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# AHP Based Grassroots Emergency Response Capability Evaluation Index System Construction

**Sijie Zhang*, Yazhou Yang**

Shandong Institute of Technology, Yantai 264005, Shandong Province, China

******Corresponding author:*** Sijie Zhang, jiliang19970523@163.com

**Abstract:** The primary and secondary catastrophes of emergencies, as well as their comprehensive disasters, add a significant deal of complexity and risk to the grassroots emergency response system's creation. The completeness of the emergency response system development is significantly related to improving the basic capacity of grassroots emergency security. The weight comparison calculation and analysis of the links at all levels in the emergency response system is carried out using the hierarchical analysis method based on the basic experience of current domestic related fields for the construction of the emergency response process system, and the results of the relative importance ranking of indicators are obtained, and this is used to provide emergency response and emergency management decision makers with emergent information.

**Keywords:** Emergency response; Indicator weights; Analytic hierarchy process; Emergency management

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## 1. Introduction

The uncertainty of emergencies has made the public safety of grassroots society face an increasingly complex and severe situation. Emergency management decisions also usher in new shocks and challenges. In the process of grassroots emergency management systems and capacity building, the concept of strengthening preventive early warning is difficult to land effectively [1]. Therefore, establishing an effective emergency response system has become an important strategic task for promoting emergency management capacity building.

## 2. Grassroots emergency response system index construction

### 2.1. Introduction to grassroots emergency response theory

Emergency Response (ER) refers to the preparatory work done by the organization or subjects at all levels in the face of emergencies at all levels, and also includes a series of response measures taken by it afterwards. The premise of the emergency response mechanism is to clarify the training targets, training methods, training scope and other factors of emergency response.

### 2.2. AHP method

The hierarchical analysis method (Analytic Hierarchy Process, AHP) is a comprehensive evaluation method combined with a qualitative and quantitative analysis method [2] proposed by American operations consultant Professor TL Saaty in the early 1970s, and is widely used in many fields.

## 3. Grassroots emergency response system indicators

According to the relevant provisions of the Emergency Response Law of the People's Republic of China, the emergency response process system is divided into four stages: emergency risk identification, emergency response preparation, emergency treatment and rescue, and post-event recovery and reconstruction, and the secondary indicators of the emergency response capability are determined and divided based on relevant domestic and foreign literature and information, combined with the actual research and experience of relevant experts.

### 3.1. Emergency Risk Identification

#### 3.1.1. Risk and hazard source identification

Risk source is the source of factors or conditions that may lead to the consequences of risk. Hazardous sources are material sources with potential energy in the process of emergencies.

#### 3.1.2. Risk level evaluation

The emergency response level is determined through the existing risk level evaluation table. If the accident level has not reached the minimum response level, the response is closed. The emergency risk is divided into five categories of risk levels according to the size of the risk value, and are marked with red, orange, yellow and blue. As shown in **Table 1**, above level II need to start emergency response.

**Table 1.** Risk level classification table

| Risk Value | Risk Level | Remarks |
|---|---|---|
| 1-2 | Low Risk | Grade I |
| 3-8 | General Risks | Class II |
| 9-16 | Medium risk | Grade III |
| 18-25 | Significant Risks | Level IV |
| 30-36 | Particularly significant risks | Grade V |

### 3.2. Emergency response preparation

#### 3.2.1. Emergency information dissemination

When the emergency risk level is determined, information and network communication systems should be opened, superiors should be contacted urgently, communication should be kept open.

#### 3.2.2. Emergency resource preparation

(1) Emergency material preparation. Emergency supplies and equipment security capacity, emergency supplies and equipment reserve in a reasonable manner, as well as advanced and applicable equipment emergency supplies configuration strength is the key to strengthen the emergency supplies and equipment security capacity of emergencies.

(2) Emergency team building Specialized teams of emergency response and rescue are an important force in the field of emergency management to prevent and deal with various disasters, accidents and emergencies.

(3) Emergency transportation management. Further improve the smoothness of railroads, highways and waterways, and vigorously improve the emergency transportation capacity is the basic premise to guarantee the emergency response capacity.

(4) Emergency communication network security. Emergency communication system is the key infrastructure for emergency protection, and the reasonable and unscientific construction of emergency communication system will directly affect the execution efficiency of the overall emergency rescue tasks.

### 3.3. Emergency response and rescue

#### 3.3.1. Emergency decision-making command

Emergency decision-making broadly refers to the timely decision-making made by adopting a special non-procedural method. In fact, it refers to the establishment of a temporary on-site combat command based on the actual situation on the spot to determine the decision-making activities of the overall emergency plan.

#### 3.3.2. Hierarchical response rescue

Graded response refers to different types of work according to the division of labor of their respective functions, which has reached the maximum human function effect value. The work of the six professional functional groups is as follows: the combat team classifies the on-site emergency rescue personnel, fully grasps the situation on the spot, and classifies the incident according to the principle of "heavy to light"; the communication liaison group is responsible for maintaining communication with the combat command center, Establish a temporary unified contact signal method to ensure the timeliness and effectiveness of two-way information feedback; the technical security team is responsible for proposing emergency plans for rescue and field plans, and field plans for rescue operations.

