Construction of Command Effectiveness Evaluation Index System of Large - scale Activities Security Work Based on Analytic Hierarchy Process

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Abstract—In this paper, Delphi method is used to score experts on the established index system, and analytic hierarchy process (AHP), Octave and other computer data analysis software are used to calculate the weight of indicators in the system. Through the experiment, the index weight of the index system is less than 0.1, and the consistency test proves the scientificity and feasibility of the establishment of the index system, which provides reference for the practice of activity security.

Keywords-activity security; AHP; command effectiveness evaluation index system

1 Introduction

Large-scale activities refer to social activities with a large number of participants organized for temporary social rent or occupation of public places. They are often divided into four categories: sports activities, cultural activities, high-end exhibitions, and temple fair parks. They are characterized by strong political nature, wide influence, open location, large number of people, and complex work.

With the rapid development of social economy, the ability of provinces, cities and counties in China to undertake various large-scale activities is becoming stronger and stronger. With the joint efforts of the activities security departments and social related departments, some gratifying achievements have been made. But it cannot be ignored that all these achievements cannot be achieved without orderly command. The normal command and emergency response command of the activity security department in the security work within the scope of the function is particularly important, and plays a leading role in the whole process. Therefore, how to improve the command efficiency of large-scale activities in the activity security department has become a hot issue in the current command discussion.

2 Establishing ideas

The construction of command effectiveness evaluation index system for large-scale activities in activity security department is a complicated process. Through the study of the current command effectiveness evaluation index system [1-3], according to the general method of

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constructing the index system and the dynamic and static performance, the author completes the construction of the command effectiveness evaluation index system of large-scale activities in the activity security department.

The construction process of the index system is a thinking process from the upper level to the lower level, from abstract to concrete. In general, the establishment of the command effectiveness evaluation index system is divided into two steps: one is to establish the basis of the index system, the other is to refine the index system.

According to the characteristics of large-scale activities contents, heavier tasks and higher standards of security work in large-scale activities, command effectiveness can be divided into two aspects: dynamic effectiveness and static effectiveness. Dynamic effectiveness not only reflects the ability of the command system itself, but also considers many other factors such as the field environment. Static performance does not take into account environmental, task and other factors, but is based on the quality, quantity and structure of the command system itself inherent ability. Therefore, in this paper, the activity security department of large-scale activities security work command effectiveness evaluation index is divided into dynamic efficiency index and static efficiency index (hereinafter referred to as ' static index ', ' dynamic index ') two categories.

Meetings are often held in closed indoors, and activities are often carried out in outdoor venues such as stadiums. Outdoor places have a large population flow, the scene environment changes rapidly, and the security of the activity is more uncertain. It also increases the difficulty of the command activities of the activity security department, and relies more on the command of the commander. Therefore, dynamic indicators can be decomposed into field environment, information collation, command decision-making, command operations.Static indicators do not consider the factors of the environment, based on the inherent attributes, such as the quality of the command personnel, the situation of the command object, the reasonable degree of the command organization, the automation of the command means.

3 construction of index system

Combining static indicators with dynamic indicators, the command effectiveness evaluation index system of large-scale activities in the activity security department (Table. 1) shows :

Table.1 Evaluation Index System of Command Effectiveness of Large-scale Activities in Activity Security Department

first grade indexes	second grade indexes	third grade indexes
Quality of command personnel A_1	knowledge ability B_1	professional field C_1
		mathematical fields C_2
		psychological realm C_3
	receptive skill B_2	The ability to understand the intention of superiors C_4
		Communication skills with departments C_5

