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An IFS-IVIFS-DEMATEL Method to Identify Critical Success Factors of Cross-Department Coordination of Emergency Management

Weijian Jin and Yajing Zhang *

School of Economics and Management, Nanjing Institute of Technology, Nanjing 211167, China; jinweijian@njit.edu.cn
* Correspondence: zyjalisa@njit.edu.cn; Tel.: +86-15251869051

Abstract: Cross-Department Coordination of Emergency Management (CDCEM) is considered a critical dimension in China to solve the problem of emergency management. The Decision Experiment and Decision-Making Trial and Evaluation Laboratory (DEMATEL) is a method used to build the structural correlation of criteria in uncertain environments to identify critical success factors (CSFs). There are coupling correlations and one-way correlations for interrelationship comparisons between selected factors of CDCEM. Therefore, there are two different assessment scales. However, most previous studies applied the DEMATEL method with a single assessment scale to identify CSFs. To fill this gap, an IFS-IVIFS-DEMATEL method is provided to comprehensively identify the CSFs of CDCEM in this study. The intuitionistic fuzzy set (IFS) is regarded as the assessment scales of coupling correlation, and the interval-valued intuitionistic fuzzy set (IFIVS) is regarded as the assessment scales of one-way correlation. The two different types of assessment scales were transformed into interval information in the improved approach. Then, using the conduction correlation among factors, a comprehensive correlation matrix was constructed. After that, the ranking of the central degree and cause degree of the factors according to the traditional DEMATEL method was obtained. Finally, a case study of Nanjing's CDCEM was illustrated to demonstrate that the proposed method is more suitable and reasonable. It is found that the factors of "cross-department organization", "cross-department information communication and transmission", "information sharing technology platform", "cross-department material supply capability", and "cross-department prediction and early warning" in Nanjing are CSFs in CDCEM, which should be emphasized to strengthen CDCEM. The findings of this study shed light on the cross-department coordination of emergency management mechanisms in uncertain situations, which would be beneficial for improving the efficiency of governmental management.

Keywords: emergency management; cross-department collaboration; IFS; IVIFS; DEMATEL

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1. Introduction

In contemporary society, a variety of disasters take place more and more frequently. Since 2003, China has carried out a series of emergency management practices to deal with emergencies (i.e., avian influenza, earthquakes, floods, and extreme temperatures) [1]. Emergency management exposed a lot of problems, such as the unbalanced distribution of emergency resources, the difficult coordination of emergency management, and the emergency subject of mutual prevarication [2]. Thus, it becomes increasingly important for emergency management to collaborate among different departments.

Departments of local governments at all levels in China are not affiliated with each other, which makes it difficult to quickly coordinate resources and decisions during emergencies [3]. Therefore, governments at all levels need to integrate the various resources of different departments to strengthen cross-departmental collaboration [4,5]. For this purpose, departments at all levels in China have launched a series of attempts to improve

the efficiency of cross-department emergency management. For instance, in 2015, the Chinese city of Beijing carried out joint work on emergency information sharing, notification, emergency talents, emergency drills, etc.

Since cross-department collaboration is a complex process, scientific cross-department coordination will improve the efficiency of emergency management. Cross-Department Coordination of Emergency Management (CDCEM) had already caught the interest of scholars, who had conducted some studies from various perspectives and made some progress in areas such as cross-departmental flexibility and cross-departmental information communication.

When carrying out emergency response, it is very important to have a high level of cross-departmental flexibility [6]. Formulating a joint emergency plan is an effective way to improve the emergency response of departmental flexibility [7]. Developing the joint allocation scheme is another effective way to coordinate the relationships of multiple departments [8]. The communicative and collaborative relationship is also crucial to the improvement of cross-departmental flexibility in emergency responses [9]. Moreover, cross-departments could take collaborative actions to better accomplish emergency tasks through knowledge sharing and information communication [10,11]. In addition, improving the practice of multimodal resources [12], identifying humanitarian information [13], and adjusting management roles [14] can also support the efficiency of CDCEM.

Prior research and the government's practice provided us with the foundation for improving the efficiency of CDCEM. However, it is unrealistic for departments at all levels to consider all the factors affecting the CDCEM equally due to the relatively small number of emergency resources in various departments. Thus, a more practical approach is to clarify the relationships among factors and identify the most urgent factors. These factors are referred to as critical success factors (CSFs), which have the greatest influence on emergency management. Unfortunately, previous studies used methods such as structural embeddedness [15], space syntax theory [16], differential-evolution-based association rule mining [17], and extracting factors from relevant studies [18] to explore the potential factors, which did not adequately address the CSFs of CDCEM. Therefore, it is critical to adopt an appropriate decision-making method to identify CSFs of CDCEM.

Researchers and emergency managers have been seeking methods to evaluate the emergency management system and enhance the efficiency of emergency management [19–23]. The Decision Experiment and Decision-Making Trial and Evaluation Laboratory (DEMATEL) method is used to identify CSFs in some circumstances [1,20,24–26]. The intuitionistic fuzzy set (IFS) and the interval-valued intuitionistic fuzzy set (IVIFS) are used as language evaluation operators to handle problems under uncertain circumstances [27,28]. Specifically, there are two kinds of correlation: a coupling correlation and a one-way correlation among factors of CDCEM. A coupling correlation means that two factors have an interactive relationship. One-way correlation illustrates that one factor influences the other factor, while the other factor does not influence this factor. Accordingly, the assessment scales for coupling correlation and one-way correlation are given with IFS and IVIFS, respectively, in our proposed method.

Hence, we proposed an IFS-IVIFS-DEMATEL method with assessment scales of IFS and IVIFS to find out the relationship among the factors in an uncertain environment and to identify CSFs of CDCEM. We applied this hybrid method to identify CSFs of CDCEM in Nanjing, where five factors were identified as key factors and three were identified as non-key factors. Based on the identification results, reasonable suggestions for CDCEM were proposed in the discussion, which would enhance the efficiency of governmental management.

The remainder of this paper is organized as follows: Section 2 reviews the previous related work. Section 3 introduces the preliminary factors, including CDCEM, conduction correlation, IFS, and IVIFS. Section 4 presents the proposed IFS-IVIFS-DEMATEL method. Section 5 illustrates a case of Nanjing's CDCEM. The conclusions are provided in the final section.

2. Literature Review

In the 1970s, Fontela and Gabus (1974) proposed the DEMATEL method, which could uncover CSFs by exploring the association among factors [29]. Similar to many other typical multi-criteria decision-making (MCDM) methods, DEMATEL needs decision-makers (DMs) to provide assessments against criteria using crisp values [30]. However, crisp values sometimes cannot express human thinking [31]. To address this problem, the DMs' preferences were measured using a fuzzy membership degree [32].

Some scholars provided the fuzzy DEMATEL method using fuzzy assessment scales, which have been widely utilized in various circumstances such as the selection of competent vendors [33], truck selection [24], and the barriers to university technology transfer [34]. In some circumstances, the fuzzy DEMATEL was used to determine the most urgent and important factors. Zhou et al. (2017) provided a D-DEMATEL method to identify the critical success factors in emergency management for addressing the fuzziness and subjectivity in linguistic assessment [20]. Ding and Liu (2018) addressed a DEMATEL method based on two-dimensional uncertain linguistic variables to determine critical success factors in emergency management [1]. Cui, Chan, Zhou, Dai, and Lim [25] adopt the company life cycle theory to identify critical success factors using the proposed Grey-DEMATEL method [25]. Song et al. (2022) identified the critical success factors for COVID-19 prevention and control in China with the DEMATEL method [26].

In the fuzzy MCDM method, the DMs' preferences could sometimes not be measured using fuzzy membership degree owing to complex human judgment under some uncertain circumstances [35]. Atanassov (1986) developed IFS as an alternative to express DMs' preferences by membership degree, non-membership degree, and hesitancy degree [36]. Later, he proposed the IVIFS as an extension of the IFS [37], in which membership degree, non-membership degree, and hesitancy degree are characterized as intervals rather than crisp values. Other scholars applied the IFS and IVIFS to solve uncertain issues in some fields. For instance, Pan and Deng (2022) employed IFS to address target and clustering issues in order to more effectively address practical issues [28]. Ananthi and Balasubramaniam (2016) provided a novel impulse noise detection method based on IVIFS to suppress noise in digital images [27].

