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Research Article

GRA and CRITIC Method for Intuitionistic Fuzzy Multiattribute Group Decision Making and Application to Development Potentiality Evaluation of Cultural and Creative Garden

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In recent years, cultural and creative industry park is becoming a kind of hot industry to promote industrial restructuring and to improve the quality of urban space. For this reason, cultural and creative industrial parks are planning to build across the country. Currently, cultural and creative industrial parks that develop better than others thank to the government's overall planning, construction, marketing, and management. At the same time, the new cultural and creative industry parks face enormous challenges, such as how to have together the cultural and creative industries and related groups or how to have area cultural creativity. And it is frequently regarded as a multiattribute group decision-making (MAGDM) process. Thus, a novel MAGDM process is needed to tackle it. Depending on the conventional grey relational analysis (GRA) method and intuitionistic fuzzy sets (IFSs), this paper designs a novel intuitive distance-based IF-GRA method for development potentiality evaluation of cultural and creative garden. First of all, some necessary theories related to IFSs are briefly reviewed. In addition, since subjective randomness frequently exists in determining criteria weights, the weights of criteria are decided objectively by utilizing the CRITIC method. Afterwards, relying on novel distance measures between IFSs, the GRA method is extended to the IFSs to calculate assessment score of each alternative. Eventually, an application about development potentiality evaluation of cultural and creative garden and some comparative analysis is given. The results think that the designed method is useful for development potentiality evaluation of cultural and creative garden.

1. Introduction

In reality, decision-making information is often given uncertainly due to the complexity of the objective world [1–6], as well as the uncertainty of the ambiguity of human thinking [7–12], which makes the uncertainty in decision-making theory, methodology, and application of the decision-making a focus for researchers [13–17]. In order to depict uncertain information, Zadeh [18] firstly defined the basic decision theory of fuzzy sets (FSs). Atanassov [19] presented the novel definition of IFSs. Gou et al. [20] defined some exponential operational law for IFNs. Gupta et al. [21] defined the fuzzy entropy under IFSs. Li and Wu [22] presented the intuitionistic fuzzy cross entropy distance. Khan et al. [23] defined similarity measure about IFNs. Li et al. [24] gave a novel grey MADM with IFNs. Liu et al. [25] built some BM fused operators under IFSs with Dombi operations. Su et al. [26] built the induced generalized OWA operator under IFSs. Garg [27] presented a method related to MAGDM on the basis of IFS preference. Chen et al. [28] developed TOPSIS method and similarity measures under IFSs. Gan and Luo [29] used the hybrid method with DEMATEL and IFSs. Krishankumar et al. [30] integrated AHP under IFSs to design a GDM model. Gupta et al. [31] modified the SIR method under IFSs. Bao et al. [32] defined prospect theory and evidential reasoning algorithms under the IFSs. Hao et al. [33] presented a theory of decision field for IFSs. Jin et al. [34] defined two GDM methods with

IFPRs, defined the MABAC model to IFSs through distance measures, and defined the VIKOR method under IFSs. Cali and Balaman [35] proposed ELECTRE I with the VIKOR method under IFSs to reflect the decision makers' preferences. Rouyendegh [36] used the ELECTRE method in IFSs to deal with some MADM process. Liang [37] defined EDAS process for MAGDM under IFSs. Xiao et al. [38] defined the intuitionistic fuzzy taxonomy approach. Ju et al. [39] built the divergence-based distance measure for IFSs. Jiang et al. [40] proposed the adjustable approach for IF-MADM. Zeshui Xu [41] developed an interactive decision method for IF-MADM. Krohling et al. [42] defined the IF-TODIM for MADM. Wang et al. [43] proposed the IF-MADM based on the based on evidential reasoning. He et al. [44] defined the generalized geometric interaction operators under IFSs. Zhao et al. [45] extended the CPT-TODIM method for interval-valued intuitionistic fuzzy MAGDM.

