

The Evaluation of Emergency Logistics Capability in Beijing-Tianjin-Hebei Region Based on Fuzzy Matter-Element Analysis

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Abstract

The correct analysis and evaluation on present situation is the key to improving emergency logistics capability in Beijing-Tianjin-Hebei region. This paper took emergency logistics capability in Beijing-Tianjin-Hebei region as the research object. It established analysis model of emergency logistics capability in Beijing-Tianjin-Hebei region based on fuzzy matter-element method. This paper did further study by applying this model. Accordingly, it obtained variation chart of the first-level indicator capability and variation trend chart of comprehensive capability. Finally, this paper summarized and verified research result. The conclusion of this paper has certain instructive effect on improving the emergency logistics capability in Beijing-Tianjin-Hebei region and that could be of referential value for the evaluation and analysis of similar problems.

Keywords

Beijing-Tianjin-Hebei Region, Emergency Logistics, Capability Evaluation, Fuzzy Matter-Element Method

1. Introduction

In the process of Beijing-Tianjin-Hebei integration, to improve the capability of emergency prevention and disposal is essential. To evaluate and summarize on present situation correctly as well as reasonably is the beginning of all key points. The fuzzy matter-element method is a method to solve the fuzzy incompatible problems by promoting the association transformation among things, which was applied to the evaluation of problems with multiple factors. In this paper, the problem of regional emergency logistics capability is complex problem with

many influencing factors. Therefore, fuzzy matter-element method research on emergency logistics capability in Beijing-Tianjin-Hebei region was adopted in this paper.

2. Research Summary on Regional Logistics Capability

In the research of regional logistics capability at present, it is mainly based on quantitative analysis abroad, and mainly based on qualitative analysis in domestic. Enterprise logistics capability was measured by Ellinger from five aspects, the time of delivery, stability of service quality, service level, advance notice of out of stock and customer response. Logistics capability in parts of Italy was analyzed and researched by DeMarco through system dynamics model. Regional logistics resources were operated and managed during a short time through the establishment of regional logistics system model to enhance the capability of regional logistics.

In addition, in terms of regional logistics capability evaluation, domestic research mainly includes: 1) The evaluation of regional logistics capability based on principal component. Index system of Sichuan logistics capability evaluation was established by Zhang Jie [1], based on five indicators: the development of logistics economy, production and consumption circulation, human resource, logistics transportation, information level by using principal component analysis. 2) The evaluation of regional logistics capability based on entropy weight method. Firstly, by analyzing the factors of affecting regional logistics capability, then evaluation indicator was selected, next capability evaluation model was established according to entropy weight method to determine the index weight by Qin Jianguo, Xu Dongfang [2]. 3) To evaluation regional logistics capability based on factor analysis. Eighteen cities in Henan province was selected as a sample by Yang Xuemei [3], and then 10 indexes that reflect regional logistics capability were selected, data was obtained by searching statistical yearbook, logistics capability was comprehensively evaluated by applying factor analysis method. 4) The evaluation of regional logistics capability based on fuzzy matter-element method. Firstly, logistics capability elements of Chongqing was studied and summarized, then four regional logistics capability first-class indexes, 11 secondary indexes were selected according to Chongqing logistics industry development situation, fuzzy matter-element analysis model was established, then logistics capability of Chongqing in the future was analyzed and forecasted by making longitudinal contrast [4]. During current study, there is no research on the evaluation of regional emergency logistics capability directly in domestic. But existing research results are significant for regional emergency logistics capability evaluation study. On this basis, Beijing-Tianjin-Hebei region emergency logistics capability was evaluated and studied in this paper.