In recent years, the DEMATEL method using IFS or IVIFS assessment scales has been employed to deal with decision-making issues [31,38,39]. Govindan, Khodaverdi, and Vafadarnikjoo [38] evaluated the green supply chain based on the DEMATEL method, in which the assessment scales of IFS are provided [38]. Giri et al. (2022) developed the Pythagorean fuzzy set (a generalized concept of fuzzy set and IFS) based on the DEMATEL method to solve the supplier selection problem in sustainable supply chain management [39]. Abdullah, Zulkifli, Liao, Herrera-Viedma, and Al-Barakati [31] proposed an interval-valued intuitionistic fuzzy DEMATEL method to identify the CSFs in sustainable solid waste management [31].

In summary, existing researchers used the DEMATEL method of IFS or IVIFS as the assessment scale for decision-making, which is a single evaluation scale. Nevertheless, single assessment scales could not show the characterization of interactive relationships among factors in CDCEM because of two kinds of different correlations in CDCEM. To fill the gap, we explored a DEMATEL method of integration of the assessment scales of IFS and IVIFS (IFS-IVIFS-DEMATEL). Furthermore, the proposed method yields a significant role in identifying the CSFs of CDCEM in Nanjing.

3. Preliminaries

3.1. Factors of CDCEM

In order to identify the CSFs of CDCEM, it is feasible to extract some factors from the relevant literature. For instance, some scholars believe that the efficiency of cross-departmental organizations [15,40] is the factor affecting CDCEM. According to the situation of emergency management in China, some factors are discarded or combined, such as organizational culture and cross-organizational connection. The other factors are extracted,

such as cross-department emergency drills. After this, the opinions of emergency management specialists are sought in the form of a questionnaire survey, and factors affecting the CDCEM are obtained. The factors are shown in Table 1.

Table 1. Influencing factors and their descriptions.

Factors	Description of Factors	Source of Factors
H1, Cross-department organization	It mainly refers to the establishment of a cross-department coordination working mechanism of the permanent organizations in order to enhance the trust, notification, and decision-making mechanisms of the cross-department.	Fan, Liu, Huang, and Zhu [15]
H2, Cross-department collaborative training	Cross-department personnel shall receive training and education on emergency management coordination according to their work in order to solve cross-department trust relationships and improve cross-department linkage capability through training.	Peng et al. [41], Ayenew et al. [42], Goktas et al. [43]
H3, Cross-department information communication and transmission	It refers to information communication between cross-departments. It is a daily communication channel in daily work and risk occurrence and an important channel for establishing trust between departments.	Ayenew, Tassew and Workneh [42], Nomoto et al. [44]
H4, Cross-department emergency drill	It refers to a daily cross-department emergency drill for all kinds of risks, which mainly includes routine work such as determining the drill, the drill date, and the drill method.	Xu et al. [45]
H5, Information sharing technology platform	It refers to the construction of a cross-department information-sharing platform to achieve cross-department information interconnection. It is an important platform to ensure timely and efficient information exchange between departments and realize information communication and transmission.	Andreassen, Borch and Sydnes [14], Colombo et al. [46]
H6, Cross-department material supply capability	It refers to the possibility of fully mobilizing cross-department material emergency resources when a risk occurs, including the tangible material resources owned by departments as well as the key resources controlled by different departments.	Zhou, Shi, Deng, and Deng [20], Carrington et al. [47]
H7, Cross-department collaborative decision making system	It refers to the process of cross-department collaborative decision-making in response to various situations according to the emergency plan when disasters occur, including the release of instructions from the horizontal department and the vertical section decision-making implementation.	Chang, Zhou, Zhang, Ding, Cheng, and Chang [11], Elbanna et al. [48]
H8, Cross-department prediction and early warning	By building meteorological, seismic, geological, network, and other monitoring and early warning systems, it provides accurate, intelligent, scientific, and efficient support for decision-making and leadership in response to emergency events.	Gangwal and Dong [49], Ji et al. [50]

3.2. Conduction Correlation

There exists a conduction correlation among the factors in the whole system. It means one factor has an indirect influence on another factor through an intermediary factor. This is called conduction correlation.

Initially, one factor has a direct influence on another. As shown in Figure 1, the factor "information sharing technology platform" has a direct influence on the factor "cross-department information communication and transmission". The factor "information communication and transmission" has a direct influence on the factor "cross-department collaborative decision-making system".

Afterwards, through the factor "cross-department information communication and transmission", the factor "information sharing technology platform" has an indirect influence on the factor "cross-department collaborative decision-making system". The correlation is shown in Figure 2.

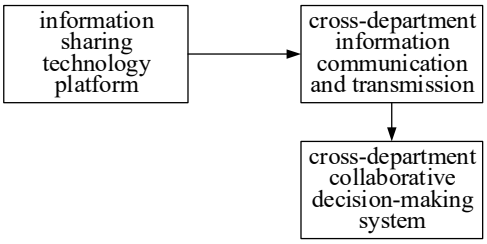


Figure 1. Direct correlation. Note: ⟶ indicates the factor has a direct influence on the factor.

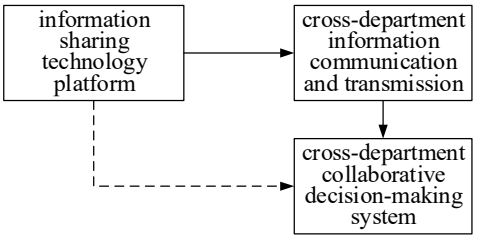


Figure 2. Conduct correlation. Note: ⟶ indicates the factor has a direct influence on the factor and ⇢ indicates the factor has a indirect influence on the factor.

Thus, the factors "information sharing technology platform"," cross-department information communication and transmission ", and "cross-department collaborative decision-making system" have a conduction correlation.

3.3. IFS and IVIFS

Definition 1: *Let* $X = \{x_1, x_2, \ldots, x_n\}$ *be a finite universal set, and then an intuitionistic fuzzy set A in X is defined as:*

$$A = \{< x, \mu_A(x), \nu_A(x) > | x \in X\} \tag{1}$$

where $\mu_A(x) : X \to [0,1]$ *and* $\nu_A(x) : X \to [0,1]$. *The notation* $\mu_A(x)$ *represents the membership degree, and* $\nu_A(x)$ *denotes a non-membership degree of element* $x \in X$ *to set A for all* $x \in X, 0 \leq \mu_A(x) + \nu_A(x) \leq 1$. $\mu_A(x)$ *and* $\nu_A(x)$ *make up an ordered pair of* $(\mu_A(x), \nu_A(x))$, *which we call an intuitionistic fuzzy set.*

Definition 2: *Let* $X = \{x_1, x_2, \ldots, x_n\}$ *be a finite universal set, and then an intuitionistic interval-valued fuzzy set A in X is defined as:*

$$A = \left\{< x, [\mu_A^L(x), \mu_A^R(x)], [\nu_A^L(x), \nu_A^R(x)] > \middle| x \in X\right\} \tag{2}$$

where $[\mu_A^L(x), \mu_A^R(x)] \subseteq [0,1]$ *and* $[v_A^L(x), v_A^R(x)] \subseteq [0,1]$ *represent the membership degree* $\mu_A(x)$ *and non-membership degree* $\nu_A(x)$ *of element* $x \in X$ *to set A, and for all* $x \in X$, $0 \leq \mu_A^R(x) + v_A^R(x) \leq 1$. $[\mu_A^L(x), \mu_A^R(x)]$ *and* $[\nu_A^L(x), \nu_A^R(x)]$ *make up an ordered pair of* $[\mu_A^L(x), \mu_A^R(x)], [\nu_A^L(x), \nu_A^R(x)]$, *which we call an interval-valued intuitionistic fuzzy set.*

3.4. Symbol Descriptions

Human assessments for interrelationship comparisons between chosen criteria are generally given by crisp values. However, assessments with preferences are often vague and difficult to estimate with crisp values. In this study, linguistic assessment is the reasonable approach for deciding the relationship between two factors.

