by other elements

3.2 Calculation of the weight of the pyramid network elements

1) Let there have M sets of pointy cone elements: $C = \{C_1, C_2, \cdots, C_M\}$.The interior elements of the mth cusp element set are: $C_m = \left\{e_{m0}^{(1)}, \cdots, e_{m0}^{(z_m)}; e_{m1}, \cdots e_{mn_m}; e_m^{(1)}, \cdots, e_m^{(u_m)}\right\}, \ m = 1,2,\cdots, M$
Where $z_m(z_m \geq 0)$ is the number of cone top elements, $n_m(n_m > 0)$ is the number of transitional cone bottom elements, $u_m(u_m \geq 0)$Is the number of elements at the base of the receptive cone.

2) The decision maker uses $e_{m0}^{(j)}$ as the comparison criterion, Pairwise comparisons were made between e_{mi} and $e_{mk}(i, k = 1,2,\cdots, n_m, k \neq i)$,Get the weights: $\delta_{m1}^{(j)}, \delta_{m2}^{(j)}, \cdots, \delta_{mn_m}^{(j)}$.Using the cone top element as a reference, the preference weights of the transitional elements can be expressed as matrix δ_m.

3) Summing over δ_m row yields the matrix: $\beta_m = (\beta_{m1}, \beta_{m2}, \cdots, \beta_{mn_m})$.Then it is normalized to get the matrix: $\overline{\beta_m} = (\overline{\beta_{m1}}, \overline{\beta_{m2}}, \cdots, \overline{\beta_{mn_m}})$
4) For transitional elements, decision-makers are invited to take transitional elements as the comparison criterion, compare the importance of other transitional elements, calculate the weight of transitional elements, and construct a matrix :
$A = [A_{11}^{(\alpha)}, \cdots A_{1n_1}^{(\alpha)} \cdots A_{m1}^{(\alpha)} \cdots A_{mh_m}^{(\alpha)} \cdots A_{mn_m}^{(\alpha)} \cdots A_{M1}^{(\alpha)} \cdots A_{Mn_M}^{(\alpha)}]$
5) According to the compound weight principle of AHP, assuming that the weights of each transitional element at *t-1* time are known, then there are:
$$\omega_{mh_m}^{(t)} = \sum_{k_1=1}^{n_1} \omega_{1_{k_1}}^{(t-1)} \alpha(e_{mh_m}, e_{1k_1}) + \sum_{k_2=1}^{n_2} \omega_{1_{k_2}}^{(t-1)} \alpha(e_{mh_m}, e_{1k_2}) + \cdots + \sum_{k_M=1}^{n_M} \omega_{1_{k_M}}^{(t-1)} \alpha(e_{mh_m}, e_{1k_M}),$$
$t = 1,2, \cdots$
Combined with the above formula, it can be obtained:$W^{(t)} = AW^{(t-1)}, t = 1,2, \cdots$
6) Setting $Q \underline{\Delta} AB$, Then $W^{(t)} = ABW^{(t-1)} = QW^{(t-1)} = Q^2 W^{(t-2)} = \cdots = Q^t W^{(0)}, t = 1,2, \cdots$
Among them$B = [\overline{\beta_m}]_{u_m \times u_m}$.
7) Therefore, when $Q^{(+\infty)}$ exists, the limit ordering weight $W^{(+\infty)}$ of each cone bottom element must exist, and has nothing to do with $W^{(0)}$. When $Q^{(+\infty)}$ does not exist, because Q is a column random matrix, $W^{(t)}$ will oscillate and converge. Based on $W^{(+\infty)} = Q^{(+\infty)}$, the limiting weight vectors of each receptivity element can be found.
8) According to the description of the element characteristic gravity and difference coefficient in the entropy weight method, the weight vector of the cone top element can be obtained:
$$\left(\omega_{m0}^{(1)}, \omega_{m0}^{(2)}, \cdots \omega_{m0}^{(z_m)}\right)^T = (\omega_{m1}, \omega_{m2}, \cdots \omega_{mn_m})(\gamma_1^m, \gamma_2^m, \cdots \gamma_{z_m}^m,)^T$$
$$\gamma_j^m = \frac{d_j^m}{\sum_{j=1}^{z_m} d_j^m}$$
$$d_j^m = 1 + \frac{1}{\ln n_m} \sum_{i=1}^{n_m} \frac{\delta_{mi}^{(j)}}{\sum_{i=1}^{n_m} \delta_{mi}^{(j)}} \ln \frac{\delta_{mi}^{(j)}}{\sum_{i=1}^{n_m} \delta_{mi}^{(j)}}$$
9) For the weight of the element at the bottom of the acceptability cone, the weight of the acceptability element can be obtained according to its preference weight and the weight of the sharp cone element.