GRA was initially developed by Deng [46] to solve MAGDM issues. Compared with other MAGDM, the GRA method can consider the shape similarity of every alternative from PIS and NIS. Chen [47] connected the IF-GRA method with entropy-TOPSIS process for choosing building materials supplier. Tan et al. [48] defined the GRA process with AHP. Alptekin et al. [49] solved the MADM process with the GRA method. Yazdani et al. [50] provided the QFD method and GRA method in dealing with supply chain drivers. Malek et al. [51] built the hybrid GRA method for green supply. Zhu et al. [52] aimed at choosing the carbon market with GRA algorithms and EMD. Chiang [53] used the GRA model through dependent criteria MADM process. Kung and Wen [54] used GRA to solve the grey-MADM issues. Wan et al. [55] defined the intuitionistic fuzzy programming method for group decision making with interval-valued fuzzy preference relations. Wan et al. [56] defined the intuitionistic fuzzy programming method for group decision making with interval-valued Atanassov intuitionistic fuzzy preference relations. Wan et al. [57] proposed the three-phase method for group decision making with interval-valued intuitionistic fuzzy preference relations. Xui et al. [58] studied the MADM with triangular intuitionistic fuzzy numbers based on the zero-sum game model.

The innovativeness of such paper can be summarized as follows: (1) the CRITIC method is built is to derive the weight information of the attribute under IFSs; (2) this paper employs a novel combined distance measures; (3) this paper designs a novel intuitive distance-based IF-GRA method for MAGDM based on the CRITIC method; (4) a case study for development potentiality evaluation of cultural and creative garden is given to show the developed approach; and (4) some comparative studies are provided with the existing methods.

In order to do so, the remainder of this paper is arranged in the following way. Some concept of IFSs is introduced in Section 2. The improved GRA process is defined under IFNs, and the calculating steps are listed in Section 3. An empirical application about development potentiality evaluation of cultural and creative garden is given to depict the superiority of such designed method, and some comparative analysis is given to prove the merits of such method in Section 4. At last, we make the useful conclusion of such work in Section 5.

2. Preliminaries

2.1. IFSs

Definition 1 (see [19]). An IFS on X is defined as follows:

$$I = \{\langle x, \mu_I(x), \nu_I(x)\rangle | x \in X\}, \tag{1}$$

where $\mu_I(x) \in [0,1]$ is named as the membership of $I$and $\nu_I(x) \in [0,1]$ is named as the nonmembership of I, and $\mu_I(x)$ and $\nu_I(x)$ meet such condition: $0 \le \mu_I(x) + \nu_I(x) \le 1$, $\forall x \in X$.

Definition 2 (see [59]). Let $I_1 = (\mu_1, \nu_1)$ and $I_2 = (\mu_2, \nu_2)$ be two IFNs, and the operation formula is as follows:

$$I_1 \oplus I_2 = (\mu_1 + \mu_2 - \mu_1\mu_2, \nu_1\nu_2), \tag{2}$$

$$I_1 \otimes I_2 = (\mu_1\mu_2, \nu_1 + \nu_2 - \nu_1\nu_2), \tag{3}$$

$$\lambda I_1 = \left(1 - (1-\mu_1)^\lambda, \nu_1^\lambda\right), \quad \lambda > 0, \tag{4}$$

$$I_1^\lambda = \left(\mu_1^\lambda, 1 - (1-\nu_1)^\lambda\right), \quad \lambda > 0. \tag{5}$$

Definition 3 (see [60]). Let $I_1 = (\mu_1, \nu_1)$ and $I_2 = (\mu_2, \nu_2)$ be IFNs, and the score and accuracy functions of I_1 and I_2 are as follows:

$$\begin{aligned} S(I_1) &= \mu_1 + \mu_1(1 - \mu_1 - \nu_1),\\ S(I_2) &= \mu_2 + \mu_2(1 - \mu_2 - \nu_2), \end{aligned} \tag{6}$$

$$\begin{aligned} H(I_1) &= \mu_1 + \nu_1,\\ H(I_2) &= \mu_2 + \nu_2, \end{aligned} \tag{7}$$