Let $H = (H_1, H_2, \ldots, H_n)$ be a set of factors of CDCEM and suppose that $F = (F_1, F_2, \ldots, F_K)$ is a set of experts. If the factor H_i against the factor H_j is a coupling correlation, the kth expert expresses his/her preferences between two factors by $A_{kij} = (a1_{kij}, b1_{kij})$,

$1 \le k \le K$, and $a1_{kij}$ is the membership degree and $b1_{kij}$ is the non-membership degree. If the factor H_i against the factor H_j is a one-way correlation, the kth expert expresses his/her preferences between two factors by $B_{kij} = ((a_{kij}, b_{kij})(c_{kij}, d_{kij}))$, and (a_{kij}, b_{kij}) is the membership degree and (c_{kij}, d_{kij}) is the non-membership degree. Therefore, the kth expert constructs a hybrid initial direct correlation matrix: $C_k = [c_{kij}]_{n\times n} = [A_{kij} \cup B_{kij}]_{n\times n}$, $1 \le k \le K$.

$$C_k = [c_{kij}]_{n\times n} = \begin{array}{c} \\ H_1 \\ H_2 \\ \cdots \\ H_n \end{array} \begin{array}{c} \begin{array}{cccc} H_1 & H_2 & \cdots & H_n \end{array} \\ \begin{bmatrix} c_{11} & c_{12} & \cdots & c_{1n} \\ c_{21} & c_{22} & \cdots & c_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ c_{n1} & c_{n2} & \cdots & c_{nn} \end{bmatrix} \end{array} \tag{3}$$

4. The Proposed Method

The proposed method is carried out in seven steps.

Step 1: Collecting data via linguistic ratings provided by the DMs. DMs represent the assessment of one factor against the other factor by IFS and IVIFS.

Step 2: Converting IFS and IVIFS into interval numbers through different transformation methods.

The IFS is converted into interval numbers [51], as follows:

$$A_k = [A_{kij}^-, A_{kij}^+]_{n\times n} = [a1_{kij}, 1 - b1_{kij}]_{n\times n} \tag{4}$$

The IVIFS is converted into interval numbers [52], as follows:
$R_{kij} = [R_{kij}^-, R_{kij}^+]_{n\times n}$.
The upper bound is as follows:

$$R_{kij}^- = \min\left(\frac{a_{kij} - c_{kij}}{2 - b_{kij} - d_{kij}}, \frac{b_{kij} - d_{kij}}{2 - a_{kij} - c_{kij}}\right) \tag{5}$$

The lower bound is as follows:

$$R_{kij}^+ = \max\left(\frac{a_{kij} - c_{kij}}{2 - b_{kij} - d_{kij}}, \frac{b_{kij} - d_{kij}}{2 - a_{kij} - c_{kij}}\right) \tag{6}$$

because of $0 \le A_{kij}^- \le 1, 0 \le A_{kij}^+ \le 1, -1 \le R_{kij}^- \le 1, -1 \le R_{kij}^+ \le 1$. For consistency, the interval [1, 1] is mapped to [0, 1], and the formula are as follows:

$$\theta_{kij}^- = \frac{R_{kij}^- - \min(R_{kij}^-)}{\max(R_{kij}^-) - \min(R_{kij}^-)} \tag{7}$$

$$\theta_{kij}^+ = \frac{R_{kij}^+ - \min(R_{kij}^+)}{\max(R_{kij}^+) - \min(R_{kij}^+)} \tag{8}$$

Therefore, the initial direct correlation matrix after the transformation is as follows:

$$\widetilde{C}_k = [\widetilde{C}_{kij}]_{n\times n} = [C_{kij}^-, C_{kij}^+]_{n\times n} = [A_{kij}^- \cup \theta_{kij}^-, A_{kij}^+ \cup \theta_{kij}^+]_{n\times n} \tag{9}$$

Step 3: Carrying out the weighted initial direct correlation matrix, the upper and lower bounds of factor i against factor j are as follows:

$$m_{ij}^- = \frac{1}{k}\sum_{k=1}^{K} C_{kij}^-, i = 1, 2, \cdots, n, j = 1, 2, \cdots n \tag{10}$$

$$m_{ij}^{+} = \frac{1}{k}\sum_{k=1}^{K} C_{kij}^{+}, i = 1, 2, \cdots, n, j = 1, 2, \cdots n \tag{11}$$

Step 4: Normalizing the upper bound of the direct correlation matrix $M^{-} = [m_{ij}^{-}]_{n\times n}$, and the lower bound of the direct correlation matrix $M^{+} = [m_{ij}^{+}]_{n\times n}$, and obtain the matrix $G^{-} = \left[g_{ij}^{-}\right]_{n\times n}$ and $G^{+} = \left[g_{ij}^{+}\right]_{n\times n}$, as follows:

$$g_{ij}^{-} = m_{ij}^{-} / \max_{1\le i\le n} \sum_{j=1}^{n} m_{ij}^{+} \tag{12}$$

$$g_{ij}^{+} = m_{ij}^{+} / \max_{1\le i\le n} \sum_{j=1}^{n} m_{ij}^{+} \tag{13}$$

The indirect correlation of CDCEM is obtained, which is the upper bound and the lower bound of the influence correlation matrix, respectively.

$$T^{-} = G^{-}(I - G^{-})^{-1} \tag{14}$$

$$T^{+} = G^{+}(I - G^{+})^{-1} \tag{15}$$

where I is the identity matrix.

As mentioned above in the conduction correlation, there is not only a direct influence correlation among the factors but also an indirect influence correlation. We construct the following comprehensive correlation matrix $Z = [z_{ij}]_{n\times n}$ using Equation (16).

$$z_{ij} = [z_{ij}^{-}, z_{ij}^{+}] = [m_{ij}^{-} + t_{ij}^{-}, m_{ij}^{+} + t_{ij}^{+}] \tag{16}$$

Step 5: Obtain the sum of rows $\widetilde{R}$ and the sum of columns $\widetilde{D}$ using Equations (17) and (18).

$$\widetilde{R} = [R_i^{-}, R_i^{+}] = [\sum_{j=1}^{n} z_{ij}^{-}, \sum_{j=1}^{n} z_{ij}^{+}] \tag{17}$$

$$\widetilde{D} = [D_i^{-}, D_i^{+}] = [\sum_{i=1}^{n} z_{ij}^{-}, \sum_{i=1}^{n} z_{ij}^{+}] \tag{18}$$

Step 6: Obtain the probability matrix of the sum of rows. We use the ranking method of interval numbers proposed by [53]. The formula is as follows:

$$R_{ij} = \frac{\max\left[0, l(Q_i) + l(Q_j) - \max(0, R_j^{U} - R_i^{L})\right]}{l(Q_i) + l(Q_j)} \tag{19}$$

where

$$l(Q_i) = R_i^{+} - R_i^{-}, l(Q_j) = R_j^{+} - R_j^{-} \tag{20}$$

The formula of the probability matrix of the sum of columns is as follows:

$$D_{ij} = \frac{\max\left[0, l(Q_i) + l(Q_j) - \max(0, D_j^{U} - D_i^{L})\right]}{l(Q_i) + l(Q_j)} \tag{21}$$

where

$$l(Q_i) = D_i^{+} - D_i^{-}, l(Q_j) = D_j^{+} - D_j^{-} \tag{22}$$

Step 7: To calculate the degree of influential impact, the formula is as follows:

$$R_i = \sum_{k=1}^{n} R_{ik}, i = 1, 2, \cdots n \tag{23}$$

To calculate the degree of influenced impact, the formula is as follows:

$$D_i = \sum_{k=1}^{n} D_{ik}, i = 1, 2, \cdots n \tag{24}$$

To calculate the central degree, the formula is as follows:

$$P_i = R_i + D_i \tag{25}$$

To calculate the causal degree, the formula is as follows:

$$H_i = R_i - D_i \tag{26}$$

Factors can be divided into two categories by causal degree. A factor's causal degree, greater than or equal to zero, is considered the cause factor. A factor's causal degree, less than zero, is regarded as the effect factor. The cause factor can influence other factors and is usually considered as CSFs when its central degree does not rank too low, while the effect factor is passive, so that it is not easily considered a CSF.