4. Comprehensive evaluation of risk indicators

4.1 Profile of a general aviation company

An aviation company integrates aviation manufacturing, operation, training and cultural travel, focusing on the field of emergency rescue, and developing a tracking and control integrated information management system. In the event of public emergency, according to the on-site video, pictures, reports for a comprehensive analysis, to determine the level of risk and early warning and command rescue, comprehensive calculation of the impact of the emergency scope and risk. Various types of navigable aircraft are ready for emergency rescue work at any time, and can quickly complete tasks such as restoring mobile phone communications, forest fire fighting and ground power supply. Affected by the domestic aviation emergency rescue environment, the network of the ground emergency rescue base of the airline is underdeveloped, the supporting aviation emergency rescue facilities are relatively backward, and the independent supply capacity and anti-pressure capacity are insufficient.

4.2 Cone-ANP structure of evaluation indicators

In this paper, experts are invited to construct a judgment matrix M by judging the direct dominance relationship between indicators, Rows in the table represent influencing factors, Columns represent affected factors. "1" means there is a direct dominating relationship between the elements, as shown in Table 3.

Table 3: Domination relationship judgment matrix

M	A1	A2	A3	A4	B1	B2	B3	C1	C2	C3	D1	D2
A1	0	0	0	0	0	0	0	1	0	0	0	0
A2	0	0	0	0	0	0	0	1	1	1	1	0
A3	0	0	0	0	0	1	0	1	1	1	1	0
A4	1	1	0	0	0	0	0	0	0	0	0	0
B1	1	1	1	0	0	1	1	1	0	0	0	1
B2	1	1	1	0	0	0	1	1	0	0	0	0
B3	0	1	1	0	0	0	0	0	1	1	0	0
C1	0	0	0	0	0	0	0	0	1	1	0	0
C2	0	0	0	0	0	0	0	1	0	1	1	0
C3	0	0	0	0	0	0	0	1	1	0	0	0
D1	0	0	0	0	0	0	0	0	0	0	0	0
D2	0	0	0	0	0	0	0	0	0	0	0	0

According to the domination relationship and element types among elements in matrix M, if A4 has a domination relationship with A1, an arrow line pointing to A1 is drawn from A4 to construct the Cone-ANP structure chart of the whole process of general aviation emergency rescue risk assessment index, as shown in Figure 1. According to the dominance relationship judgment matrix and Cone-ANP structure chart in Table 2, the pointed Cone elements are divided. The source elements are the elements whose rows are not all 0 and columns are all 0, and the table includes A4 and B1; Transitional elements are the elements whose rows are not all 0 and columns are not all 0, including A1, A2, A3, B2, B3, C1, C2 and C3 in the table; Receptive elements are elements whose rows are all zeros and columns are not all zeros, with D1 and D2 in the table. The division of pyramidal network elements is also evident from the arrow line relationship in Figure 1.

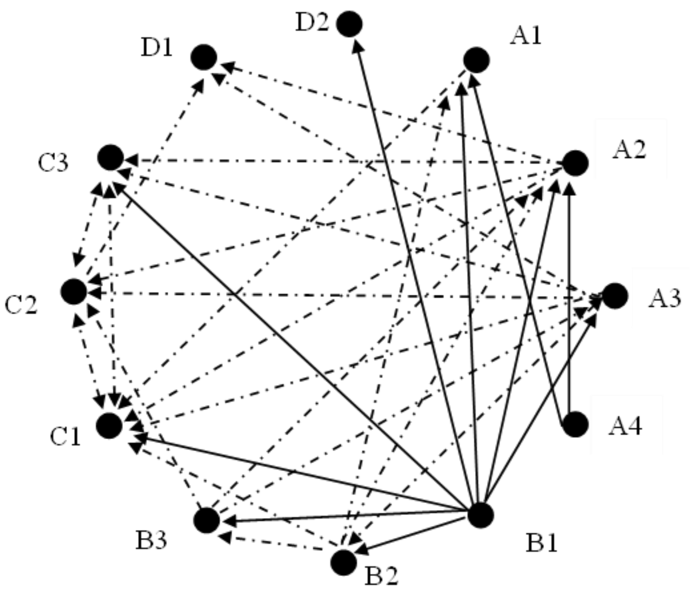

Figure 1: The Cone-ANP plots of the evaluation index

According to the above analysis, for the evaluation index of the emergency rescue capability of general aviation in the whole process, the division results of the sharp-cone elements are shown in Table 4.