### 3.4. Post-event recovery and reconstruction

(1) Personnel placement. It is important to actively encourage self-help to reduce their psychological trauma, build up their confidence to live again, and enhance their psychological stress resistance.
(2) Ecological restoration. The main task is to refurbish damaged and polluted rivers and lakes, as well as landscaping, green spaces and parks in cities and towns, and to gradually restore the general ecological vitality.
(3) Hardware reconstruction. The "hardware" mentioned in this paper refers specifically to the infrastructure of transportation facilities, communication networks, energy facilities, water conservancy facilities, urban and rural buildings and the corresponding social service guarantee system.
(4) Event Analysis and Summary. Incident analysis and summary mainly focus on public safety, enhancing the construction intensity and risk resistance of infrastructure.

## 4. Evaluation of grassroots emergency response process indicators

Emergency decision-making broadly refers to the timely decision-making made by adopting a special non-procedural method. As shown in **Table 2**, it refers to the establishment of a temporary on-site combat command based on the actual situation on the spot to determine the decision-making activities of the overall emergency plan.

### 4.1. Calculation of the weights of first-level indicators

The first-level indicators include emergency risk identification $B_1$, emergency response preparation B2, emergency treatment and rescue $B_3$, and post-event recovery and reconstruction $B_4$ according to the chart, and their judgment matrix is shown in **Table 3**.

### 4.2. Calculation of secondary index weights

The judgment matrix of the three secondary factors corresponding to the emergency risk identification stage is shown in **Table 4**. The two factor weights in the emergency response preparation phase are 0.24 and 0.76. The two factor weights of the emergency disposal and rescue phase are 0.24 and 0.76. The four factor weights in the recovery and reconstruction phase after the event were 0.52, 0.2, 0.2, 0.08.

**Table 2.** Emergency response process structure diagram

<table>
<tr><td rowspan="19">Emergency response flow chart A</td><td rowspan="3">Emergency risk identification $B_1$</td><td>Risk and Hazard Source Identification $C_{11}$</td><td></td></tr>
<tr><td>Emergency rating evaluation $C_{12}$</td><td></td></tr>
<tr><td>Emergency response level decision $C_{13}$</td><td></td></tr>
<tr><td rowspan="5">Emergency response preparation $B_2$</td><td>Emergency information release $C_{21}$</td><td></td></tr>
<tr><td rowspan="4">Emergency resources preparation $C_{22}$</td><td>Emergency materials preparation $D_{21}$</td></tr>
<tr><td>Emergency team construction $D_{22}$</td></tr>
<tr><td>Emergency delivery management $D_{23}$</td></tr>
<tr><td>Emergency communication guarantee $D_{24}$</td></tr>
<tr><td rowspan="7">Emergency disposal and rescue $B_3$</td><td>Emergency decision command $C_{31}$</td><td></td></tr>
<tr><td rowspan="6">Grade response rescue $C_{32}$</td><td>Combat Group $D_{31}$</td></tr>
<tr><td>Communication Contact Group $D_{32}$</td></tr>
<tr><td>Technical Security Group $D_{33}$</td></tr>
<tr><td>Medical assistance group $D_{34}$</td></tr>
<tr><td>Security Group $D_{35}$</td></tr>
<tr><td>Documentation Recording Group $D_{36}$</td></tr>
<tr><td rowspan="4">Restoration and reconstruction $B_4$</td><td>Staff placement $C_{41}$</td><td></td></tr>
<tr><td>Eco-environment restoration $C_{42}$</td><td></td></tr>
<tr><td>Hardware reconstruction $C_{43}$</td><td></td></tr>
<tr><td>Event analysis summary $C_{44}$</td><td></td></tr>
</table>

**Table 3.** Judgment matrix of first-level indicators (A)

| **A** | **$B_1$** | **$B_2$** | **$B_3$** | **$B_4$** | **$W_{(2)}$** | |
|---|---|---|---|---|---|---|
| **$B_1$** | 1 | 3 | 1/5 | 3 | 0.21 | $\lambda_{max}$ =0.78, |
| **$B_2$** | 1/3 | 1 | 1/5 | 3 | 0.12 | C.I=（λ-n）/（n-1）=-1.07, R.I=0.9, |
| **$B_3$** | 5 | 5 | 1 | 5 | 0.60 | C.R=C.I / R.I= -1.19<0.1 |
| **$B_4$** | 1/3 | 1/3 | 1/5 | 1 | 0.07 | Satisfy consistency |

**Table 4.** The second-level emergency risk identification stage ($B_1$) judgment matrix

| **$B_1$** | **$C_{11}$** | **$C_{12}$** | **$C_{13}$** | **$W_{(2)}$** | |
|---|---|---|---|---|---|
| **$C_{11}$** | 1 | 3 | 5 | 0.64 | $\lambda_{max}$ =0.776, |
| **$C_{12}$** | 1/3 | 1 | 3 | 0.26 | C.I=（λ-n）/（n-1）=-1.11, R.I=0.58, |
| **$C_{13}$** | 1/5 | 1/3 | 1 | 0.10 | C.R=C.I / R.I=-1.9<0.1<br>Satisfy consistency |

### 4.3. Calculation of the weights of the three-level indicators

The weighting values of the four three-level factors in the emergency resource preparation stage are shown in **Table 5** below. In the graded response and rescue phase, the weights of six tertiary factors were 0.16,0.14,0.25,0.33,0.07,0.05.