5. Case Study

The Chinese city of Nanjing, located in the delta of the Yangtze River, is frequently affected by natural disasters such as winter snowstorms. Because emergency management involves meteorological, transportation, water, energy, and communication departments, the complexity of many emergency management problems is increasing. Clearly, it is becoming increasingly difficult for emergency management to meet the needs of the public. This issue needs to be solved through CDCED. Upper-level departments must spend a lot of time organizing and coordinating cross-departmental collaboration because there are barriers to communication and decision-making among various departments. Therefore, the upper-level departments decided to invite experts to identify the CSFs of CDCEM. Three experts from different industries with different professional backgrounds were invited by the upper-level department to participate in this decision-making.

5.1. Steps for Decision-Making

Step 1: Each expert provided the IFS and IFIVS assessments through a pairwise comparison of two factors. The initial direct relation matrix (take Expert (I) as an example) is obtained and is shown in Table 2, the matrixes for Expert (II) and Expert (III) see Tables A1 and A2 in the Appendix A.

Table 2. Expert (I) hybrid initial direct correlation matrix.

	H1	H2	H3	H4	H5	H6	H7	H8
H1	0	(0.1, 0.4)	(0.3, 0.5)	(0.3, 0.4)	(0.4, 0.5)	(0.4, 0.5)	(0.5, 0.3)	(0.2, 0.5)
H2	(0.1, 0.7)	0	(0.4, 0.3)	(0.4, 0.6)	(0, 1)	(0.1, 0.4),(0.3, 0.6)	(0.4, 0.5)	(0.3, 0.4)
H3	(0.1, 0.6)	(0.4, 0.5)	0	(0.4, 0.6),(0.3, 0.4)	(0.3, 0.5)	(0.5, 0.3)	(0.2, 0.3),(0.3, 0.5)	(0.1, 0.3)
H4	(0.3, 0.6)	(0.5, 0.2)	0	0	0	(0.6, 0.1)	(0.4, 0.5),(0.3, 0.5)	(0.1, 0.2)
H5	(0.6, 0.3)	(0.2, 0.4),(0.3, 0.5)	(0.7, 0.2)	(0.4, 0.5),(0.3, 0.4)	0	(0.8, 0.1)	(0.7, 0.2)	0
H6	(0.7, 0.2)	0	(0.4, 0.4)	(0.7, 0.2)	(0.6, 0.1)	0	(0.6, 0.7),(0.3, 0.3)	(0.2, 0.4)
H7	(0.4, 0.5)	(0.2, 0.5)	0	0	(0.3, 0.5)	0	0	(0.3, 0.5)
H8	(0.4, 0.6)	(0.1, 0.5)	(0.7, 0.2)	(0.5, 0.5)	(0.3, 0.5),(0.4, 0.5)	(0.2, 0.5)	(0.3, 0.4)	0

Step 2: The initial direct relation matrix was converted to the interval number matrix and is shown in Table 3, the matrixes for Expert (II) and Expert (III) see Tables A3 and A4 in the Appendix A.

Table 3. Expert (I) hybrid initial direct correlation interval number matrix.

	H1	H2	H3	H4	H5	H6	H7	H8
H1	[0, 0]	[0.1, 0.6]	[0.3, 0.5]	[0.3, 0.6]	[0.4, 0.5]	[0.4, 0.5]	[0.5, 0.7]	[0.2, 0.5]
H2	[0.1, 0.3]	[0, 0]	[0.4, 0.7]	[0.4, 0.4]	[0, 0]	[0.4, 0.8]	[0.4, 0.5]	[0.3, 0.6]
H3	[0.1, 0.4]	[0.4, 0.5]	[0, 0]	[0.6, 0.6]	[0.3, 0.5]	[0.5, 0.7]	[0.4, 0.7]	[0.1, 0.7]
H4	[0.3, 0.4]	[0.5, 0.8]	[0, 0]	[0, 0]	[0, 0]	[0.6, 0.9]	[0.5, 0.7]	[0.1, 0.8]
H5	[0.6, 0.7]	[0.5, 0.7]	[0.7, 0.8]	[0.5, 0.6]	[0, 0]	[0.8, 0.9]	[0.7, 0.8]	[0, 0]
H6	[0.7, 0.8]	[0, 0]	[0.4, 0.6]	[0.7, 0.8]	[0.6, 0.9]	[0, 0]	[0.6, 0.6]	[0.2, 0.6]
H7	[0.4, 0.5]	[0.2, 0.5]	[0, 0]	[0, 0]	[0.3, 0.5]	[0, 0]	[0, 0]	[0.3, 0.5]
H8	[0.4, 0.6]	[0.1, 0.5]	[0.7, 0.8]	[0.5, 0.5]	[0.5, 0.8]	[0.2, 0.5]	[0.3, 0. 6]	[0, 0]

Step 3: We obtained the weighted initial direct correlation matrix, which is shown in Table 4.

Table 4. Initial direct correlation matrix of interval number weighted by evaluators.

	H1	H2	H3	H4	H5	H6	H7	H8
H1	[0.00, 0.00]	[0.13, 0.63]	[0.27, 0.50]	[0.37, 0.50]	[0.33, 0.50]	[0.40, 0.50]	[0.50.70]	[0.23, 0.50]
H2	[0.10, 0.30]	[0.00, 0.00]	[0.43, 0.70]	[0.40, 0.40]	[0.00, 0.00]	[0.40, 0.77]	[0.40, 0.47]	[0.30, 0.60]
H3	[0.10, 0.40]	[0.40, 0.50]	[0.00, 0.00]	[0.57, 0.63]	[0.30, 0.47]	[0.50, 0.70]	[0.43, 0.70]	[0.10, 0.70]
H4	[0.30, 0.40]	[0.57, 0.80]	[0.00, 0.00]	[0.00, 0.00]	[0.00, 0.00]	[0.53, 0.83]	[0.50, 0.67]	[0.17, 0.80]
H5	[0.57, 0.67]	[0.47, 0.70]	[0.67, 0.80]	[0.53, 0.60]	[0.00, 0.00]	[0.73, 0.83]	[0.70, 0.80]	[0.00, 0.00]
H6	[0.67, 0.80]	[0.00, 0.00]	[0.40, 0.60]	[0.77, 0.80]	[0.57, 0.83]	[0.00, 0.00]	[0.57, 0.60]	[0.23, 0.60]
H7	[0.30, 0.53]	[0.30, 0.50]	[0.00, 0.00]	[0.00, 0.00]	[0.30, 0.50]	[0.00, 0.00]	[0.00, 0.00]	[0.30, 0.50]
H8	[0.33, 0.40]	[0.10, 0.37]	[0.60, 0.80]	[0.43, 0.50]	[0.50, 0.80]	[0.30, 0.50]	[0.30, 0.57]	[0.00, 0.00]

Step 4: We obtained the comprehensive correlation matrix, which is shown in Table 5.

Table 5. Comprehensive impact correlation matrix.

	H1	H2	H3	H4	H5	H6	H7	H8
H1	[0.08, 0.49]	[0.13, 0.75]	[0.19, 0.68]	[0.25, 0.68]	[0.21, 0.66]	[0.26, 0.76]	[0.33, 0.91]	[0.15, 0.73]
H2	[0.11, 0.56]	[0.06, 0.41]	[0.25, 0.71]	[0.26, 0.59]	[0.06, 0.41]	[0.25, 0.8]	[0.27, 0.73]	[0.18, 0.72]
H3	[0.13, 0.71]	[0.25, 0.73]	[0.07, 0.5]	[0.35, 0.78]	[0.2, 0.69]	[0.31, 0.88]	[0.31, 0.95]	[0.1, 0.85]
H4	[0.2, 0.62]	[0.3, 0.76]	[0.06, 0.43]	[0.08, 0.42]	[0.06, 0.42]	[0.3, 0.84]	[0.31, 0.83]	[0.12, 0.82]
H5	[0.37, 0.85]	[0.31, 0.84]	[0.39, 0.86]	[0.38, 0.79]	[0.1, 0.51]	[0.45, 0.97]	[0.48, 1.03]	[0.08, 0.6]
H6	[0.4, 0.9]	[0.1, 0.56]	[0.27, 0.78]	[0.46, 0.87]	[0.34, 0.87]	[0.13, 0.62]	[0.4, 0.95]	[0.17, 0.84]
H7	[0.18, 0.51]	[0.17, 0.49]	[0.05, 0.28]	[0.06, 0.27]	[0.17, 0.47]	[0.05, 0.32]	[0.06, 0.34]	[0.16, 0.5]
H8	[0.24, 0.7]	[0.13, 0.67]	[0.34, 0.83]	[0.3, 0.72]	[0.3, 0.82]	[0.24, 0.8]	[0.26, 0.89]	[0.05, 0.54]

Step 5: We calculated the sum of rows and the sum of columns, and they are shown in Table 6.