3. General Steps of Fuzzy Matter-Element Evaluation

- 1) Fuzzy composite element of establishing evaluation object

Matter-element is the basic unit of matter-element theory, which is consist of evaluation object M , characteristic index C and characteristic value X . In the evaluation of emergency logistics capability in Beijing-Tianjin-Hebei region, m Evaluation of things and n main factors C_1, C_2, \dots, C_n were assumed, each major factor has p minor factors $C_{11}, C_{12}, \dots, C_{1p}; C_{21}, C_{22}, \dots, C_{2p}; C_{n1}, C_{n2}, \dots, C_{np}$ the corresponding value is

$$X_{jik} (j = 1, 2, \dots, m; i = 1, 2, \dots, n; k = 1, 2, \dots, p)$$

n dimensional fuzzy composite element of m things R_{mn} is obtained. That is:

$$R_{mn} = \begin{bmatrix} & M_1 & M_2 & \dots & M_m \\ C_{11} & X_{111} & X_{211} & \dots & X_{m11} \\ C_{12} & X_{112} & X_{212} & \dots & X_{m12} \\ \dots & \dots & \dots & \dots & \dots \\ C_{1p} & X_{11p} & X_{21p} & \dots & X_{m1p} \\ C_{21} & X_{121} & X_{221} & \dots & X_{m21} \\ C_{22} & X_{122} & X_{222} & \dots & X_{m22} \\ \dots & \dots & \dots & \dots & \dots \\ C_{2p} & X_{12p} & X_{22p} & \dots & X_{m2p} \\ \dots & \dots & \dots & \dots & \dots \\ C_{n1} & X_{1n1} & X_{2n1} & \dots & X_{mn1} \\ C_{n2} & X_{1n2} & X_{2n2} & \dots & X_{mn2} \\ \dots & \dots & \dots & \dots & \dots \\ C_{np} & X_{1np} & X_{2np} & \dots & X_{mnp} \end{bmatrix} \quad (1)$$

2) To determine membership

Because characteristic value X_{ji} of fuzzy matter-element make different contributions to M_j , and the dimensions are different. So blurring these values X_{ji} , which is about to change these values into membership $\mu(X_{ji})$. Membership is used to measure the extent of the amount of value attached to a fuzzy set. Generally speaking, it contains two types of memberships, respectively are:

Positive index (the bigger the better):

$$\mu_{ji} = \frac{X_{ji} - \min X_{ji}}{\max X_{ji} - \min X_{ji}} \quad (2)$$

Negative index (the smaller the better):

$$\mu_{ji} = \frac{\max X_{ji} - X_{ji}}{\max X_{ji} - \min X_{ji}} \quad (3)$$

Among them, $\max X_{ji}$ and $\min X_{ji}$ respectively represent the maximum and minimum of all magnitudes X_{ji} ($j = 1, 2, \dots, m; i = 1, 2, \dots, n$) corresponding to the i th index of each evaluation object. Therefore, magnitudes X_{ji} of fuzzy composite element R_{mn} (1) is transformed into membership μ_{ji} , fuzzy composite element R'_{mn} composed of optimal membership degree is established according to Equation (2) and Equation (3), it is given by:

$$R'_{mm} = \begin{bmatrix} & M_1 & M_2 & \cdots & M_m \\ C_{11} & \mu_{111} & \mu_{211} & \cdots & \mu_{m11} \\ C_{12} & \mu_{112} & \mu_{212} & \cdots & \mu_{m12} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ C_{1p} & \mu_{11p} & \mu_{21p} & \cdots & \mu_{m1p} \\ C_{21} & \mu_{121} & \mu_{221} & \cdots & \mu_{m21} \\ C_{22} & \mu_{122} & \mu_{222} & \cdots & \mu_{m22} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ C_{2p} & \mu_{12p} & \mu_{22p} & \cdots & \mu_{m2p} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ C_{n1} & \mu_{1n1} & \mu_{2n1} & \cdots & \mu_{mn1} \\ C_{n2} & \mu_{1n2} & \mu_{2n2} & \cdots & \mu_{mn2} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ C_{np} & \mu_{1np} & \mu_{2np} & \cdots & \mu_{mnp} \end{bmatrix} \quad (4)$$