For two IFNs I_1 and I_2, regarding Definition 3,

(1) If $s(I_1) < s(I_2)$, then $I_1 < I_2$

(2) If $s(I_1) = s(I_2), h(I_1) < h(I_2)$, then $I_1 < I_2$

(3) If $s(I_1) = s(I_2), h(I_1) = h(I_2)$, then $I_1 = I_2$

Definition 4 (see [61]). Let $I_1 = (\mu_1, \nu_1)$ and $I_2 = (\mu_2, \nu_2)$ be IFNs, and the novel Euclidean distances between two IFNs can be defined as follows:

$$\text{IFED}(I_1, I_2) = \sqrt{\frac{1}{6}\left(\left(\ell_1\right)^2 + \left(\ell_2\right)^2 + \left(\ell_3\right)^2\right)}, \tag{8}$$

where $\ell_1 = |\mu_1 - \mu_2| + |\nu_1 - \nu_2| + |(\mu_1 + 1 - \nu_1) - (\mu_2 + 1 - \nu_2)|/2$, $\ell_2 = \pi_1 + \pi_2/2$, and $\ell_3 = \max(|\mu_1 - \mu_2|, |\nu_1 - \nu_2|, |\pi_1 - \pi_2|/2)$

2.2. Intuitionistic Fuzzy Aggregation Operators. Under the IFSs, some fused operators will be introduced, including IFWA fused operator and IFWG fused operator.

Definition 5 (see [59]). Let $I_j = (\mu_{I_j}, \nu_{I_j})\,(j = 1, 2, \ldots, n)$ be a group of IFNs, and the IFWA operator is as follows:

$$\mathrm{IFWA}_\omega(I_1, I_2, \ldots, I_n) = \overset{n}{\underset{j=1}{\oplus}} (\omega_j I_j), \quad (9)$$

where $\omega = (\omega_1, \omega_2, \ldots, \omega_n)^T$ be the weight of $I_j\,(j = 1, 2, \ldots, n)$, $\omega_j > 0, \sum_{j=1}^{n} \omega_j = 1$.

From Definition 5, the result could be derived.

Theorem 1. *The fused value by IFWA is an IFN, where*

$$\mathrm{IFWA}_\omega(I_1, I_2, \ldots, I_n) = \overset{n}{\underset{j=1}{\oplus}} (\omega_j I_j) = \left(1 - \prod_{j=1}^{n}\left(1 - \mu_{I_j}\right)^{\omega_j}, \prod_{j=1}^{n}\left(\nu_{I_j}\right)^{\omega_j}\right), \quad (10)$$

where $\omega = (\omega_1, \omega_2, \ldots, \omega_n)^T$ be the weight of $I_j\,(j = 1, 2, \ldots, n)$, $\omega_j > 0, \sum_{j=1}^{n} \omega_j = 1$.

Definition 6 (see [59]). Let $I_j\,(j = 1, 2, \ldots, n)$ be a set of IFNs, and the IFWG operator is as follows:

$$\mathrm{IFWG}_\omega(I_1, I_2, \ldots, I_n) = \overset{n}{\underset{j=1}{\otimes}} (I_j)^{\omega_j}, \quad (11)$$

where $\omega = (\omega_1, \omega_2, \ldots, \omega_n)^T$ be the weight of $I_j\,(j = 1, 2, \ldots, n)$, $\omega_j > 0, \sum_{j=1}^{n} \omega_j = 1$.

From Definition 6, the result could be derived.

Theorem 2. *The fused value by IFWG is an IFN.*

$$\mathrm{IFWG}_\omega(I_1, I_2, \ldots, I_n) = \overset{n}{\underset{j=1}{\otimes}} (I_j)^{\omega_j} = \left(\prod_{j=1}^{n}\left(\mu_{I_j}\right)^{\omega_j}, 1 - \prod_{j=1}^{n}\left(1 - \nu_{I_j}\right)^{\omega_j}\right), \quad (12)$$

where $\omega = (\omega_1, \omega_2, \ldots, \omega_n)^T$ be the weight of $I_j\,(j = 1, 2, \ldots, n)$, $\omega_j > 0, \sum_{j=1}^{n} \omega_j = 1$.