Table 6. The sum of rows and sum of columns.

	H1	H2	H3	H4	H5	H6	H7	H8
sum of rows	[1.61, 5.67]	[1.44, 4.94]	[1.71, 6.08]	[1.45, 5.15]	[2.56, 6.45]	[2.27, 6.38]	[0.89, 3.18]	[1.87, 5.96]
sum of columns	[1.72, 5.34]	[1.45, 5.21]	[1.61, 5.07]	[2.15, 5.12]	[1.44, 4.84]	[2.01, 6]	[2.42, 6.63]	[1, 5.6]

Step 6: We calculated the probability matrix of the sum of the rows and the probability matrix of the sum of the columns and they are shown in Tables 7 and 8.

Table 7. The probability of the sum of rows.

	H1	H2	H3	H4	H5	H6	H7	H8
H1	0.5	0.56	0.47	0.54	0.39	0.42	0.75	0.47
H2	0.44	0.5	0.41	0.48	0.32	0.35	0.7	0.4
H3	0.53	0.59	0.5	0.57	0.43	0.45	0.78	0.5
H4	0.46	0.52	0.43	0.5	0.34	0.37	0.71	0.42
H5	0.61	0.68	0.57	0.66	0.5	0.52	0.9	0.57
H6	0.58	0.65	0.55	0.63	0.48	0.5	0.86	0.55
H7	0.25	0.3	0.22	0.29	0.1	0.14	0.5	0.21
H8	0.53	0.6	0.5	0.58	0.43	0.45	0.8	0.5

Table 8. The probability of the sum of columns.

	H1	H2	H3	H4	H5	H6	H7	H8
H1	0.5	0.53	0.53	0.48	0.56	0.44	0.37	0.53
H2	0.47	0.5	0.5	0.46	0.53	0.41	0.35	0.5
H3	0.47	0.5	0.5	0.45	0.53	0.41	0.35	0.51
H4	0.52	0.55	0.55	0.5	0.58	0.45	0.38	0.54
H5	0.44	0.47	0.47	0.42	0.5	0.38	0.32	0.48
H6	0.56	0.59	0.59	0.55	0.62	0.5	0.44	0.58
H7	0.63	0.65	0.65	0.62	0.68	0.56	0.5	0.64
H8	0.47	0.5	0.49	0.46	0.52	0.42	0.36	0.5

5.2. The Result of Decision-Making

Step 7: The degree of influential impact, the degree of influenced impact, central degree, and causal degree of the influencing factors of CDCEM are obtained, as are shown in Table 9.

Table 9. Influence degree, influenced degree, central degree, and causal degree.

	H1	H2	H3	H4	H5	H6	H7	H8
the degree of influential impact	4.10	3.61	4.35	3.74	5.02	4.80	2.00	4.38
The degree of influenced impact	3.93	3.72	3.72	4.05	3.49	4.43	4.94	3.72
central degree	8.03	7.33	8.07	7.79	8.51	9.23	6.94	8.10
cause degree	0.17	−0.11	0.63	−0.31	1.52	0.38	−2.94	0.66

As can be seen from Table 9, the sort of the central degree is $H6 > H5 > H8 > H3 > H1 > H4 > H2 > H7$ and the sort of the causal degree is $H5 > H8 > H3 > H6 > H1 > H2 > H4 > H7$. The evaluation results were split into two groups based on the causal degree. The scores of $H1$, $H3$, $H5$, $H6$, $H8$ were greater than 0, belonging to the cause factors, and the values of $H2$, $H4$, $H7$ were less than 0, thus belonging to the effect factors.

5.3. Discussion

Cross-department organization ($H1$) belongs to the cause factors, and its central degree ranks as the fifth. Therefore, $H1$ is classified as a CSF. Currently, the Nanjing Emergency Management Bureau has established corresponding emergency management mechanisms with organizations in Nanjing's public security, planning, and natural resources. The cooperation among the various departments is still not sufficiently evident. Therefore, it is urgent to establish a cross-departmental organization and clarify the responsibilities and authorities of cross-departments so as to effectively enhance the ability to deal with various emergencies.

Cross-department collaborative training ($H2$) belongs to the effect factors, and its central degree ranks as the seventh. By careful observation of the degree of influential impact and the degree of influenced impact, it also shows that it is a relatively weak factor. As a result, it is not classified as a CSF. Nanjing is located in a relatively developed

area in China, where the cultural quality of government personnel is relatively high. The majority of employees have a certain degree of knowledge of cross-departmental emergency management. Therefore, the current cross-departmental training in emergency management in Nanjing is not a priority.

Cross-department information communication and transmission ($H3$) belongs to the cause factors, and its central degree ranks as the third. $H3$ is classified as a CSF. Cross-departmental collaboration, which is the foundation for winning the trust of departments, depends heavily on communication and the transmission of information between departments. According to Pan and Fan [54], cross-departmental information sharing and communication are critical for enhancing CDCEM, and the interaction between cross-departments makes it easy to reach a consensus and generate synergies. The upper-level department needs to attach importance to cross-department information communication and transmission.

Cross-department emergency drill ($H4$) belongs to the effect factors, and its central degree ranks as the sixth. A careful observation of the degree of influential impact and the degree of influenced impact reveals that they are both ranked low. Evidently, experts do not consider $H4$ as a CSF. In Nanjing, several emergency management activities take place annually. All departments have taken part in emergency drills. Drilling more frequently will not improve interdepartmental collaboration skills.

Information sharing technology platform ($H5$) belongs to the cause factors, and its central degree ranks as the second. It shows that this factor has a significant effect on other factors and also has a relatively important role. It is believed that information-sharing technology platforms can enhance the efficiency of emergency coordination [1,46]. At present, an information-sharing technology platform has been established in Nanjing and has proven critical on different occasions. Therefore, it is classified as a CSF.

Cross-department material supply capability ($H6$) belongs to the cause factors, and its central degree ranks as the first. It indicates that this factor has the potential to influence other factors. Nanjing's economy is comparatively advanced in China, and different material reserves in Nanjing are quite abundant. However, each department has not reached a consensus on the utility of emergency resources. Therefore, the unified control of these resources will inevitably promote the efficiency of CDCEM. Hence, it is classified as a CSF.

The cross-departmental collaborative decision-making system ($H7$) belongs to the effect factors, and its central degree ranks as the last, as evidenced by the fact that the cross-departmental collaborative decision-making mechanism in Nanjing is unimportant. Furthermore, it indicates that this factor is significantly affected by other factors. This factor can be replaced by other factors such as cross-departmental organizational coordination, cross-departmental information exchange and transmission, etc. In other words, other factors may fully perform the functions of its cross-department collaborative decision-making system when an emergency occurs. Hence, it is not considered a CSF.

Cross-department prediction and early warning ($H8$) belongs to the cause factors, and its central degree ranks as the second. It indicates that this factor is of high importance. This factor heavily affects some factors, while it is less affected by other factors. It is believed that if the early warning capability is not further strengthened, the risk of emergencies cannot be avoided in the initial state. Cross-department prediction and early warning have a greater impact on the emergency management of the entire city and possibly the entire province. Therefore, it is classified as a CSF.

To sum up, the factors $H1, H3, H5, H6, H8$ are classified as CSFs and the factors $H2, H4, H7$ are not classified as CSFs. Therefore, the following work needs to be performed to improve the CDCEM in Nanjing: Various departments in Nanjing first need to establish a unified cross-department coordination organization. It needs to perform well in cross-department prediction and early warning. Furthermore, it should continue to make good use of the information-sharing technology platform, collect detailed information, fully utilize the cross-departmental information-sharing transmission mechanism, and

make full use of various emergency resources. These factors will inevitably improve the efficiency of CDCEM.