3) To construct evaluation index weight compound element

a) C_{np} and ω_{np}

$$C_{np} \frac{1}{m} (\mu_{1np} + \mu_{2np} + \cdots + \mu_{mnp}) = \frac{1}{m} \sum_{j=1}^m \mu_{jnp} \quad (5)$$

$$\omega_{np} = \frac{1}{m} \sum_{j=1}^m \mu_{jnp} / \frac{1}{m} \sum_{j=1}^m \sum_{i=1}^n \sum_{k=1}^p \mu_{mik} \quad (6)$$

b) Weight

To establish a minor factor of weighted composite element R_{oik} , that is:

$$R_{oik} = \begin{bmatrix} C_{11} & C_{12} & \cdots & C_{1p} & C_{21} & C_{22} & \cdots & C_{2p} & \cdots & C_{n1} & C_{n2} & \cdots & C_{np} \\ \omega_{11} & \omega_{12} & \cdots & \omega_{1p} & \omega_{21} & \omega_{22} & \cdots & \omega_{2p} & \cdots & \omega_{n1} & \omega_{n2} & \cdots & \omega_{np} \end{bmatrix} \quad (7)$$

Supposing R_{oi} represents main factor weighted composite element, we use method to subjectively determine the weight of indexes, the weighted composite element of main factor is established, that is:

$$R_{oi} = \begin{bmatrix} C_1 & C_2 & \cdots & C_n \\ \omega_1 & \omega_2 & \cdots & \omega_n \end{bmatrix} \quad (8)$$

4) To define central composite fuzzy matter-element

Supposing R_k represents central composite fuzzy matter-element,

$$R_k = R'_{mm} * R_{oik}$$

where “*” indicates that multiplication is first, then do addition, according to Equation (4) and Equation (7), R_k is obtained, that is:

$$R_k = \begin{bmatrix} & M_1 & M_2 & \cdots & M_m \\ C_1 & K_{11} = \sum_{k=1}^p \mu_{11k} \omega_{1k} & K_{21} = \sum_{k=1}^p \mu_{21k} \omega_{1k} & \cdots & K_{m1} = \sum_{k=1}^p \mu_{m1k} \omega_{1k} \\ C_2 & K_{12} = \sum_{k=1}^p \mu_{12k} \omega_{2k} & K_{22} = \sum_{k=1}^p \mu_{22k} \omega_{2k} & \cdots & K_{m2} = \sum_{k=1}^p \mu_{m2k} \omega_{2k} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ C_n & K_{1n} = \sum_{k=1}^p \mu_{1nk} \omega_{nk} & K_{2n} = \sum_{k=1}^p \mu_{2nk} \omega_{nk} & \cdots & K_{mn} = \sum_{k=1}^p \mu_{mnk} \omega_{nk} \end{bmatrix} \quad (9)$$

5) To establish comprehensive evaluation of compound fuzzy matter-element

Supposing comprehensive evaluation of compound fuzzy matter-element is R_D , before which single evaluation compound fuzzy matter-element R_d is obtained by the equation $R_d = R_k * R_{oi}$, Equation (8) and Equation (9), R_d is given by:

$$R_d = \begin{bmatrix} & M_1 & M_2 & \cdots & M_m \\ C_1 & d_{11} = K_{11}\omega_1 & d_{21} = K_{21}\omega_1 & \cdots & d_{m1} = K_{m1}\omega_1 \\ C_2 & d_{12} = K_{12}\omega_2 & d_{22} = K_{22}\omega_2 & \cdots & d_{m2} = K_{m2}\omega_2 \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ C_n & d_{1n} = K_{1n}\omega_n & d_{2n} = K_{2n}\omega_n & \cdots & d_{mn} = K_{mn}\omega_n \end{bmatrix} \quad (10)$$

Finally, on the basis of the above equation, comprehensive evaluation of compound fuzzy matter-element R_D is:

$$R_D = \begin{bmatrix} M_1 & M_2 & \cdots & M_m \\ D_1 & D_2 & \cdots & D_m \end{bmatrix} \quad (11)$$

Among which, the equation $D_j = \sum d_{ji} (j=1,2,\dots,m; i=1,2,\dots,n)$ is the final comprehensive evaluation value of the j th thing to be obtained.

