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Research on urgency classification of emergency supplies based on combined method

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CONTENTS

1 | INTRODUCTION

- ✓ Background
- ✓ Research status

BACKGROUND

Large-scale emergencies continue to occur around the world, including **natural disasters**, **accident disasters** and **public health events**, which have brought great life and health injuries and economic losses to the society and the people. Therefore, emergency rescue of disaster-stricken people is needed, in which the **transfer and transportation of emergency materials** is the key link in the rescue process.

BACKGROUND

Emergency materials are often faced with practical constraints such as limited total amount of materials, scattered demand points and valuable rescue time.

Therefore, it is urgent to grade the urgency of emergency material demand at the disaster-stricken points and determine the distribution plan according to the priority of the disaster-stricken points, so as to maximize the rescue effect and reduce the rescue response time .

RESEARCH STATUS

- emergency supplies
  - demand urgency classification
    - different periods after the disaster
    - the evolution evaluation factor set of the emergency demand structure of the victims
    - the dynamic hierarchical evaluation process of emergency material demand
    - the extension fuzzy comprehensive evaluation method
  - the classified calculation
    - expert scoring method
    - fuzzy evaluation matrix
    - genetic algorithm、neural network
    - analytic hierarchy proces、material modularizations

RESEARCH STATUS

The purpose of the research on the **urgency of emergency material demand** is mainly to solve the problems of emergency material **path planning or allocation center location** in the next step.

However,most of the existing research on the calculation and classification of emergency material demand urgency is concentrated **before the research on the allocation path and location of emergency materials**, and there are few research results on **systematic, specialized and refined demand urgency**.

2 | METHODS

METHODS

- considers the information of the **main decision-making factors** of the disaster-stricken points
- determine the **combined weight coefficient** of each index
- establish the emergency material **demand urgency classification model** of the disaster-stricken points.

2.1 Analysis on Influencing Factors of demand urgency at affected points

Tab 1. Impact Indicators of Demand Urgency At Affected Points

Primary index	Secondary index	Indicator type
Environmental factor	Affected area C_1	Exact
	Epicenter intensity C_2	Exact
	Damage level of building C_3	Fuzzy
	Road damage degree C_4	Fuzzy
Demographic factors	Number of victims C_5	Exact
	Number of injured C_6	Exact
	Affected population ratio C_7	Exact
Material factors	Material demand C_8	Exact
	Demand gap rate C_9	Exact

METHODS

Tab 2. Damage Classification of Buildings and Roads

Damage levelof building/Road damage degree	Affected percentage（%）	Grade	Score
Intact	0-20	one	2
Minor damage	20-40	two	4
Moderate damage	40-60	three	6
Serious damage	60-80	four	8
Complete damage	80-100	five	10

2.2 Determination of index weight and evaluation method

Determination of comprehensive weight

- subjective weight by REM
  - Give the group decision matrix
  - Transform into normalized decision matrix $k_{ij} = h_{ij} / \sum_{j=1}^{n} h_{ij}$
  - get the group preference vector $\alpha_j = \prod_{i=1}^{m} (k_{ij})^{\lambda_j} \Big/ \sum_{j=1}^{n} \prod_{i=1}^{m} (k_{ij})^{\lambda_j}$
- objective weight by the entropy method
  - determine the decision matrix and standardize the matrix
  - the entropy of the index, representing the disorder degree of the material system
  - calculate the redundancy of information entropy

$$\alpha_j = \prod_{i=1}^{m} (k_{ij})^{\lambda_j} \Big/ \sum_{j=1}^{n} \prod_{i=1}^{m} (k_{ij})^{\lambda_j}$$

2.3 Demand urgency classification based on Grey Relational Analysis -TOPSIS evaluation method

1. determine the weighted gauge matrix

$$Z = RW_J = \begin{vmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{vmatrix} \begin{vmatrix} W_{J1} & 0 & \cdots & 0 \\ 0 & W_{J2} & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \cdots & W_{Jn} \end{vmatrix} = \begin{vmatrix} z_{11} & z_{12} & \cdots & z_{1m} \\ z_{21} & z_{22} & \cdots & z_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ z_{n1} & z_{n2} & \cdots & z_{nm} \end{vmatrix}$$

2. determine the positive and negative ideal solutions

$$Z^{+} = \left\{\max_j z_{11}, \ldots \max_j z_{im}\right\} = \left\{Z_1^{+}, \ldots Z_m^{+}\right\} (i = 1, 2 \ldots n)$$

$$Z^{-} = \left\{\min_j z_{i1}, \ldots \min_j z_{im}\right\} = \left\{Z_1^{-}, \ldots Z_m^{-}\right\} (i = 1, 2 \ldots n)$$

3. calculate the grey relational degree from the disaster point to the positive and negative ideal solution respectively

$$\theta_{ij}^{+} = \frac{\min_i \min_j \left|Z_j^{+} - z_{ij}\right| + \rho \max_i \max_j \left|Z_j^{+} - z_{ij}\right|}{\left|Z_j^{+} - z_{ij}\right| + \rho \max_i \max_j \left|Z_j^{+} - z_{ij}\right|}$$

$$\theta_{ij}^{-} = \frac{\min_i \min_j \left|Z_j^{-} - z_{ij}\right| + \rho \max_i \max_j \left|Z_j^{-} - z_{ij}\right|}{\left|Z_j^{-} - z_{ij}\right| + \rho \max_j \max_j \left|Z_j^{-} - z_{ij}\right|}$$

$$s_i^{+} = \frac{1}{n} \sum_{j=1}^{n} \theta_{ij}^{+} \qquad s_i^{-} = \frac{1}{n} \sum_{j=1}^{n} \theta_{ij}^{-}$$

4. the relative closeness of grey relational

$$ss_i = \frac{s_i^{-}}{s_i^{+} + s_i^{-}}, 1 \le i \le n$$

3 | RESULTS

RESULTS

Taking the material transportation of **Wenchuan earthquake** as an example, this paper analyzes the demand urgency of 10 disaster-stricken areas in the extremely severe disaster areas.