5.4. Comparative Analysis

Two DEMATEL-based methods are chosen to conduct a comparative analysis in this study. Table 10 presents the comparative results with different methods.

Table 10. Comparative results of the proposed methods against two other methods.

	Evaluation Method	Background	Results	Literature
1	IFS-IVIFS-DEMATEL	Two assessment scale	central degree: $H6 > H5 > H8 > H3 > H1 > H4 > H2 > H7$ causal degree:$H5 > H8 > H3 > H6 > H1 > H2 > H4 > H7$	Our studies
2	IVIFS-DEMATEL	IVIFS	central degree: $H6 > H5 > H1 > H8 > H4 > H3 > H1 > H7$ causal degree: $H5 > H8 > H4 > H6 > H1 > H2 > H3 > H7$	[24]
3	IFS-DEMATEL	IFS	central degree: $H6 > H5 > H3 > H8 > H1 > H4 > H2 > H7$ causal degree: $H3 > H5 > H8 > H6 > H2 > H4 > H1 > H7$	[36]

Firstly, the decision-making environment is different. Literature [24] introduced the DEMATEL method with single IVIFS to enhance judgments in a group decision-making environment. Literature [36] used the DEMATEL method with single assessment scales of IFs to handle the interrelations between factors of green supply chain management (GSCM) practices and performances. Those two studies used an extension of the DEMATEL method with single assessment scales of IFS or IVIFS. In our study, the DEMATEL method with two kinds of assessment scales is another fuzzy DEMATEL method, which is successfully applied in identifying the CSFs of CDCEM. From this perspective, our proposed method is more suitable for situations where there are different conductive decision-making environments among influencing factors.

Secondly, the two methods produce different results. The results of IVIFS-DEMATEL and IFS-DEMATEL show that $H6$ is the most important factor according to the central degree, which is the same as our method. In our method and the IVIFS-DEMATEL method, $H5$ is the most influential factor on other factors. However, in the IFS-DEMATEL method, $H3$ is the most influential factor on other factors according to the causal degree. After careful analysis, the CSFs $H1$, $H3$, $H5$, $H6$, $H8$ are using the IVIFS-DEMATEL method, while the CSFs $H3$, $H5$, $H6$, $H8$ are using the IFS-DEMATEL method. Despite the fact that the results of IFS-DEMATEL and IVIFS-DEMATEL have little difference from our proposed method, they reflect different features from existing studies. This is a favorable improvement on the DEMATEL method.

6. Conclusions

Cross-departmental collaboration has been proven to be an effective way of improving the efficiency of emergency management. There are two types of correlation among the factors of CDCEM: coupling correlation and one-way correlation. This study proposed the IFS-IFIVS-DEMATEL method to carry out the CSFs of CDCEM. In the process, we built a hybrid initial direct correlation matrix with two different assessment scales based on the correlation among the factors. This case study in Nanjing found that cross-department organization, cross-department information communication and transmission, information sharing technology platforms, cross-department material supply capability, cross-department prediction, and early warning are significant in CDCEM, while cross-department collaborative training, cross-department emergency drills, and cross-department collaborative decision-making systems are not important in CDCEM. The Nanjing government would attach importance to these CSFs to make up the gap in CDCEM.

This study enlightens the cross-department coordination of emergency management mechanisms in uncertain situations, which is conducive to promoting the efficiency of governmental management. Firstly, it improves traditional methods of using single assessment scales to identify the influencing factors of CDCEM. Secondly, it is characterized by a clear

concept, simplicity, and practicality, which offer a scientific and effective decision-making method for the government to enhance the efficiency of CDCEM. Therefore, this method can be widely adopted in more complex and uncertain environments, such as knowledge management, fault identification, and other fields.

However, this study only focuses on the results of critical influencing factors. Future research can also specify the relationship between CSFs through methods such as structural equation models or interpretive structural models.

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Institutional Review Board Statement: This study does not require ethical approval, and we have chosen to exclude this statement.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Expert (II) hybrid initial direct correlation matrix.

	H1	H2	H3	H4	H5	H6	H7	H8
H1	0	(0.2, 0.4)	(0.2, 0.5)	(0.4, 0.6)	(0.2, 0.4)	(0.4, 0.5)	(0.6, 0.3)	(0.2, 0.5)
H2	(0.1, 0.7)	0	(0.4, 0.3)	(0.4, 0.6)	0	(0.1, 0.4),(0.3, 0.5)	(0.4, 0.6)	(0.3, 0.4)
H3	(0.1, 0.6)	(0.4, 0.5)	0	(0.3, 0.6),(0.3, 0.4)	(0.3, 0.6)	(0.5, 0.3)	(0.2, 0.4),(0.3, 0.5)	(0.1, 0.3)
H4	(0.3, 0.6)	(0.6, 0.2)	0	0	0	(0.4, 0.3)	(0.2, 0.5),(0.3, 0.5)	(0.3, 0.2)
H5	(0.5, 0.3)	(0.2, 0.5),(0.3, 0.5)	(0.5, 0.2)	(0.3, 0.5),(0.3, 0.4)	0	(0.6, 0.3)	(0.7, 0.2)	0
H6	(0.7, 0.2)	0	(0.4, 0.4)	(0.8, 0.2)	(0.5, 0.3)	0	(0.3, 0.6),(0.3, 0.3)	(0.2, 0.4)
H7	(0.1, 0.3)	(0.3, 0.5)	0	0	(0.3, 0.5)	0	0	(0.3, 0.5)
H8	(0.3, 0.6)	(0.1, 0.7)	(0.6, 0.2)	(0.4, 0.5)	(0.3, 0.5),(0.4, 0.5)	(0.3, 0.5)	(0.3, 0.5)	0

Table A2. Expert (III) hybrid initial direct correlation matrix.

	H1	H2	H3	H4	H5	H6	H7	H8
H1	0	(0.1, 0.3)	(0.3, 0.5)	(0.4, 0.5)	(0.4, 0.6)	(0.4, 0.5)	(0.4, 0.3)	(0.3, 0.5)
H2	(0.1, 0.7)	0	(0.5, 0.3)	(0.4, 0.6)	0	(0.2, 0.4),(0.3, 0.6)	(0.4, 0.5)	(0.3, 0.4)
H3	(0.1, 0.6)	(0.4, 0.5)	0	(0.5, 0.6),(0.3, 0.4)	(0.3, 0.5)	(0.5, 0.1)	(0.2, 0.3),(0.3, 0.5)	(0.1, 0.3)
H4	(0.3, 0.6)	(0.6, 0.2)	0	0	0	(0.6, 0.1)	(0.2, 0.5),(0.2, 0.3)	(0.1, 0.2)
H5	(0.6, 0.4)	(0.2, 0.3),(0.3, 0.5)	(0.8, 0.2)	(0.4, 0.6),(0.3, 0.4)	0	(0.8, 0.1)	(0.7, 0.2)	0
H6	(0.6, 0.2)	0	(0.4, 0.4)	(0.8, 0.2)	(0.6, 0.1)	0	(0.5, 0.6),(0.3, 0.3)	(0.3, 0.4)
H7	(0.4, 0.6)	(0.4, 0.5)	0	0	(0.3, 0.5)	0	0	(0.3, 0.5)
H8	(0.3, 0.6)	(0.1, 0.7)	(0.5, 0.2)	(0.4, 0.5)	(0.3, 0.5),(0.4, 0.5)	(0.4, 0.5)	(0.3, 0.4)	0

Table A3. Expert [II] hybrid initial direct correlation matrix.