4. To Establish Beijing-Tianjin-Hebei Region Emergency Logistics Capability Evaluation Index

According to the status of Beijing-Tianjin-Hebei region emergency logistics, we can establish two-level rating system. Specific indicators are emergency logistics human resources support capability (including the proportion of people who receive higher education C_{11} (%); the scale of employment in information and information technology industry C_{12} (ten thousand persons); employment in transportation industry C_{13} (ten thousand persons); the scale of rescue team C_{14} (person); emergency logistics economic support capability (including the GDP of Beijing-Tianjin-Hebei C_{21} (one hundred million yuan)); fixed assets investment in transportation industry C_{22} (one hundred million yuan); fixed assets investment in information and information technology industry C_{23} (one hundred million yuan); disaster relief material reserve expenditure C_{24} (ten thousand yuan); emergency logistics information system security capability (including the internet penetration rate C_{31} (%)); the perfection degree of emergency database C_{32} (%); the perfection degree of regional emergency C_{33} (%); infrastructure equipment support capability (including highway mileage C_{41} (ten thousand kilometers)); railway mileage C_{42} (ten thousand kilometers); cargo handling capacity of ports C_{43} (ten million tons); vehicles of freight transportation C_{44} (ten thousand tractor); the satisfaction of emergency material coverage C_{45} (%); the reliability of emergency access C_{46} ; the number of beds in medical and health institutions C_{47} (ten thousand sheet) and emergency logistics management capability (including the capability of pre-arranged planning of emergency C_{51} ; the capability of government coordination C_{52} ; the capability of law guarantee C_{53} ; the capability of expert decision decision-making C_{54} ; the cooperation degree of regional logistics C_{55}).

5. Beijing-Tianjin-Hebei Region Emergency Logistics Capability Fuzzy Matter-Element Comprehensive Evaluation

5.1. To Construct the Matter-Element Analysis Model of Beijing-Tianjin-Hebei Region Emergency Logistics Capability

1) To establish fuzzy composite element of Beijing-Tianjin-Hebei region emergency logistics capability

In this paper, these six years from 2009-2014 is regarded as six things to be evaluated, these 23 indexes that are selected from preceding text, the related index data is regarded as characteristic value. The quantitative index was obtained by querying China statistical yearbook, the National Bureau of statistics and relevant government websites, Beijing, Tianjin, Hebei three relevant index, qualitative index was set by using expert scoring, divided into nine grades {very good, fine, better, good, general, poor, poorer, very poor, extreme poor, (9, 8, 7, 6, 5, 4, 3, 2, 1)} corresponding to [1] [9], finally all the evaluation index data of Beijing-Tianjin-Hebei region is shown in **Table 1**.

Table 1. Quantitative value of each index data.

	2009	2010	2011	2012	2013	2014
C ₁₁	11.4	12.3	13.0	14.3	16.5	17.8
C ₁₂	44.74	50.2	57.03	62.4	70.44	73.52
C ₁₃	87.84	86.67	93.22	96.21	101.17	109.49
C ₁₄	200,936	243,312	390,763	671,529	795,501	898,195
C ₂₁	36,910.36	43,732.3	52,074.97	57,348.29	62,685.77	66,474.45
C ₂₂	2020.93	2552.2	2403.75	2947.81	3364.83	3539.43
C ₂₃	201.75	230.9	261.86	326.03	377.82	400.96
C ₂₄	472.3	1059.8	1303.1	1526.4	1593.7	1732.3
C ₃₁	35.6	40.5	44.9	49.5	54.0	55.8
C ₃₂	50.1	55.7	64.1	74.9	83.6	91.2
C ₃₃	3.1	3.9	5.1	5.6	5.9	6.7
C ₄₁	18.72	19.02	19.35	19.99	21.19	21.72
C ₄₂	0.69	0.69	0.73	0.78	0.86	0.89
C ₄₃	8.90	10.21	11.64	12.38	13.90	14.94
C ₄₄	84.36	97.98	114.78	127.81	166.09	174.46
C ₄₅	53.6	58	65.9	67.7	74	86.3
C ₄₆	3.6	4.4	5.3	6.1	6.9	7.6
C ₄₇	36.91	39.13	41.06	43.81	46.52	49.36
C ₅₁	4.9	5.7	6.3	6.7	7.2	8.1
C ₅₂	4.3	5.1	6.1	6.6	7	7.7
C ₅₃	4.6	5.3	5.7	6	6.6	7.1
C ₅₄	5.4	5.7	6.4	6.9	7.6	8.3
C ₅₅	2.6	3.4	3.9	4.4	5.6	6.9