		The ability to judge the contents of subordinate reports C_6
	Directorship B_3	Command quality C_7
		Command speed C_8
	Reactivity B_4	reaction quality C_9
		reaction velocity C_{10}
	Ability to use tools B_5	The proficiency of communication tools C_{11}
		The proficiency of command tools C_{12}
		The proficiency of using safeguard tools C_{13}
	decision making capacity B_6	decision quality C_{14}
		decision speed C_{15}
	operation capacity B_7	operation quality C_{16}
		operating speed C_{17}
Headquarters A_2	The reasonable degree of command organization setting B_8	personnel quantity C_{18}
		Personnel quality C_{19}
		The clarity of organizational relationship C_{20}
		Rationality of institutional setting C_{21}
	The police force that can be allocated by the command organization B_9	Number of police forces C_{22}
		The quality of police force C_{23}
	The smoothness of information transmission in command institutions B_{10}	Types of information transmission channels C_{24}
		Smoothness of information transmission channelsC_{25}
		Time of information transmission C_{26}
command object A_3	The educational level of command object B_{11}	academic credentials C_{27}
		Degree of self-study C_{28}
		Degree of experience C_{29}
	Performance of Command Objects B_{12}	Degree of emotional stability of command object C_{30}
		The psychological state of the command object C_{31}
		Age of command object C_{32}
		The appearance of command object C_{33}
		Number of command objects C_{34}
		The demands of command objects C_{35}
command means A_4	Command equipment B_{13}	Quality of command equipment C_{36}
		Number of command equipment C_{37}

	command method B_{14}	The types of command methods C_{38}
		Practicality of command methods C_{39}

4 Quantification of Qualitative Index of Index System

AHP hierarchy method and optimal sequence diagram method are relatively easy to operate by using the relative size information of numbers. The following mainly introduces how to use AHP method and octave software to quantify the qualitative indicators in the index system.

4.1 Determining Index Weight Scale

In order to compare each index and get the quantitative judgment matrix, 1 ~ 9 scales are introduced, as shown in Table. 2[4-6]:

Table. 2 Table of index weight scales

Value	meaning
1	Indicator i is as important as indicator j
3	Index i is slightly more important than index j
5	Indicator i is significantly more important than indicator j
7	Index i is certainly more important than index j
9	Index i is absolutely more important than index j
2,4,6,8 are other intermediate values that can be used ; if index i is less important than index j, this value is 1 / v, v is 1-9	

4.2 Constructing the weight judgment matrix

Using Delphi Method, Combined Weight Scale and Matrix Concrete Form

$$A=\begin{bmatrix} a_{1,1} & a_{1,2} & \cdots & a_{1,n} \\ a_{2,1} & a_{2,2} & \cdots & a_{2,n} \\ \vdots & \vdots & & \vdots \\ a_{n,1} & a_{n,1} & \cdots & a_{n,n} \end{bmatrix} \tag{1}$$

where ai, j represents the relative weight of index ai relative to index aj), and the relative weight of each index factor is calculated. Common steps are as follows:

Step 1. Calculation of eigenvalues and eigenvectors of judgment matrix

$$w_i=\left(\prod_{j=1}^{n} a_{ij}\right)^{\frac{1}{n}} / \sum_{k=1}^{n}\left(\prod_{j=1}^{n} a_{kj}\right)^{\frac{1}{n}}, \quad \text{i, j=1,2.....n} \tag{2}$$

And the weight coefficient is 1. Namely $\sum_{i=1}^{n} w_i = 1$

The coefficient matrix is denoted as :

$$W=[w_1\ w_{2...}\ w_n]^T \quad (3)$$

According to the method steps described above and Formulas (1) (2) (3), the calculation results of each judgment matrix in the first-level index system are shown in the following Table.3.

Table. 3 A1-A4 Weight Coefficient Table

U	A1	A2	A3	A4	W
A1	1	4	8	4	0.570071
A2	1/4	1	6	5	0.280474
A3	1/8	1/6	1	1/2	0.054148
A4	1/4	1/5	2	1	0.095307

Similarly, the index weight coefficients in the second and third-level index systems are :

$W_{UB1\text{-}7}=\begin{bmatrix}0.047150\\0.149019\\0.169859\\0.181656\\0.087016\\0.249934\\0.115366\end{bmatrix}$ $W_{UB8\text{-}10}=\begin{bmatrix}0.44343\\0.16920\\0.38737\end{bmatrix}$