	H1	H2	H3	H4	H5	H6	H7	H8
H1	[0, 0]	[0.2, 0.6]	[0.2, 0.5]	[0.4, 0.4]	[0.2, 0.6]	[0.4, 0.5]	[0.6, 0.7]	[0.2, 0.5]
H2	[0.1, 0.3]	[0, 0]	[0.4, 0.7]	[0.4, 0.4]	[0, 0]	[0.4, 0.8]	[0.4, 0.4]	[0.3, 0.6]
H3	[0.1, 0.4]	[0.4, 0.5]	[0, 0]	[0.5, 0.7]	[0.3, 0.4]	[0.5, 0.7]	[0.5, 0.7]	[0.1, 0.7]
H4	[0.3, 0.4]	[0.6, 0.8]	[0, 0]	[0, 0]	[0, 0]	[0.4, 0.7]	[0.5, 0.7]	[0.3, 0.8]
H5	[0.6, 0.7]	[0.5, 0.7]	[0.5, 0.8]	[0.5, 0.6]	[0, 0]	[0.6, 0.7]	[0.7, 0.8]	[0, 0]
H6	[0.7, 0.8]	[0, 0]	[0.4, 0.6]	[0.8, 0.8]	[0.5, 0.7]	[0, 0]	[0.5, 0.6]	[0.2, 0.6]
H7	[0.4, 0.7]	[0.3, 0.5]	[0, 0]	[0, 0]	[0.3, 0.5]	[0, 0]	[0, 0]	[0.3, 0.5]
H8	[0.4, 0.4]	[0.1, 0.5]	[0.6, 0.8]	[0.4, 0.5]	[0.5, 0.8]	[0.3, 0.5]	[0.3, 0.5]	[0, 0]

Table A4. Expert [III] hybrid initial direct correlation matrix.

	H1	H2	H3	H4	H5	H6	H7	H8
H1	[0, 0]	[0.1, 0.7]	[0.3, 0.5]	[0.4, 0.5]	[0.4, 0.4]	[0.4, 0.5]	[0.4, 0.7]	[0.3, 0.5]
H2	[0.1, 0.3]	[0, 0]	[0.5, 0.7]	[0.4, 0.4]	[0, 0]	[0.4, 0.7]	[0.4, 0.5]	[0.3, 0.6]
H3	[0.1, 0.4]	[0.4, 0.5]	[0, 0]	[0.6, 0.6]	[0.3, 0.5]	[0.5, 0.9]	[0.5, 0.7]	[0.1, 0.7]
H4	[0.3, 0.4]	[0.6, 0.8]	[0, 0]	[0, 0]	[0, 0]	[0.6, 0.9]	[0.5, 0.6]	[0.1, 0.8]
H5	[0.6, 0.6]	[0.4, 0.7]	[0.8, 0.8]	[0.6, 0.6]	[0, 0]	[0.8, 0.9]	[0.7, 0.8]	[0, 0]
H6	[0.6, 0.8]	[0, 0]	[0.4, 0.6]	[0.8, 0.8]	[0.6, 0.9]	[0, 0]	[0.6, 0.6]	[0.3, 0.6]
H7	[0.4, 0.4]	[0.4, 0.5]	[0, 0]	[0, 0]	[0.3, 0.5]	[0, 0]	[0, 0]	[0.3, 0.5]
H8	[0.3, 0.4]	[0.1, 0.3]	[0.5, 0.8]	[0.4, 0.5]	[0.5, 0.8]	[0.4, 0.5]	[0.3, 0.6]	[0, 0]

References

1. Ding, X.-F.; Liu, H.-C. A 2-dimension uncertain linguistic DEMATEL method for identifying critical success factors in emergency management. *Appl. Soft Comput.* **2018**, *71*, 386–395. [CrossRef]
2. Kundu, T.; Sheu, J.-B.; Kuo, H.-T. Emergency logistics management—Review and propositions for future research. *Transp. Res. Part E Logist. Transp. Rev.* **2022**, *164*, 102789. [CrossRef]
3. Wu, Q.; Han, J.; Lei, C.; Ding, W.; Li, B.; Zhang, L. The challenges and countermeasures in emergency management after the establishment of the ministry of emergency management of china: A case study. *Int. J. Disaster Risk Reduct.* **2021**, *55*, 102075. [CrossRef]
4. Jensen, J.; Kirkpatrick, S. Local emergency management and comprehensive emergency management (CEM): A discussion prompted by interviews with Chief Resilience Officers. *Int. J. Disaster Risk Reduct.* **2022**, *79*, 103136. [CrossRef]
5. Li, B.; Qian, J.; Xu, J.; Li, Y. Collaborative governance in emergencies: Community food supply in COVID-19 in Wuhan, China. *Urban Gov.* **2022**, *2*, 188–196. [CrossRef]
6. Provan, K.G.; Lemaire, R.H. Core Concepts and Key Ideas for Understanding Public Sector Organizational Networks: Using Research to Inform Scholarship and Practice. *Public Adm. Rev.* **2012**, *72*, 638–648. [CrossRef]
7. Tang, P.; Shen, G.Q. Decision-making model to generate novel emergency response plans for improving coordination during large-scale emergencies. *Knowl.-Based Syst.* **2015**, *90*, 111–128. [CrossRef]
8. Zhang, H.; Zhou, W.; Sun, Y. Joint allocation of emergency medical resources with time-lag correlation during cross-regional epidemic outbreaks. *Comput. Ind. Eng.* **2022**, *164*, 107895. [CrossRef]
9. Kapucu, N.; Arslan, T.; Demiroz, F. Collaborative emergency management and national emergency management network. *Disaster Prev. Manag. Int. J.* **2010**, *19*, 452–468. [CrossRef]