According to the data in **Table 1**, membership grade compound fuzzy matter-element is obtained by using membership principle, membership compound fuzzy matter-element R'_{mn} is obtained as shown in Equation (12):

$$R'_{mn} = \begin{bmatrix} & 2009 & 2010 & 2011 & 2012 & 2013 & 2014 \\ C_{11} & 0 & 0.14 & 0.25 & 0.45 & 0.79 & 1 \\ C_{12} & 0 & 0.19 & 0.43 & 0.61 & 0.89 & 1 \\ C_{13} & 0.05 & 0 & 0.29 & 0.42 & 0.64 & 1 \\ C_{14} & 0 & 0.06 & 0.27 & 0.67 & 0.85 & 1 \\ C_{21} & 0 & 0.23 & 0.51 & 0.69 & 0.87 & 1 \\ C_{22} & 0 & 0.35 & 0.25 & 0.61 & 0.89 & 1 \\ C_{23} & 0 & 0.15 & 0.30 & 0.62 & 0.88 & 1 \\ C_{24} & 0 & 0.47 & 0.66 & 0.84 & 0.89 & 1 \\ C_{31} & 0 & 0.24 & 0.46 & 0.69 & 0.91 & 1 \\ C_{32} & 0 & 0.14 & 0.34 & 0.60 & 0.82 & 1 \\ C_{33} & 0 & 0.22 & 0.56 & 0.69 & 0.48 & 1 \\ C_{41} & 0 & 0.10 & 0.21 & 0.42 & 0.82 & 1 \\ C_{42} & 0 & 0 & 0.20 & 0.45 & 0.85 & 1 \\ C_{43} & 0 & 0.22 & 0.45 & 0.58 & 0.83 & 1 \\ C_{44} & 0 & 0.15 & 0.34 & 0.48 & 0.91 & 1 \\ C_{45} & 0 & 0.13 & 0.38 & 0.43 & 0.62 & 1 \\ C_{46} & 0 & 0.20 & 0.43 & 0.63 & 0.83 & 1 \\ C_{47} & 0 & 0.18 & 0.33 & 0.55 & 0.77 & 1 \\ C_{51} & 0 & 0.25 & 0.44 & 0.56 & 0.72 & 1 \\ C_{52} & 0 & 0.24 & 0.55 & 0.68 & 0.79 & 1 \\ C_{53} & 0 & 0.28 & 0.44 & 0.56 & 0.80 & 1 \\ C_{54} & 0 & 0.10 & 0.34 & 0.52 & 0.76 & 1 \\ C_{55} & 0 & 0.19 & 0.30 & 0.42 & 0.70 & 1 \end{bmatrix} \quad (12)$$

Then, weighted composite element R_{oik} is established, as shown in Equation (13).

$$R_{oik} = \begin{matrix} C_{11}0.0387 & C_{12}0.0461 & C_{13}0.0353 & C_{14}0.0422 \\ C_{21}0.0488 & C_{22}0.0457 & C_{23}0.0436 & C_{24}0.0569 \\ C_{31}0.0486 & C_{32}0.0427 & C_{33}0.0480 & \\ C_{41}0.0377 & C_{42}0.0369 & C_{43}0.0454 & C_{44}0.0425 & C_{45}0.0379 & C_{46}0.0454 & C_{47}0.0419 \\ C_{51}0.0438 & C_{52}0.0477 & C_{53}0.0455 & C_{54}0.0402 & C_{55}0.0384 \end{matrix} \quad (13)$$

