

# Public Safety Risk Assessment of Power Investment Project Based on Fuzzy Set and DS Evidence Theory

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**Abstract:** In recent years, the international situation has become more and more complex, and the regional conflicts have been escalating, and the risks of overseas public security have been increasing. Based on the four types of public security events, a public safety risk assessment index system of "one belt and one road" electric power investment project is established. Combining the Bayesian network model, and using fuzzy set and DS evidence theory, the public security risk level of the "Belt and Road" countries can be this method has been effectively verified and put forward countermeasures by an example.

## 1. Introduction

In recent years, the tense situation in many countries and regions around the world has been escalating, and the demand of Chinese enterprises for "going global" to prevent overseas public security risks is increasing. Therefore, when investing in the construction of electric power projects along the "one belt and one road", Chinese enterprises should make an advance prediction and assessment of the public security risks of the country or region, so as to forewarn and avoid risks and reduce casualties and economic losses.

This paper will establish a safety risk assessment index system, and use fuzzy set and DS evidence theory to combine with Bayesian network model to deduce its public security risk rating. Finally, take a country's power investment as an example, verify effectively this method, and put forward corresponding countermeasures.

## 2. Public Safety Risk Identification

In the process of project investment and construction, there are many possible forms of social and public security events<sup>[1]</sup>, such as: ethnic and religious conflict events, kidnapping (hijacking) events, terrorist attacks and demonstrations.

### 2.1 Ethnic and religious conflicts

Most of the countries along the "Silk Road Economic Belt" believe in Islam, and their ethnic and religious contradictions are complex, which Chinese enterprises abroad are often threatened by violence and terrorism<sup>[2]</sup>.

### 2.2 Kidnappings (hijacking) incidents

Because of the serious poverty and unemployment problems in some countries along the belt and road, the crime rate remains high. Kidnapping and hijacking are frequent. Electric power investment enterprises often face the risk of kidnapping and hijacking.

### 2.3 terrorist attacks

The main causes of terrorism in the countries and regions along the "belt and road" are mainly the gap between the rich and the poor, and internal conflicts and wars in some countries, and the disorderly development and diffusion of high technology, and world hegemonism and power politics.

### 2.4 Demonstrations

There are internal conflicts and unstable political situations in some countries along the "one belt and one road", which have long been dominated by sanctions and hegemonism in western countries, which will bring security risks.

## 3. Construction of evaluation model

### 3.1 Establish a risk assessment indicator system

Based on the previous analysis and the current research results, the social public security risk assessment index system for the "One Belt, One Road" power investment project is shown in Figure 1.

The risk assessment set of this paper is divided into five levels, namely low (*VL*), low (*L*), medium (*M*), high (*H*) and very high (*VH*). The range is [0, 1], and the quantized values are 0.1, 0.3, 0.5, 0.7, 0.9, respectively.

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### 3.2 Construct membership matrix

Let the centers of the membership functions corresponding to the five different risk levels be 0, 0.25, 0.5, 0.75, 1, then the membership functions are respectively [8]

$$\begin{aligned}
 y_{VL}(x, \sigma) &= e^{-\frac{x^2}{2\sigma^2}} \\
 y_L(x, \sigma) &= e^{-\frac{(x-0.25)^2}{2\sigma^2}} \\
 y_M(x, \sigma) &= e^{-\frac{(x-0.5)^2}{2\sigma^2}} \\
 y_H(x, \sigma) &= e^{-\frac{(x-0.75)^2}{2\sigma^2}} \\
 y_{VH}(x, \sigma) &= e^{-\frac{(x-1)^2}{2\sigma^2}}
 \end{aligned}$$

Based on the results of expert evaluation, the evaluation data is substituted into the membership matrix corresponding to the four indicator events (*HA*, *HB*, *HC*, *HD*).