Disaster site	C1	C2	C3	C4	C5	C6	C7	C8	C9
Wenchuan	4083	8.89	10	10	58454	34583	55.15	923.37	64.72
Beichuan	2869	9.16	8	8	26361	9693	17.12	258.8	54.2
Mianzhu	1245	9.14	8	6	47864	36468	9.32	973.7	66.45
Shifang	863	8.68	6	6	38133	31990	8.81	854.13	52.19
Qingchuan	3269	8.74	6	6	20272	15453	8.24	412.6	28.23
Maoxian	4075	7.91	6	4	12452	8183	11.64	218.49	34.56
Anxian	1404	8.89	4	4	15047	13476	3.43	359.81	36.12
dujiangyan	1280	9.13	4	4	7457	4388	1.22	117.16	27.61
Pingwu	2720	8.15	4	4	33691	32145	18.08	858.27	45.88
Pengzhou	1420	8.53	4	4	6722	5770	0.86	154.06	31.94

RESULTS

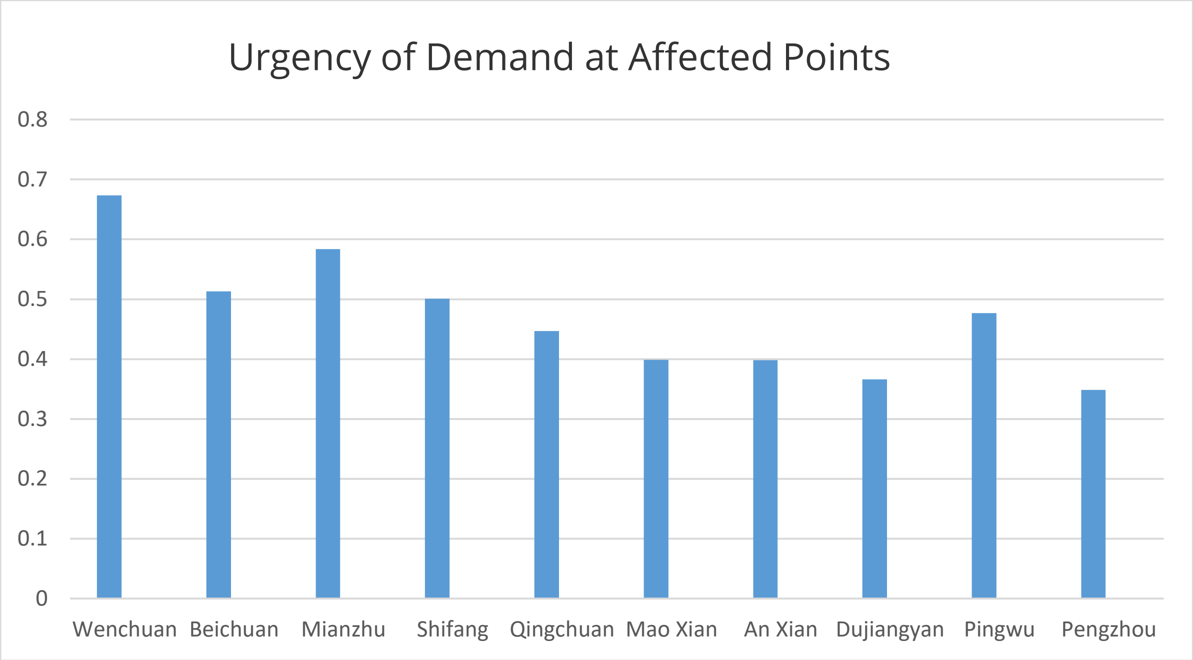
Determination of index weight by combination weighting:

$$W_J = (0.1229, 0.1711, 0.089, 0.0751, 0.0924, 0.1407, 0.0605, 0.1344, 0.1138)$$

Determine the weighted normalized matrix and the positive and negative ideal solutions:

$$ss_i = (0.6736, 0.5129, 0.5836, 0.5009, 0.447, 0.399, 0.3981, 0.3663, 0.4767, 0.3483)$$

RESULTS



The greater the demand urgency, the higher the response level of rescue material distribution.

And the analysis results are basically consistent with the national results on Issuing the disaster scope assessment of Wenchuan earthquake.

Fig. 1 Comparison of Demand Urgency at Disaster Affected Points

4 | CONCLUSION

CONCLUSION

1. Analyze the earthquake disaster with the most serious harm among the major sudden natural disasters, and construct the affected points from three aspects: **environmental factors, demographic factors and material demand.** construct the **urgency evaluation index system**;

2. **REM and entropy method** are used to determine the index weight;

3. The **grey relational-TOPSIS evaluation method** is proposed to analyze the ten extremely severe disaster areas of Wenchuan earthquake, and the demand urgency coefficient of each disaster point is obtained to ensure that the disaster points with high demand urgency can be met first.

CONCLUSION

Although the model has certain universality, it fails to take into account all the actual situations in emergency rescue. Therefore, in future research, the method should be improved to make it more in line with the actual situation.

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Thank you for watching!

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