3. GRA Method for MAGDM with IFNs

In such section, we build the IF-GRA process for MAGDM. The calculating steps of the defined process could be depicted subsequently. Let $R = \{R_1, R_2, \ldots, R_n\}$ be the group of attributes and $r = \{r_1, r_2, \ldots, r_n\}$ be the weight of R_j, where $r_j \in [0, 1]$, $j = 1, 2, \ldots, n, \sum_{j=1}^{n} r_j = 1$. Assume $H = \{H_1, H_2, \ldots, H_l\}$ be a set of DMs that have degree of $h = \{h_1, h_2, \ldots, h_l\}$, where $h_k \in [0, 1]$, $k = 1, 2, \ldots, l$ $\sum_{k=1}^{l} h_k = 1$. Let $F = \{F_1, F_2, \ldots, F_m\}$ be a set of alternatives. And $Q = (q_{ij})_{m\times n}$ is the matrix with IFNs, where q_{ij} means the F_i for R_j. Subsequently, the specific calculating steps will be depicted.

Step 1. Get each DM's matrix $Q^{(k)} = (q_{ij}^k)_{m\times n}$ with IFNs and derive the overall IF-matrix $Q = (q_{ij})_{m\times n}$.

$$Q^{(k)} = \left[q_{ij}^k\right]_{m\times n} = \begin{bmatrix} q_{11}^k & q_{12}^k & \cdots & q_{1n}^k \\ q_{21}^k & q_{22}^k & \cdots & q_{2n}^k \\ \vdots & \vdots & \vdots & \vdots \\ q_{m1}^k & q_{m2}^k & \cdots & q_{mn}^k \end{bmatrix}, \quad (13)$$

$$Q = \left[q_{ij}\right]_{m\times n} = \begin{bmatrix} q_{11} & q_{12} & \cdots & q_{1n} \\ q_{21} & q_{22} & \cdots & q_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ q_{m1} & q_{m2} & \cdots & q_{mn} \end{bmatrix}, \quad (14)$$

$$q_{ij} = \left(1 - \prod_{k=1}^{l}\left(1 - \mu_{q_{ij}^k}\right)^{h_k}, \prod_{k=1}^{l}\left(\nu_{q_{ij}^k}\right)^{h_k}\right), \quad (15)$$

where q_{ij}^k is the value of $F_i\,(i = 1, 2, \ldots, m)$ $R_j\,(j = 1, 2, \ldots, n)$ and the $H_k\,(k = 1, 2, \ldots, l)$.

Step 2. Normalize the matrix $Q = (q_{ij})_{m\times n}$ with IFNs to $Q^N = [q_{ij}^N]_{m\times n}$.

$$q_{ij}^N = \begin{cases} \left(\mu_{ij}, \nu_{ij}\right), & R_j \text{ is a benefit, criterion,} \\ \left(\nu_{ij}, \mu_{ij}\right), & R_j \text{ is a cost criterion.} \end{cases} \quad (16)$$

Step 3. Employ CRITIC process to derive the weight of attributes.

The CRITIC method is proposed to decide attributes' weights. This method was initially defined by Diakoulaki et al. [62]. Then, the calculating steps of such method are presented.

(1) Depending on the normalized overall matrix $Q^N = (q_{ij}^N)_{m\times n}$ with IFNs, the correlation coefficient between attributes can be defined.

$$\mathrm{IFCC}_{jt} = \frac{\sum_{i=1}^m \left(S\left(q_{ij}^N\right) - S\left(q_j^N\right)\right)\left(S\left(q_{it}^N\right) - S\left(q_t^N\right)\right)}{\sqrt{\sum_{i=1}^m \left(S\left(q_{ij}^N\right) - S\left(q_j^N\right)\right)^2}\sqrt{\sum_{i=1}^m \left(S\left(q_{it}^N\right) - S\left(q_t^N\right)\right)^2}}, \quad j, t = 1, 2, \ldots, n, \quad (17)$$

where $S(q_j^N) = 1/m \sum_{i=1}^m S(q_{ij}^N)$ and $S(q_t^N) = 1/m \sum_{i=1}^m S(q_{it}^N)$.