$$H_A = \begin{bmatrix} y_{VL}(a_1, \sigma_{a_1}) & y_L(a_1, \sigma_{a_1}) & y_M(a_1, \sigma_{a_1}) & y_H(a_1, \sigma_{a_1}) & y_{VH}(a_1, \sigma_{a_1}) \\ y_{VL}(a_2, \sigma_{a_2}) & y_L(a_2, \sigma_{a_2}) & y_M(a_2, \sigma_{a_2}) & y_H(a_2, \sigma_{a_2}) & y_{VH}(a_2, \sigma_{a_2}) \\ y_{VL}(a_3, \sigma_{a_3}) & y_L(a_3, \sigma_{a_3}) & y_M(a_3, \sigma_{a_3}) & y_H(a_3, \sigma_{a_3}) & y_{VH}(a_3, \sigma_{a_3}) \\ y_{VL}(a_4, \sigma_{a_4}) & y_L(a_4, \sigma_{a_4}) & y_M(a_4, \sigma_{a_4}) & y_H(a_4, \sigma_{a_4}) & y_{VH}(a_4, \sigma_{a_4}) \end{bmatrix} \quad (1)$$

$$H_B = \begin{bmatrix} y_{VL}(b_1, \sigma_{b_1}) & y_L(b_1, \sigma_{b_1}) & y_M(b_1, \sigma_{b_1}) & y_H(b_1, \sigma_{b_1}) & y_{VH}(b_1, \sigma_{b_1}) \\ y_{VL}(b_2, \sigma_{b_2}) & y_L(b_2, \sigma_{b_2}) & y_M(b_2, \sigma_{b_2}) & y_H(b_2, \sigma_{b_2}) & y_{VH}(b_2, \sigma_{b_2}) \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ y_{VL}(b_6, \sigma_{b_6}) & y_L(b_6, \sigma_{b_6}) & y_M(b_6, \sigma_{b_6}) & y_H(b_6, \sigma_{b_6}) & y_{VH}(b_6, \sigma_{b_6}) \end{bmatrix}$$