**Table 5.** Sub-judgment matrix for the three-level emergency resource preparation phase ($C_{22}$)

| $C_{22}$ | $D_{21}$ | $D_{22}$ | $D_{23}$ | $D_{24}$ | $W_{(2)}$ | |
|---|---|---|---|---|---|---|
| $D_{21}$ | 1 | 1/3 | 3 | 3 | 0.28 | $\lambda_{max}$=0.85, |
| $D_{22}$ | 3 | 1 | 3 | 3 | 0.48 | C.I=（λ-n）/（n-1）=-1.05, R.I=0.9, |
| $D_{23}$ | 1/3 | 1/3 | 1 | 1 | 0.12 | C.R=C.I / R.I =-1.17<0.1 |
| $D_{24}$ | 1/3 | 1/3 | 1 | 1 | 0.12 | Satisfy consistency |

### 4.4. Calculation of comprehensive weights of emergency response factors

The calculation of the composite weight should be carried out for each layer through the top-down order of the synthetic calculation of indicator weight values, which continues to the last layer of each relevant indicator, and the specific calculated values are shown in **Table 6** and **Table 7**.

**Table 6.** Calculated values of synthetic weights at the third level

| $C_{11}$ | $C_{12}$ | $C_{13}$ | $C_{21}$ | $C_{22}$ | $C_{31}$ | $C_{32}$ | $C_{41}$ | $C_{42}$ | $C_{43}$ | $C_{44}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.13 | 0.05 | 0.02 | 0.03 | 0.11 | 0.03 | 0.11 | 0.04 | 0.01 | 0.01 | 0.01 |

| $D_{21}$ | $D_{22}$ | $D_{23}$ | $D_{24}$ | $D_{31}$ | $D_{32}$ | $D_{33}$ | $D_{34}$ | $D_{35}$ | $D_{36}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.03 | 0.05 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.04 | 0.00 | 0.00 |

**Table 7.** Calculation value of relative weight at the fourth level

| $C_{22}$ | | | | $C_{32}$ | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $D_{21}$ | $D_{22}$ | $D_{23}$ | $D_{24}$ | $D_{31}$ | $D_{32}$ | $D_{33}$ | $D_{34}$ | $D_{35}$ | $D_{36}$ |
| 0.21 | 0.36 | 0.09 | 0.09 | 0.12 | 0.11 | 0.19 | 0.25 | 0.05 | 0.05 |

## 5. Recommendations and Conclusions

As can be seen from **Tables 6**, $C_{11}$, $C_{22}$, and $C_{32}$ have the third-level synthetic weight value> 0.1, and the larger values in **Table 7** are $D_{21}$, $D_{22}$, $D_{33}$, and $D_{34}$.Therefore, it is necessary to strengthen the identification of potential risks, improve the material reserve and dispatch strength, improve the emergency material reserve system, improve the comprehensive level of emergency management work, strengthen the construction of high-quality emergency specialization rescue teams such as medical teams [3], and vigorously optimize Professional emergency rescue team layout, rationally allocate emergency forces, and exert the effect of "maximizing rescue" [4] to promote the dynamic management of emergency reserve materials to protect the basic masses [5].

## Disclosure statement

The author declares no conflict of interest.

## References


[1] Jiang C, Jiang H, 2020, Examination of the National Emergency Management System and Capabilities for the Prevention and Control of the New Crown Pneumonia Epidemic. Managing the World, 36(08): 8-18+31+19.

[2] Guo J, Zhang Z, Sun Q, 2008, Research and Application of Hierarchical Analysis. Chinese Journal of

Safety Science, (05): 148-153.

[3] Sun Y, 2019, Closely Focus on the Adaptation and Disposal Response. The Entire Disaster Emergency Needs to be Built Flag-Provided Speech on the First Anniversary of the Fire Rescue Team Practiced the Spirit of the Training Work to Extract. China Emergency Management, (10): 13-19.

[4] Mashoka RJ, Murray B, Upendo G, et al., 2019, Implementation of Electronic Medical Records at an Emergency Medicine Department in Tanzania: The Information Technology Perspective. African Journal of Emergency Medicine.

[5] Zhu L, Cao J, Gu J, et al., 2020, Consider the Optimization of Dynamic Dispatch of Emergency Materials after Heterogeneous Behavior. Chinese Management Science, 28(12): 151-161.