(2) Attributes' standard deviation is obtained.

$$\mathrm{IFSD}_j = \sqrt{\frac{1}{m-1} \sum_{i=1}^m \left(S\left(q_{ij}^N\right) - S\left(q_j^N\right)\right)^2}, \quad j = 1, 2, \ldots, n. \quad (18)$$

where $S(q_j^N) = 1/m \sum_{i=1}^m S(q_{ij}^N)$.

(3) The attributes' weights are defined.

$$r_j = \frac{\mathrm{IFSD}_j \sum_{t=1}^n \left(1 - \mathrm{IFCC}_{jt}\right)}{\sum_{j=1}^n \left(\mathrm{IFSD}_j \sum_{t=1}^n \left(1 - \mathrm{IFCC}_{jt}\right)\right)}, \quad j = 1, 2 \ldots, n. \quad (19)$$

where $r_j \in [0, 1]$ and $\sum_{j=1}^n r_j = 1$.

Step 4. Define the intuitionistic fuzzy PIS (IFPIS) A_j^+ and the intuitionistic fuzzy NIS (IFNIS) A_j^- as follows:

$$A_j^+ = \max_i \left(q_{ij}^N\right) = \left(\max_i \left(\mu_{ij}^N\right), \min_i \left(\nu_{ij}^N\right)\right), \quad (20)$$

$$A_j^- = \min_i \left(q_{ij}^N\right) = \left(\min_i \left(\mu_{ij}^N\right), \max_i \left(\nu_{ij}^N\right)\right). \quad (21)$$

where q_{ij}^N denotes the normalized IFNs.

Step 5. Compute the grey relational coefficient (GRC) of every alternative between each alternative and IFPIS and the GRC between each alternative and IFPIS as follows:

$$\mathrm{IFPIS}\left(\xi_{ij}\right) = \frac{\min\limits_{1\le i\le m} \min\limits_{1\le j\le n} \mathrm{IFED}\left(q_{ij}^N, A_j^+\right) + \rho \max\limits_{1\le i\le m} \max\limits_{1\le j\le n} \mathrm{IFED}\left(q_{ij}^N, A_j^+\right)}{\mathrm{IFED}\left(q_{ij}^N, A_j^+\right) + \rho \max\limits_{1\le i\le m} \max\limits_{1\le j\le n} \mathrm{IFED}\left(q_{ij}^N, A_j^+\right)},$$

$$\mathrm{IFNIS}\left(\xi_{ij}\right) = \frac{\min\limits_{1\le i\le m} \min\limits_{1\le j\le n} \mathrm{IFED}\left(q_{ij}^N, A_j^-\right) + \rho \max\limits_{1\le i\le m} \max\limits_{1\le j\le n} \mathrm{IFED}\left(q_{ij}^N, A_j^-\right)}{\mathrm{IFED}\left(q_{ij}^N, A_j^-\right) + \rho \max\limits_{1\le i\le m} \max\limits_{1\le j\le n} \mathrm{IFED}\left(q_{ij}^N, A_j^-\right)}, \quad (22)$$

$$i = 1, 2, \ldots, m, j = 1, 2, \ldots, n.$$

Step 6. Derive the degree of GRC of all alternatives from IFPIS and IFNIS as follows:

$$\mathrm{IFPIS}\left(\xi_i\right) = \sum_{j=1}^n r_j \mathrm{IFPIS}\left(\xi_{ij}\right), \quad i = 1, 2, \ldots, m, \quad (23)$$

$$\mathrm{IFNIS}\left(\xi_i\right) = \sum_{j=1}^n r_j \mathrm{IFNIS}\left(\xi_{ij}\right), \quad i = 1, 2, \ldots, m. \quad (24)$$

Step 7. Compute each alternative's intuitionistic fuzzy relative relational degree (IFRRD) of all alternatives from IFPIS as follows:

$$\mathrm{IFRRD}_i = \frac{\mathrm{IFNIS}\left(\xi_i\right)}{\mathrm{IFNIS}\left(\xi_i\right) + \mathrm{IFPIS}\left(\xi_i\right)}, \quad i = 1, 2, \ldots, m. \quad (25)$$

Step 8. According to the $\text{IFRRD}_i\,(i = 1, 2, \ldots, m)$, the largest value of $\text{IFRRD}_i\,(i = 1, 2, \ldots, m)$ is, the optimal alternative is.