10. Eom, S.-J.; Hwang, H.; Kim, J.H. Can social media increase government responsiveness? A case study of Seoul, Korea. *Gov. Inf. Q.* **2018**, *35*, 109–122. [CrossRef]
11. Chang, F.; Zhou, G.; Zhang, C.; Ding, K.; Cheng, W.; Chang, F. A maintenance decision-making oriented collaborative cross-organization knowledge sharing blockchain network for complex multi-component systems. *J. Clean. Prod.* **2021**, *282*, 124541. [CrossRef]
12. Wu, X.; Mao, J.; Xie, H.; Li, G. Identifying humanitarian information for emergency response by modeling the correlation and independence between text and images. *Inf. Process. Manag.* **2022**, *59*, 102977. [CrossRef]
13. Tundis, A.; Melnik, M.; Naveed, H.; Mühlhäuser, M. A social media-based over layer on the edge for handling emergency-related events. *Comput. Electr. Eng.* **2021**, *96*, 107570. [CrossRef]
14. Andreassen, N.; Borch, O.J.; Sydnes, A.K. Information sharing and emergency response coordination. *Saf. Sci.* **2020**, *130*, 104895. [CrossRef]
15. Fan, B.; Liu, R.; Huang, K.; Zhu, Y. Embeddedness in cross-agency collaboration and emergency management capability: Evidence from Shanghai's urban contingency plans. *Gov. Inf. Q.* **2019**, *36*, 101395. [CrossRef]
16. Yao, Y.; Shi, W.; Zhang, A.; Liu, Z.; Luo, S. Examining the diffusion of coronavirus disease 2019 cases in a metropolis: A space syntax approach. *Int. J. Health Geogr.* **2021**, *20*, 17. [CrossRef]
17. Zhang, A.; Shi, W.; Tong, C.; Zhu, X.; Liu, Y.; Liu, Z.; Yao, Y.; Shi, Z. The fine-scale associations between socioeconomic status, density, functionality, and spread of COVID-19 within a high-density city. *BMC Infect. Dis.* **2022**, *22*, 274. [CrossRef]
18. Luthra, S.; Sharma, M.; Kumar, A.; Joshi, S.; Collins, E.; Mangla, S. Overcoming barriers to cross-sector collaboration in circular supply chain management: A multi-method approach. *Transp. Res. Part E Logist. Transp. Rev.* **2022**, *157*, 102582. [CrossRef]
19. He, Y.; Liu, N. Methodology of emergency medical logistics for public health emergencies. *Transp. Res. E Logist. Transp. Rev.* **2015**, *79*, 178–200. [CrossRef]
20. Zhou, X.; Shi, Y.; Deng, X.; Deng, Y. D-DEMATEL: A new method to identify critical success factors in emergency management. *Saf. Sci.* **2017**, *91*, 93–104. [CrossRef]
21. Liu, Y.; Wang, Y.; Xu, M.; Xu, G. Emergency Alternative Evaluation Using Extended Trapezoidal Intuitionistic Fuzzy Thermodynamic Approach with Prospect Theory. *Int. J. Fuzzy Syst.* **2019**, *21*, 1801–1817. [CrossRef]
22. Hu, X.; Naim, K.; Jia, S.; Zhengwei, Z. Disaster policy and emergency management reforms in China: From Wenchuan earthquake to Jiuzhaigou earthquake. *Int. J. Disaster Risk Reduct.* **2021**, *52*, 101964. [CrossRef]
23. Han, J.; Wu, Q.; Zhang, L.; Lei, C. How can the urban emergency capability gap be measured? Construction of a standardized indicator system in China. *Int. J. Disaster Risk Reduct.* **2022**, *80*, 103236. [CrossRef]
24. Baykasoğlu, A.; Kaplanoğlu, V.; Durmuşoğlu, Z.D.U.; Şahin, C. Integrating fuzzy DEMATEL and fuzzy hierarchical TOPSIS methods for truck selection. *Expert Syst. Appl.* **2013**, *40*, 899–907. [CrossRef]
25. Cui, L.; Chan, H.K.; Zhou, Y.; Dai, J.; Lim, J.J. Exploring critical factors of green business failure based on Grey-Decision Making Trial and Evaluation Laboratory (DEMATEL). *J. Bus. Res.* **2019**, *98*, 450–461. [CrossRef]
26. Song, P.; Zhao, J.; Mubarak, S.M.A.; Taresh, S.M. Critical success factors for epidemic emergency management in colleges and universities during COVID-19: A study based on DEMATEL method. *Saf. Sci.* **2022**, *145*, 105498. [CrossRef]
27. Ananthi, V.P.; Balasubramaniam, P. A new image denoising method using interval-valued intuitionistic fuzzy sets for the removal of impulse noise. *Signal Process.* **2016**, *121*, 81–93. [CrossRef]
28. Pan, L.; Deng, Y. A novel similarity measure in intuitionistic fuzzy sets and its applications. *Eng. Appl. Artif. Intell.* **2022**, *107*, 104512. [CrossRef]
29. Fontela, E.; Gabus, A. DEMATEL: Progress achieved. *Futures* **1974**, *6*, 361–363. [CrossRef]
30. Kashyap, A.; Kumar, C.; Kumar, V.; Shukla, O.J. A DEMATEL model for identifying the impediments to the implementation of circularity in the aluminum industry. *Decis. Anal. J.* **2022**, *5*, 100134. [CrossRef]
31. Abdullah, L.; Zulkifli, N.; Liao, H.; Herrera-Viedma, E.; Al-Barakati, A. An interval-valued intuitionistic fuzzy DEMATEL method combined with Choquet integral for sustainable solid waste management. *Eng. Appl. Artif. Intell.* **2019**, *82*, 207–215. [CrossRef]
32. Zadeh, L.A. Fuzzy sets. *Inf. Control* **1965**, *8*, 338–353. [CrossRef]
33. Yang, J.L.; Tzeng, G.-H. An integrated MCDM technique combined with DEMATEL for a novel cluster-weighted with ANP method. *Expert Syst. Appl.* **2011**, *38*, 1417–1424. [CrossRef]
34. Quiñones, R.S.; Caladcad, J.A.A.; Himang, C.M.; Quiñones, H.G.; Castro, C.J.; Caballes, S.A.A.; Abellana, D.P.M.; Jabilles, E.M.Y.; Ocampo, L.A. Using Delphi and fuzzy DEMATEL for analyzing the intertwined relationships of the barriers of university technology transfer: Evidence from a developing economy. *Int. J. Innov. Stud.* **2020**, *4*, 85–104. [CrossRef]
35. Liao, H.; Xu, Z.; Zeng, X.-J.; Merigó, J.M. Qualitative decision making with correlation coefficients of hesitant fuzzy linguistic term sets. *Knowl.-Based Syst.* **2015**, *76*, 127–138. [CrossRef]
36. Atanassov, K.T. Intuitionistic fuzzy sets. *Fuzzy Sets Syst.* **1986**, *20*, 87–96. [CrossRef]
37. Atanassov, K.T. Interval-valued intuitionistic fuzzy sets. *Fuzzy Sets Syst.* **1989**, *31*, 343–349. [CrossRef]
38. Govindan, K.; Khodaverdi, R.; Vafadarnikjoo, A. Intuitionistic fuzzy based DEMATEL method for developing green practices and performances in a green supply chain. *Expert Syst. Appl.* **2015**, *42*, 7207–7220. [CrossRef]
39. Giri, B.C.; Molla, M.U.; Biswas, P. Pythagorean fuzzy DEMATEL method for supplier selection in sustainable supply chain management. *Expert Syst. Appl.* **2022**, *193*, 116396. [CrossRef]

40. Liu, X.; Zheng, L. Cross-departmental collaboration in one-stop service center for smart governance in China: Factors, strategies and effectiveness. *Gov. Inf. Q.* **2018**, *35*, S54–S60. [CrossRef]
41. Peng, X.; Lee, S.; Lu, Z. Employees' perceived job performance, organizational identification, and pro-environmental behaviors in the hotel industry. *Int. J. Hosp. Manag.* **2020**, *90*, 102632. [CrossRef]
42. Ayenew, T.; Tassew, S.F.; Workneh, B.S. Level of emergency and disaster preparedness of public hospitals in Northwest Ethiopia: A cross-sectional study. *Afr. J. Emerg. Med.* **2022**, *12*, 246–251. [CrossRef] [PubMed]
43. Goktas, S.; Gezginci, E.; Kartal, H. The Effects of Motivational Messages Sent to Emergency Nurses During the COVID-19 Pandemic on Job Satisfaction, Compassion Fatigue, and Communication Skills: A Randomized Controlled Trial. *J. Emerg. Nurs.* **2022**, *48*, 547–558. [CrossRef] [PubMed]
44. Nomoto, H.; Ishikane, M.; Lee, S.; Komiya, N.; Maeki, T.; Matsui, T.; Morita, K.; Oshitani, H.; Saijo, M.; Yamagishi, T.; et al. Facilitating the deployment of Japanese human resources for responding global outbreaks of emerging and Re-emerging infectious diseases: A cross-sectional study. *J. Infect. Chemother.* **2022**, *28*, 41–46. [CrossRef] [PubMed]
45. Xu, S.; Yang, Q.; Xie, M.; Wang, J.; Shan, A.; Shi, F. Work experience of triage nurses in emergency departments during the prevalence of COVID-19. *Int. Emerg. Nurs.* **2021**, *56*, 101003. [CrossRef]
46. Colombo, P.; Ferrari, E.; Tumer, E.D. Efficient ABAC based information sharing within MQTT environments under emergencies. *Comput. Secur.* **2022**, *120*, 102829. [CrossRef]
47. Carrington, M.A.; Ranse, J.; Hammad, K. The impact of disasters on emergency department resources: Review against the Sendai framework for disaster risk reduction 2015–2030. *Australas. Emerg. Care* **2021**, *24*, 55–60. [CrossRef]
48. Elbanna, A.; Bunker, D.; Levine, L.; Sleigh, A. Emergency management in the changing world of social media: Framing the research agenda with the stakeholders through engaged scholarship. *Int. J. Inf. Manag.* **2019**, *47*, 112–120. [CrossRef]
49. Gangwal, U.; Dong, S. Critical facility accessibility rapid failure early-warning detection and redundancy mapping in urban flooding. *Reliab. Eng. Syst. Saf.* **2022**, *224*, 108555. [CrossRef]
50. Ji, W.; Li, G.-Q.; Zhu, S. Real-time prediction of key monitoring physical parameters for early warning of fire-induced building collapse. *Comput. Struct.* **2022**, *272*, 106875. [CrossRef]
51. Lin, L.; Yuan, X.-H.; Xia, Z.-Q. Multicriteria fuzzy decision-making methods based on intuitionistic fuzzy sets. *J. Comput. Syst. Sci.* **2007**, *73*, 84–88. [CrossRef]
52. Shao, L.; Zhao, L.; Wen, T.; Kong, X. Bidirectional projection method with interval-valued intuitionistic fuzzy information based on prospect theory. *Control Decis.* **2016**, *31*, 1143–1147.
53. Xu, Z. *Uncertain Multi-Attribute Decision-Making Method and Its Application*; Tsinghua University Press: Beijing, China, 2004.
54. Pan, X.; Fan, B. Research on Cross-agency Collaboration in the Process of Emergency Management—Employing Collaborative Supervision on Food and Medicine as Background. *Soft Sci.* **2014**, *28*, 52–55.

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