Study on Emergency Capability of City Public Safety Based on Entropy Method

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Abstract. As the issues of city public safety are highlighted increasingly they cause serious threat to the sustained and healthy development of urban economy. So the urban public safety management is facing unprecedented challenges. This paper analyzes the factors that affect the urban public safety. Those factors include the natural environment and social environment. This paper design 6 first grade indexes and 27 secondary indexes. Through using the entropy method, the paper proposed some indexes that has a significantly impact on the urban public safety. Based on the resources-based industrial city-Pingdingshan, this paper verified the statistical data of 2010 to 2014.The 5 outstanding indexes were selected, while the city's overall safety keeps a strong momentum. The results provide reference significance to urban public safety analysis and decision management.

Introduction

In recent years, our country under the various natural disasters condition, SARS and other infectious diseases once rampant, the situation of safety production and the environment of public security remain grim. After the SARS incident, the State Council, January 8, 2006 release, "Overall Emergency Preplan for National Sudden Public Incidents" (hereinafter referred to as the overall preplan) proposed that the government should improve the ability to safeguard public safety and disposal sudden public incidents. Furthest prevent and reduce the damage that caused by sudden public incidents. This aim is to protect the safe of public life and property, and maintenance national security and social stability [1-5]. The overall preplan makes clear the four types of sudden public emergencies that the government needed to reply, namely natural disasters, accident disasters, public health events and social safety incidents. With the rapid development of China's economy, the increasing size of cities around the concept of super city is already ready to come. Subsequently, the difficulty that the government plays a leading role risk prevention of urban public safety is also increasing. Therefore, the current status of urban public safety, how to improve the emergency response capability, and reduce the risk loss, has become an urgent problem that governments at all levels faced, must be solved urgently.

The Present Situation on Emergency Capability Assessment

In order to improve the emergency capability and the response level of urban public safety. Firstly, we need to make a risk assessment of urban public safety emergency status to find out the current shortcomings and deficiencies of urban public safety emergency response system. The key point of this work is to establish a complete and appropriate evaluation system. Currently, the emergency capability

of urban public safety had been studied by a number of institutions, experts and scholars. At the same time, they proposed relevant business and index system of capability evaluation. The typical representative is evaluation scale of US COOP agency [6]. COOP evaluation scale is short for the Federal Emergency Management Coordination Committee of National Security business continuity assessment scale. The COOP evaluation scale system including COOP plans, the supporting assessment project of COOP plans, training programs and exercise programs. Those evaluation scales and programs are the basic tool for US authorities to maintain its emergency response capacity. Zhu Zhengwei who is a domestic scholar put forward the ability index to deal with public safety risk in perspective of "vulnerability-ability". The index system includes the secondary indicators of infrastructure, regulation capacity, social defense and economic capacity. It also includes more than ten kinds of collective evaluation indexes [7]. Zheng Shuangzhong put forward the assessment method of urban public emergency capability and proposed 18 first grade indexes which include foundation of legal system [8]. Hu Shuhua put forward city safety evaluation system from the point view of food safety, environmental safety, production safety, economic security and social safety. He also establishes the evaluation model through using fuzzy analytic hierarchy process [9]. Those proposed indexes play a promoting role for the development of emergency response capability. However, the index system has some drawbacks. On the one hand, it is hard to quantify the indexes. The acquisition of basic data is mostly scored by experts, so there is a poor objectivity. On the other hand, index system failed to reflect the current characteristics of the city block management system that is carried out by governments. In view of status of city block management; this paper proposes an evaluation system for emergency response capability. The system includes 6 first grade indexes and 27 second indexes. This paper made a classification of those indexes through using entropy method. Finally, we determine the right objective weight of the evaluation indexes.

Entropy Method

Entropy method is proposed by Shannon. Entropy reflects the size of information. Generally, if the indicator has small entropy, it indicates the variation degree of its index value. Then, it will play an important role. So it will provide the amount of information, its weight should be more great. Conversely, a great index of entropy indicates the variation degree of its index value is small. Then, it will provide a little of information. So, it will play a minor role. Its weight should be small [10]. The method is mainly based on the information scale that passed to decision makers to determine their weight.

The analysis process of this method is as follow.

If there is m evaluation indexes and n evaluation objects. That is to say, the evaluation index set is:

$$C = (c_1, c_2, \cdots, c_m) . \tag{1}$$

The evaluation object set is:

$$F = (f_1, f_2, \cdots, f_n) . \tag{2}$$

So original data matrix is:

$$X = (x_{ij})_{m \times n} . \tag{3}$$

The Entropy method for determination of weight mainly has the following three steps.