2) To establish Beijing-Tianjin-Hebei region emergency logistics capability central composite fuzzy matter-element

Supposing R_k represents Beijing-Tianjin-Hebei region emergency logistics capability centralized composite fuzzy matter-element, Equation (19) is given by equation $R_k = R'_{mn} * R_{oik}$, Equation (12) and Equation (13).

$$R_k = \begin{bmatrix} & 2009 & 2010 & 2011 & 2012 & 2013 & 2014 \\ C_1 & 0.0018 & 0.0166 & 0.0509 & 0.0899 & 0.1304 & 0.1624 \\ C_2 & 0 & 0.0601 & 0.0872 & 0.1364 & 0.1722 & 0.1950 \\ C_3 & 0 & 0.0283 & 0.0636 & 0.0925 & 0.1163 & 0.1393 \\ C_4 & 0 & 0.0417 & 0.0977 & 0.1471 & 0.2320 & 0.2876 \\ C_5 & 0 & 0.0462 & 0.0899 & 0.1193 & 0.1631 & 0.2157 \end{bmatrix} \quad (14)$$

3) To define Beijing-Tianjin-Hebei region emergency logistics capability central composite fuzzy matter-element

By expert scoring, we get four first-level evaluation indexes, their weighted composite element R_{oi} is shown in Equation (15).

$$R_{oi} = \begin{bmatrix} C_1 & C_2 & C_3 & C_4 & C_5 \\ 0.0752 & 0.4734 & 0.1503 & 0.0551 & 0.2460 \end{bmatrix} \quad (15)$$

R_D represents comprehensive evaluation compound fuzzy matter-element. Firstly, R_d is obtained by equation $R_d = R_k * R_{oi}$, adopting Equation (14) and Equation (15), as shown in Equation (16).

$$R_d = \begin{bmatrix} 2009 & 2010 & 2011 & 2012 & 2013 & 2014 \\ C_1 & 0.0001 & 0.0012 & 0.0038 & 0.0067 & 0.0098 & 0.0122 \\ C_2 & 0 & 0.0285 & 0.0413 & 0.0646 & 0.0815 & 0.0923 \\ C_3 & 0 & 0.0042 & 0.0096 & 0.0139 & 0.0175 & 0.0209 \\ C_4 & 0 & 0.0023 & 0.0054 & 0.0081 & 0.0128 & 0.0158 \\ C_5 & 0 & 0.0114 & 0.0221 & 0.0293 & 0.0401 & 0.0531 \end{bmatrix} \quad (16)$$

Finally, comprehensive evaluation compound fuzzy matter-element R_D is given by:

$$R_D = \begin{bmatrix} 2009 & 2010 & 2011 & 2012 & 2013 & 2014 \\ D_j & 0.001 & 0.0476 & 0.0822 & 0.1226 & 0.1617 & 0.1944 \end{bmatrix} \quad (17)$$

We could find $D_6 > D_5 > D_4 > D_3 > D_2 > D_1$, there is increasing trends of Beijing-Tianjin-Hebei region emergency logistics capability from the year 2009 to the year 2014.

5.2. Result Analysis

1) Comprehensive capability evaluation of Beijing-Tianjin-Hebei region emergency logistics

In order to facilitate evaluation and analysis, Equation (17) is transformed into figure, as shown in **Figure 1** and **Figure 2**.