$$(2)$$

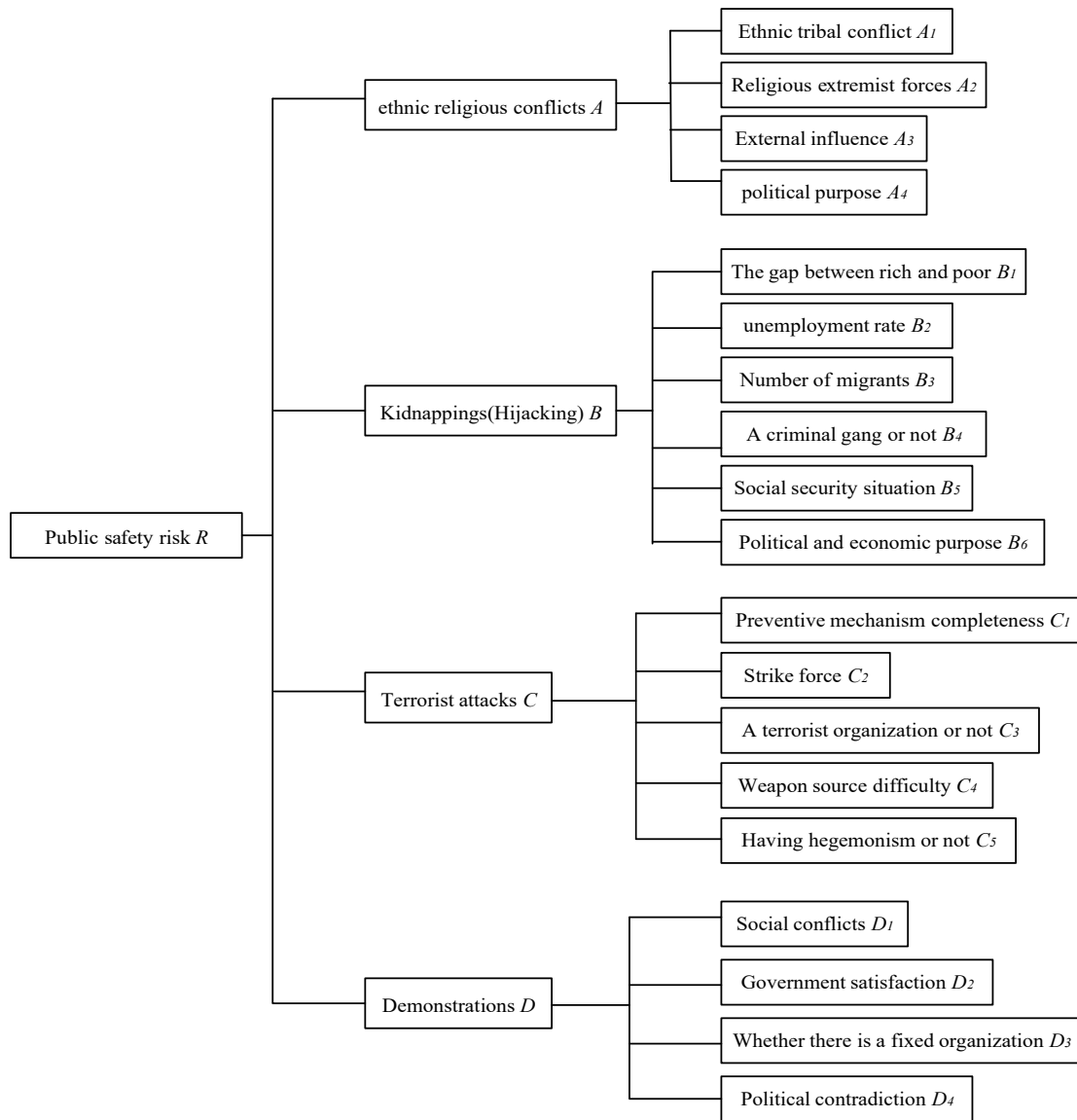
$$H_C = \begin{bmatrix} y_{VL}(c_1, \sigma_{c_1}) & y_L(c_1, \sigma_{c_1}) & y_M(c_1, \sigma_{c_1}) & y_H(c_1, \sigma_{c_1}) & y_{VH}(c_1, \sigma_{c_1}) \\ y_{VL}(c_2, \sigma_{c_2}) & y_L(c_2, \sigma_{c_2}) & y_M(c_2, \sigma_{c_2}) & y_H(c_2, \sigma_{c_2}) & y_{VH}(c_2, \sigma_{c_2}) \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ y_{VL}(c_5, \sigma_{c_5}) & y_L(c_5, \sigma_{c_5}) & y_M(c_5, \sigma_{c_5}) & y_H(c_5, \sigma_{c_5}) & y_{VH}(c_5, \sigma_{c_5}) \end{bmatrix} \quad (3)$$

$$H_D = \begin{bmatrix} y_{VL}(d_1, \sigma_{d_1}) & y_L(d_1, \sigma_{d_1}) & y_M(d_1, \sigma_{d_1}) & y_H(d_1, \sigma_{d_1}) & y_{VH}(d_1, \sigma_{d_1}) \\ y_{VL}(d_2, \sigma_{d_2}) & y_L(d_2, \sigma_{d_2}) & y_M(d_2, \sigma_{d_2}) & y_H(d_2, \sigma_{d_2}) & y_{VH}(d_2, \sigma_{d_2}) \\ y_{VL}(d_3, \sigma_{d_3}) & y_L(d_3, \sigma_{d_3}) & y_M(d_3, \sigma_{d_3}) & y_H(d_3, \sigma_{d_3}) & y_{VH}(d_3, \sigma_{d_3}) \\ y_{VL}(d_4, \sigma_{d_4}) & y_L(d_4, \sigma_{d_4}) & y_M(d_4, \sigma_{d_4}) & y_H(d_4, \sigma_{d_4}) & y_{VH}(d_4, \sigma_{d_4}) \end{bmatrix} \quad (4)$$

Find out the extent to which the expert's evaluation value of each influencing factor belongs to different risk levels.