Table 4: Classification of Cone-ANP elements

Single index	Element symbol	Pointy cone element type	Primitive element symbol
Early warning facility capability	$e_{10}^{(1)}$	Generative elements	A4
Daily building ability	$e_{10}^{(2)}$	Generative elements	B1
Information processing ability	e_{11}	Transitional elements	A1
Communication support capability	e_{12}	Transitional elements	A2
Material support capability	e_{13}	Transitional elements	A3
Contingency planning ability	e_{14}	Transitional elements	B2
Emergency training advocacy ability	e_{15}	Transitional elements	B3
Operational command capability	e_{16}	Transitional elements	C1
Emergency team rescue capability	e_{17}	Transitional elements	C2
Accident scene handling capability	e_{18}	Transitional elements	C3
Post-disaster resilience	$e_{1}^{(1)}$	Element of receptivity	D1
Evaluation and summary ability	$e_{1}^{(2)}$	Elements of receptivity	D2

4.3 Evaluation index weight calculation

For the classification results of general aviation emergency rescue capability evaluation indicators, combined with the domination relationship in Table 3, experts were invited to construct the importance judgment matrix of the cone base element relative to the cone top element $e_{10}^{(1)}$、$e_{10}^{(2)}$, and the relative weight of each transitional element $e_{10}^{(1)}$ relative to the cone top element in the sharp cone element set was obtained as follows:

$$(\delta_1, \delta_2, \cdots, \delta_8)^T = (0.2,0.8,0,0,0,0,0,0,0,0)^T$$

The relative weight of the relative to $e_{10}^{(2)}$ is as follows:

$$e_{10}^{(2)}(\delta_1, \delta_2, \cdots, \delta_8)^T = (0.0327,0.1340,0.0814,0.2105,0.3943,0.1471,0,0)^T$$

Normalized processing to obtain the weight value of the matrix transition element relative to the cone top element: $((\overline{\delta_1}, \overline{\delta_2}, \cdots, \overline{\delta_8},)^T$ =0.11635,0.46700,0.0407,0.10525,0.19715,0.07355,0,0)

For the transitional elements in the cusp-cone element set, experts are invited to make A pairwise comparison of all transitional elements except e_{h_m} as the comparison criterion, and then the matrix A is constructed:

$$A = \begin{bmatrix} 0 & 0 & 0 & 0.1354 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.1136 & 0.4863 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.0624 & 0.0826 & 0 & 0 & 0 \\ 0 & 0 & 0.4703 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.3358 & 0 & 0 & 0 & 0 \\ 1 & 0.5 & 0.2797 & 0.3528 & 0 & 0 & 0.6667 & 0.75 \\ 0 & 0.25 & 0.1142 & 0 & 0.2233 & 0.3333 & 0 & 0.25 \\ 0 & 0.25 & 0.1358 & 0 & 0.2078 & 0.6667 & 0.3333 & 0 \end{bmatrix}$$

In summary, the limit weight vector of each transitional element can be obtained:

$(\omega_{11}, \omega_{12}, \dots, \omega_{18})^T = (0.0143,0.1078,0.00229,0.0191,0.0353,0.3984,0.1899,0.2123)^T$

According to the description of element characteristic gravity and difference coefficient in entropy weight method, the weight vector of cone top element is obtained: $\left(\omega_{10}^{(1)}, \omega_{10}^{(2)}\right)^T = (0.7533,0.2467)^T$

For the weight of the base element of the receptive cone, based on its preference weight and the weight of the sharp cone element, the weight of the base element of the receptive cone in the set of sharp cone elements can be obtained as follows: $\left(\omega_1^{(1)}, \omega_1^{(2)}\right)^T = (0.3835,0.6165)^T$

The weight of evaluation index of general aviation emergency rescue capability can be obtained:

$(\omega_{A1}, \omega_{A2}, \omega_{A3}, \omega_{A4}, \omega_{B1}, \omega_{B2}, \omega_{B3}, \omega_{C1}, \omega_{D1}, \omega_{D2})^T$

$= (0.0084,0.0359,0.0076,0.2511,0.0822,0.0064,0.0118,0.1328,,0.0633,0.0708,0.1278,0.02055)^T$

The evaluation index weights of general aviation emergency rescue capability were calculated by the pointed cone network analysis method as follows: Early warning facility ability > action command ability > disaster recovery ability > daily construction ability > accident site processing ability > emergency rescue ability > communication support ability > evaluation and summary ability > emergency training and publicity ability > Information processing ability > material support ability > emergency plan formulation ability.

4.4 Fuzzy comprehensive evaluation

According to the weights obtained by the sharp cone network analysis method, the fuzzy comprehensive evaluation evaluation method is used to evaluate the general navigation company comprehensively. In order to make the evaluation results accurate, according to the relevant standards at home and abroad and relevant literature, the five-level evaluation set is determined as: $V = (V_1, V_2, V_3, V_4, V_5)$, Among them, V_1 to V_5 were rated as excellent, good, fair, poor, and very poor.

In order to determine the membership degree of evaluation objects, 20 experts are invited to analyze according to the membership degree of evaluation indicators. For example, 8 experts think that the communication security ability is "good", that is, the evaluation result is calculated as 0.4 in the form of percentage comparison method, so as to determine the membership degree of evaluation indicators. The details are shown in Table 5.