We can see intuitively from **Figure 1** and **Figure 2** that Beijing-Tianjin-Hebei region emergency logistics capability maintains growth from the year 2009 to

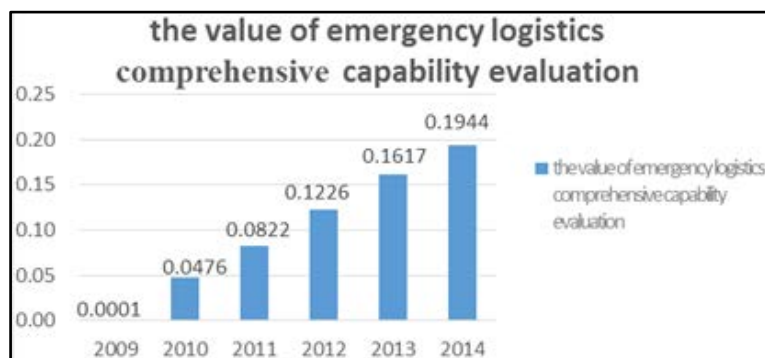


Figure 1. The histogram of Beijing-Tianjin-Hebei region emergency logistics capability comprehensive evaluation results.

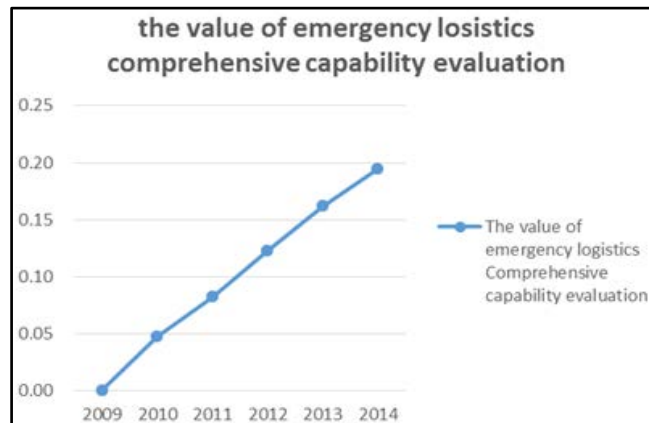


Figure 2. The curves chart of Beijing-Tianjin-Hebei region emergency logistics capability comprehensive evaluation results.

the year 2014, but the growth rate slowed down year by year. From the year 2009 to the year 2010, Beijing-Tianjin-Hebei region emergency logistics capability rose sharply.

2) The evaluation of Beijing-Tianjin-Hebei region emergency logistics capability of indexes at all levels.

Beijing-Tianjin-Hebei region emergency logistics capability is the result of comprehensive function of each first-class influence index, so we need to make further analysis. Equation (16) is transformed into **Figure 3**, shown as following.

Figure 3 reveals that each first-class index of Beijing-Tianjin-Hebei region emergency logistics capability took on an increasing tendency, the support capability of economic growth was most obvious, followed by which was emergency logistics management capability and information system security capability, human resources support capability and infrastructure support capability showed a smaller increase. From Equation (15), in all of first-class indexes, the support capability of economic growth in emergency logistics capability accounted for the maximum weight, followed by emergency logistics management capability and information systems security capability, the weight of human resources support capability and infrastructure support capability was smallest. Combined with these two aspects, we could find that the first-class index elements of economic support made the biggest impact on Beijing-Tianjin-Hebei region emergency logistics capability. But from **Figure 1**, we could find that disaster relief materials reserve expenditure C_{24} accounted for the highest weight, followed by Beijing-Tianjin-Hebei regional GDP index C_{21} , but the growth rate of these two indexes was relatively low in the past two years, which showed that it needs to ensure the rapid development of regional economy and continuing to increase the reserves of disaster relief supplies to improve regional emergency logistics capability.