### 3.3 Data Fusion Using DS Evidence Theory

In this paper, the DS synthesis algorithm based on matrix analysis and weight analysis is used [3]. Assuming that there are *n* experts who evaluate the risk factors and evaluate the five levels as described above, the basic probability distribution obtained by the Gaussian membership function is assigned as:



**Fig.1.** Social Public Security Risk Assessment Index System of Power Project

$$M = \begin{bmatrix} M_1 \\ M_2 \\ \vdots \\ M_n \end{bmatrix} = \begin{bmatrix} m_{11} & m_{12} & m_{13} & m_{14} & m_{15} \\ m_{21} & m_{22} & m_{23} & m_{24} & m_{25} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ m_{n1} & m_{n1} & m_{n3} & m_{n4} & m_{n5} \end{bmatrix}$$

Among them,  $m_{ij}$  in the matrix  $M$  represents the basic probability distribution of the  $i$ -th expert for the  $j$ -th risk level, and the matrix sum is  $I$ .

The matrix  $R$  is obtained by multiplying the transposition of  $M_1$  by  $M_2$ .

$$R = M_1^T \times M_2 = \begin{bmatrix} m_{11} \times m_{21} & \cdots & m_{11} \times m_{25} \\ \vdots & & \vdots \\ m_{15} \times m_{21} & \cdots & m_{15} \times m_{25} \end{bmatrix}$$

The sum of the main diagonals of the matrix  $R$  is the numerator of the  $DS$  synthesis rule, and the sum of the non-diagonal lines is the degree of collision  $K$  of the  $DS$  synthesis rule.

Multiply the column matrix  $A$  composed of the main diagonal elements of the matrix  $R$  by  $M_3$  to obtain a new matrix.

$$R = A \times M_3 = \begin{bmatrix} m_{11} \times m_{21} \times m_{31} & \cdots & m_{11} \times m_{21} \times m_{35} \\ \vdots & & \vdots \\ m_{15} \times m_{25} \times m_{31} & \cdots & m_{15} \times m_{25} \times m_{35} \end{bmatrix}$$

By analogy, the evaluation results of  $n$  experts are merged. The sum of the off-diagonal elements of all matrices  $R$  in this process is the data conflict  $K$  between  $n$  pieces of evidence.

### 3.4 Bayesian network reasoning

According to the Bayesian network model constructed by *MATLAB*, the probability of security events and the whole public security risk is obtained<sup>[4]</sup>. Construct the Bayesian network with *mk bnet* function, set the conditional probability of the network by *tabular\_CPD()*. Using *jtree\_inf\_engine()* as the

inference algorithm, after adding the evidence data, the confidence of the node is obtained by *marginal\_nodes()*, thereby inferring the public security risk level probability.

#### 4. Case Analysis

Taking a country or region along the “Belt and Road” as an example, according to the public safety risk assessment system of Figure 1, several experts are invited to give the risk level of each influencing factor and the uncertainty of this level. Based on Bayesian network reasoning by the reference data, the probability  $P(R)$  of the security incident and the entire security risk are respectively at five risk levels, and use the weighted average to get the security incidents and the public security risks in the “Belt and Road” countries.

It shows that the probability of ethnic and religious conflicts  $A$  and terrorist attacks  $C$  is high in the country, and the probability of ethnic-religious conflicts  $A$  is the highest; the country's public security risk has the highest probability of having a medium  $R$  risk, the risk value is  $0.5609$ . Therefore, Chinese enterprises should strengthen their own cultural and safety management, respect national cultural differences, establish mutual trust and friendly cooperative relations, and strengthen protection measures to improve employee safety awareness.

#### 5. Conclusion

Based on the above research results, this paper analyzes the social public safety risk factors of the "one belt and one road" power investment project, and constructs the evaluation index system of the safety risk, and proposes a social public safety risk assessment model based on fuzzy sets and DS theory. This study provides an effective assessment method for Chinese enterprises to understand the public safety risks of the power investment and construction along the "one belt and one road" country, so as to provide an important basis for enterprises to do well in risk prevention and response strategies.

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