Do a Standardization of Original Data Matrix. The original data matrix is as follows.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}. \quad (4)$$

We can obtain the matrix after doing standardization.

$$Y = (y_{ij})_{m \times n}. \quad (5)$$

In the formula, represents, y_{ij} the standard value that j object acts on i index. $y_{ij} \in [0, 1]$. For the indexes that is bigger always better.

$$y_{ij} = \frac{x_{ij} - \min\limits_{j}(x_{ij})}{\max\limits_{j}(x_{ij}) - \min\limits_{j}(x_{ij})}. \quad (6)$$

For the indexes that is smaller always better.

$$y_{ij} = \frac{\max\limits_{j}(x_{ij}) - x_{ij}}{\max\limits_{j}(x_{ij}) - \min\limits_{j}(x_{ij})}. \quad (7)$$

Calculate Entropy. Entropy of the i index is defined as follows.

$$H_i = -k \sum_{j=1}^{n} f_{ij} \ln f_{ij}, \ i = 1, 2, 3, \cdots, m. \quad (8)$$

$$f_{ij} = y_{ij} \Big/ \sum_{j=1}^{n} y_{ij}, \ k = 1/\ln n. \quad (9)$$

When $f_{ij} = 0$, let be $f_{ij} \ln f_{ij} = 0$.

The entropy weight corresponding to i entropy is defined as follows.

$$\omega_i = \frac{1 - H_i}{m - \sum\limits_{i=1}^{m} H_i}. \quad (10)$$

In the formula, $0 \le \omega_i \le 1$, $\sum\limits_{i=1}^{m} \omega_i = 1$.

Example Analysis

In this paper, we take the Pingdingshan as an example. Pingdingshan is a medium resource city. In order to assess its response ability of urban public safety risk. The factors that affect the response ability are as follows. The statistical data of 2011-2014 are also considered.

We use equations (4) - (10) to calculate the entropy. Then, we obtain the weight ω of each secondary index. As shown in Table 1 .

Table 1 The value of weight ω

Serial number of	1	2	3	4	5	6	7
	0.0048	0.0588	0.0155	0.0044	0.0182	0.0177	0.0306
the second grade index and its values	8	9	10	11	12	13	14
	0.0026	0.0039	0.0600	0.0014	0.0046	0.0064	0.0538
	15	16	17	18	19	20	21
	0.0075	0	0.4553	0.0015	0.0094	0.0003	0.0002
	22	23	24	25	26	27	
	0.0001	0.0019	0.1970	0.0024	0.0061	0.0096	

Through making the multiplication between weight ω and normalized matrix, we can obtain the standardized index value of risk response capacity. The result is (0.1586, 0.2001, 0.3066, and 0.3347). Draw the response ability map based on the result. As shown in Fig. 1 .

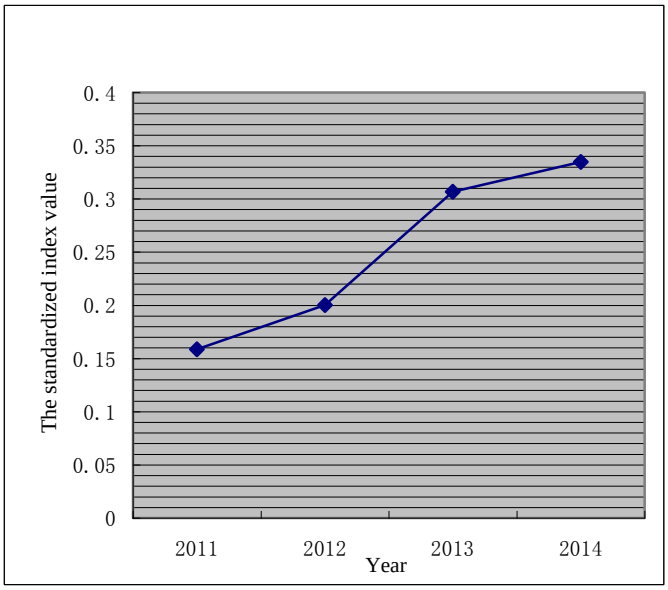

Fig. 1 The standardized index values of Pingdingshan risk response capability

Summary

Fig. 1 shows that the response ability has an increasing trend. It indicated that the city is continuously raising its response ability and management level. This conclusion accords with the law of social and economic development.

As shown in Fig. 1 , we can obtain that the city's respond ability has an average increase more than 25%. Especially 2012 to 2013 the growth rate is about 53.22%.

Make a comparison between Table 1 and Table 1 . We can see a phenomenon that the standardized index of the city's response ability has a significant increase in 2012 to 2013. The total industrial investment of pollution management and gas supply make an outstanding contribution to the increase. It indicates that investment has a sharp decrease. Since the first two years of efforts to increase the industrial pollution control, pollution control achieved remarkable results after 2013. The total gas supply has a significant reduction. The reason is that the awareness of residents constantly intensifies. The government spread its policy that the use of new energy or other energy is encouraged. The policy make an active effect on improving the environment that the residents living in.

In addition, financial revenue and tax revenue have a good contribution to the increase of response ability. Along with economic development, the government's economy affordability against public safety risks has a significant increase.

Finally, a significant increase happened on the net income of rural residents, the number who participated in the basic medical insurance and the total funding of social welfare institutions. This phenomenon will make an active effect on individual (especially in rural residents) and collective

response ability. At the same time, the increase can significantly enhance the city's overall response ability.

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