Table 5: Classification of Cone-ANP elements

Indicators	Excellence	Good	Average	Poor	Very poor
Information processing ability A1	0.3	0.45	0.25	0	0
Communication Assurance Capability A2	0.3	0.4	0.2	0.1	0
Material support capacity A3	0.4	0.2	0.25	0.1	0.05
Early warning facility Capacity A4	0.35	0.35	0.25	0.05	0
Daily building ability B1	0.25	0.3	0.4	0.05	0
Contingency planning ability B2	0.35	0.3	0.3	0.05	0
Emergency training advocacy capacity B3	0.3	0.3	0.3	0.1	0
Operational command capability C1	0.4	0.4	0.2	0	0
Emergency team rescue capability C2	0.35	0.35	0.2	0.1	0
Accident site handling capacity C3	0.2	0.3	0.35	0.15	0
Disaster recovery D1	0.35	0.3	0.3	0.05	0
Evaluate summary ability D2	0.25	0.25	0.3	0.2	0

According to the above index weight calculation results and membership matrix, according to the formula U=W*R(where U represents the evaluation results, W represents the weight vector of each evaluation factor, R represents the corresponding membership moment) can obtain the whole navigable emergency rescue capability U:

$$U = \begin{pmatrix} 0.0048 & 0.0359 & 0.0076 & 0.2511 & 0.0822 & 0.0064 & 0.0118 & 0.1328 & 0.0633 & 0.0708 & 0.1278 & 0.2055 \end{pmatrix}$$

$$* \begin{pmatrix} 0.3 & 0.45 & 0.25 & 0 & 0 \\ 0.3 & 0.4 & 0.2 & 0.1 & 0 \\ 0.4 & 0.2 & 0.25 & 0.1 & 0.05 \\ 0.35 & 0.35 & 0.25 & 0.05 & 0 \\ 0.25 & 0.3 & 0.4 & 0.05 & 0 \\ 0.35 & 0.3 & 0.3 & 0.05 & 0 \\ 0.3 & 0.3 & 0.3 & 0.1 & 0 \\ 0.4 & 0.4 & 0.2 & 0 & 0 \\ 0.35 & 0.35 & 0.2 & 0.1 & 0 \\ 0.2 & 0.3 & 0.35 & 0.15 & 0 \\ 0.35 & 0.3 & 0.3 & 0.05 & 0 \\ 0.25 & 0.25 & 0.3 & 0.2 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 0.3150 & 0.3223 & 0.2754 & 0.0870 & 0.0004 \end{pmatrix}$$

The evaluation grade of the overall index, that is, in the membership degree, "excellent" is 0.3150, "good" is

0.3223, "average" is 0.2754, "poor" is 0.0870, "very poor" is 0.0004. Among them, "good" is the largest membership, indicating that the emergency rescue ability of the general aviation company is generally good.

4.5 Analysis of evaluation results

In this paper, the evaluation index weight of navigation emergency rescue capability is obtained by the sharp-cone network analysis method, and the overall emergency rescue status is good by the fuzzy comprehensive evaluation method. As can be seen from the evaluation index results, communication support ability, evaluation and summary ability, and action command ability, as indicators with high weight, need to be paid more attention by the organization and management. The emergency rescue process requires all parties to communicate in real time, communication support ability is particularly important, should ensure the reliability of equipment and the diversification of technical means; Evaluation and summary ability has a large weight in the navigation emergency rescue ability, but in the whole process of the navigation enterprise rescue capacity building, this process is easy to be ignored, only in each emergency rescue activity to summarize the shortcomings and advantages of the operation, can be improved in the next emergency rescue, so that the navigation emergency rescue ability is constantly improved; For operational command capacity, the state has issued relevant laws and regulations to gather the forces of aviation emergency rescue parties together, and standardize the actions of all parties according to policies, establish a unified command platform, carry out unified scheduling, formulate aviation emergency rescue system planning, and clarify the responsibilities of each department and the person in charge of each department. In addition, the emergency rescue process should be grasped as a whole, focusing on several weak links, and improving the efficiency of emergency rescue.

5. Conclusion

According to the characteristics of emergencies, starting from each emergency stage of early warning, preparation, handling and recovery, the main risk factors of general navigation emergency rescue are comprehensively identified, and the risk index evaluation system is systematically constructed, which is combined with the sharp cone network analysis method to provide the basis for the evaluation of general navigation emergency rescue capability in the future.

Based on the calculation method of Cone-ANP general structure, the weight of each evaluation index obtained is more objective and reasonable. The general navigation company should strengthen the management of high-weight indicators, grasp the risk indicators as a whole, and put forward relevant suggestions for the general navigation company to improve the emergency rescue management level as a reference.

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