4. Numerical Example and Comparative Analysis

4.1. Numerical Example. Traditional culture is the essence of Chinese history of civilization; considering the intangible cultural heritage as an important part of traditional culture, the development of China's history of civilization progress and the social economy has a far-reaching influence. In China, cultural creative industry is an emerging industry, showing a good momentum of development. The cultural resources of China's rich heritage provided plenty of cultural capital for development of creative industry and, at the same time, put forward the theory and practice of cultural and creative industry park, provideing the material basis for the development of creative industries. Many cities have many categories of intangible cultural heritage items, and government and groups are working to contribute the protection and inheritance of intangible cultural heritage actively. However, in the background of new era, the traditional protection measures have been unable to meet development requirements of the times and intangible cultural heritage protection, and inheritance work needs innovation. In this chapter, an empirical application about development potentiality evaluation of cultural and creative garden is provided through the IF-GRA method. There are five potential cultural and creative gardens $F_i\,(i = 1, 2, 3, 4, 5)$ preparing to evaluate their development potentiality. In order to assess these cultural and creative gardens fairly, three experts $H = \{H_1, H_2, H_3\}$ (expert's weight $h = (0.35, 0.32, 0.33)$) are invited. All experts depict their information through four subsequent attributes: ① R_1 is market risk; ② R_2 is environmental risk; ③ R_3 is risk of enterprise assets structure; and ④ R_4 is cost of enterprise operation and management. Evidently, R_4 is cost attribute, while R_1, R_2, and R_3 are benefit attributes, and the decision-making matrix is depicted in Tables 1–3.

Step 1. Based on the information $Q^{(k)} = (q_{ij}^k)_{m\times n}\,(i = 1, 2, \ldots, m, j = 1, 2, \ldots, n)$ given in Tables 1–3 and the expert's weight $h = (0.35, 0.32, 0.33)$, we can derive the overall matrix $Q = (q_{ij})_{m\times n}\,(i = 1, 2, \ldots, m, j = 1, 2, \ldots, n)$ according to equation (16), and the computing results are listed in Table 4.

Step 2. Normalize the matrix $Q = [q_{ij}]_{m\times n}$ to $Q^N = [q_{ij}^N]_{m\times n}$ (see Table 5).

Step 3. Decide the attribute weights $r_j\,(j = 1, 2, \ldots, n)$ by CRITIC as listed in Table 6.

Step 4. Calculate the IFPISA_j^+ and IFNISA_j^- according to (20) and (21).

Step 5. Compute the GRC of every alternative from IFPIS and IFNIS (Tables 7 and 8).

Step 6. Derive the degree of GRC of all given alternatives from IFPIS and IFNIS (Table 9).

Table 1: Decision-making information depicted by H_1.

	R_1	R_2	R_3	R_4
F_1	(0.1, 0.3)	(0.5, 0.2)	(0.5, 0.4)	(0.3, 0.3)
F_2	(0.2, 0.5)	(0.4, 0.1)	(0.4, 0.5)	(0.2, 0.4)
F_3	(0.3, 0.6)	(0.4, 0.2)	(0.6, 0.3)	(0.5, 0.2)
F_4	(0.1, 0.3)	(0.7, 0.1)	(0.5, 0.4)	(0.2, 0.4)
F_5	(0.5, 0.4)	(0.4, 0.3)	(0.8, 0.1)	(0.4, 0.5)

Table 2: Decision-making information given by H_2.