$W_{UB11\text{-}12}=\begin{bmatrix}0.3\\0.7\end{bmatrix}$ $W_{UB13\text{-}14}=\begin{bmatrix}0.5\\0.5\end{bmatrix}$ $W_{UC1\text{-}3}=\begin{bmatrix}0.59363\\0.24931\\0.15706\end{bmatrix}$

$W_{UC4\text{-}6}=\begin{bmatrix}0.33333\\0.33333\\0.33333\end{bmatrix}$ $W_{UC7\text{-}8}=\begin{bmatrix}0.5\\0.5\end{bmatrix}$ $W_{UC9\text{-}10}=\begin{bmatrix}0.5\\0.5\end{bmatrix}$ $W_{UC11\text{-}13}=\begin{bmatrix}0.33333\\0.33333\\0.33333\end{bmatrix}$

$W_{UC14\text{-}15}=\begin{bmatrix}0.5\\0.5\end{bmatrix}$

$W_{UC16\text{-}17}=\begin{bmatrix}0.5\\0.5\end{bmatrix}$ $W_{UC22\text{-}23}=\begin{bmatrix}0.5\\0.5\end{bmatrix}$ $W_{UC36\text{-}37}=\begin{bmatrix}0.5\\0.5\end{bmatrix}$ $W_{UC38\text{-}39}=\begin{bmatrix}0.5\\0.5\end{bmatrix}$

$W_{UC18\text{-}21}=\begin{bmatrix}0.13429\\0.19558\\0.30611\\0.36402\end{bmatrix}$

$W_{UC24\text{-}26}=\begin{bmatrix}0.33333\\0.33333\\0.33333\end{bmatrix}$ $W_{UC27\text{-}29}=\begin{bmatrix}0.33333\\0.33333\\0.33333\end{bmatrix}$ $W_{UC30\text{-}35}=\begin{bmatrix}0.165977\\0.149468\\0.057033\\0.057769\\0.171098\\0.398656\end{bmatrix}$

4.3 Consistency test

In order to improve the reliability of weight evaluation, it is necessary to test the consistency of judgment matrix. The consistency check algorithm is:

$$\text{CI}=\frac{\lambda_{\max}-n}{n-1} \tag{4}$$

In the formula, n is the dimension of the matrix, which is actually the number of the same matrix index; λmax is the maximum eigenvalue of a matrix.

$$\lambda_{\max}=\frac{1}{n}\sum_{i=1}^{n}\frac{(A*W)_i}{W_i} \tag{5}$$

Consistency index needs to be modified when matrix dimension is large.

$$CR=\frac{CI}{RI}$$

RI is a correction factor, for different dimensions, the value of common Table. 4 [1-3]:

Table. 4 Table of modified functions

Dimension	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.96	1.12	1.24	1.32	1.41	1.45

5 Conclusion

Since the judgment matrix is easy to be completely consistent when the dimension of the index is less than 3 dimensions, it is not necessary to calculate the consistency index.

Generally, when CR < 0.1, it is considered that the matrix meets the consistency requirement. After consistency verification, CRA = 0.0975 < 0.1, CRB1 - 7 = 0.0764 < 0.1, CRB8 - 10 = 0.0176 < 0.1, CRC1 - 3 = 0.0516 < 0.1, CRC18 - 21 = 0.0439 < 0.1, CRC30 - 35 = 0.0228 < 0.1, other CR = 0, so the weight obtained above meets the consistency requirements.

Therefore, the index system is feasible.

6 Discuss

This paper is reliable and has sufficient theoretical basis, but objectively speaking, the subjectivity of expert scoring based on Delphi method is still large. How to select experts more targeted, how to reduce the error caused by human subjectivity will be the next step to consider. There are different views on the experimental results :

- Should the selection criteria of experts be quantified ?
- Is there a better method suitable for the construction of the index system ?

- How to reduce the experimental error caused by human subjectivity ?

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