The weigh of the first-class index of emergency logistics management capability is only second to the economic support capability, but we can see from **Table 2**, the cooperation degree of regional emergency logistics in it's secondary

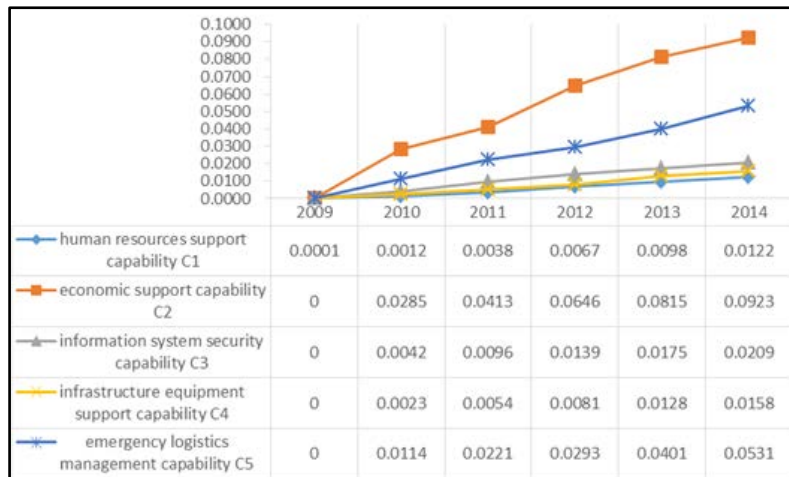


Figure 3. The curves chart of Beijing-Tianjin-Hebei region emergency logistics capability comprehensive evaluation results.

Table 2. Each index weight.

	2009	2010	2011	2012	2013	2014	$\bar{\mu}_k$	ω_k
C11	0	0.14	0.25	0.45	0.79	1	0.438	0.0387
C12	0	0.19	0.43	0.61	0.89	1	0.521	0.0461
C13	0.05	0	0.29	0.42	0.64	1	0.399	0.0353
C14	0	0.06	0.27	0.67	0.85	1	0.477	0.0422
C21	0	0.23	0.51	0.69	0.87	1	0.551	0.0488
C22	0	0.35	0.25	0.61	0.89	1	0.516	0.0457
C23	0	0.15	0.30	0.62	0.88	1	0.493	0.0436
C24	0	0.47	0.66	0.84	0.89	1	0.642	0.0569
C31	0	0.24	0.46	0.69	0.91	1	0.549	0.0486
C32	0	0.14	0.34	0.60	0.82	1	0.483	0.0427
C33	0	0.22	0.56	0.69	0.78	1	0.542	0.0480
C41	0	0.1	0.21	0.42	0.82	1	0.426	0.0377
C42	0	0	0.2	0.45	0.85	1	0.417	0.0369
C43	0	0.22	0.45	0.58	0.83	1	0.513	0.0454
C44	0	0.15	0.34	0.48	0.91	1	0.480	0.0425
C45	0	0.13	0.38	0.43	0.62	1	0.428	0.0379
C46	0	0.20	0.43	0.63	0.83	1	0.513	0.0454
C47	0	0.18	0.33	0.55	0.77	1	0.473	0.0419
C51	0	0.25	0.44	0.56	0.72	1	0.495	0.0438
C52	0	0.24	0.53	0.68	0.79	1	0.539	0.0477
C53	0	0.28	0.44	0.56	0.80	1	0.513	0.0455
C54	0	0.10	0.34	0.52	0.76	1	0.454	0.0402
C55	0	0.19	0.30	0.42	0.70	1	0.434	0.0384

measurable index still need to be strengthened. In addition, the weight of Internet penetration rate C_{31} , the degree of regional emergency information sharing C_{33} , and government coordination capability C_{52} are higher, so emergency logistics capability can be improved by enhancing these capabilities.

6. Conclusions

The following conclusions are drawn by the analysis and evaluation on Beijing-Tianjin-Hebei region emergency logistics capability:

1) Fuzzy matter-element method is suitable for solving the quantitative and qualitative analysis, the calculation process is simple and clear, which can clearly reflect the impact of each index on regional emergency logistics capability.

2) Disaster relief materials reserve expenditure and Gross Regional Product are the main factors that influence on Beijing-Tianjin-Hebei region emergency logistics capability, regional emergency logistics level can be improved by increasing the reserves of relief supplies and improving the regional economic strength.

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