	R_1	R_2	R_3	R_4
F_1	(0.2, 0.5)	(0.4, 0.3)	(0.1, 0.1)	(0.4, 0.5)
F_2	(0.1, 0.3)	(0.4, 0.5)	(0.3, 0.2)	(0.5, 0.2)
F_3	(0.5, 0.1)	(0.2, 0.7)	(0.4, 0.2)	(0.3, 0.4)
F_4	(0.4, 0.2)	(0.3, 0.3)	(0.3, 0.5)	(0.5, 0.1)
F_5	(0.5, 0.1)	(0.6, 0.2)	(0.6, 0.2)	(0.3, 0.6)

Table 3: Decision-making information given by H_3.

	R_1	R_2	R_3	R_4
F_1	(0.4, 0.1)	(0.3, 0.4)	(0.4, 0.5)	(0.2, 0.2)
F_2	(0.3, 0.4)	(0.5, 0.3)	(0.5, 0.2)	(0.1, 0.2)
F_3	(0.4, 0.2)	(0.3, 0.5)	(0.7, 0.2)	(0.8, 0.1)
F_4	(0.5, 0.2)	(0.4, 0.3)	(0.4, 0.1)	(0.3, 0.6)
F_5	(0.3, 0.1)	(0.5, 0.4)	(0.6, 0.2)	(0.2, 0.4)

Step 7. Derive the IFRRD (ξ_i) of every alternative from IFPIS (Table 10).

Step 8. Relying on the IFRRD (ξ_i), all the given alternatives could be ordered; the larger value of IFRRD (ξ_i) is, the better alternative selected is. Evidently, the order is $F_3 > F_1 > F_5 > F_4 > F_2$, and F_3 is the optimal cultural and creative gardens.

$$
\begin{aligned}
A_j^+ &= \left\{ \begin{array}{l} (0.4413, 0.1625), (0.5054, 0.2042), \\ (0.6862, 0.1569), (0.4924, 0.2844) \end{array} \right\}, \\
A_j^- &= \left\{ \begin{array}{l} (0.2051, 0.3945), (0.3078, 0.4041), \\ (0.3169, 0.2763), (0.1986, 0.5885) \end{array} \right\}.
\end{aligned}
\tag{26}
$$

4.2. Compare Analysis. In such section, IF-GRA is made comparison with some existing methods to show their superiority.

The IF-GRA model is compared with the IF-VIKOR method [63]. Then, we could derive the calculating result. The closest ideal scores are as follows: $\text{CI}^*(F_1) = 0.9042$, $\text{CI}^*(F_2) = 0.6776$, $\text{CI}^*(F_3) = 0.0000$, $\text{CI}^*(F_4) = 0.9876$, and $\text{CI}^*(F_5) = 0.9563$. And the farthest worst score is as follows: $\text{CI}^-(F_1) = 0.0122$, $\text{CI}^-(F_2) = 0.3442$, $\text{CI}^-(F_3) = 1.0000$, $\text{CI}^-(F_4) = 0.0175$, and $\text{CI}^-(F_5) = 0.0000$. Then, each alternatives' relative closeness are calculated as follows: $\text{DRC}_1 = 0.9854$, $\text{DRC}_2 = 0.6465$, $\text{DRC}_3 = 0.0000$, $\text{DRC}_4 = 0.9764$, and $\text{DRC}_5 = 1.0000$. Hence, the order is $F_3 > F_2 > F_4 > F_1 > F_5$.

Furthermore, our defined method is compared with IFWA and IFWG [59]. For IFWA operator, the calculating value is as follows: $S(F_1) = 0.0797, S(F_2) =$

Table 4: Overall matrix with IFNS.

	R_1	R_2	R_3	R_4
F_1	(0.2418, 0.2458)	(0.4077, 0.2862)	(0.3169, 0.2763)	(0.3037, 0.3090)
F_2	(0.2051, 0.3945)	(0.4350, 0.2405)	(0.4065, 0.2756)	(0.2844, 0.2549)
F_3	(0.4026, 0.2353)	(0.3078, 0.4041)	(0.5858, 0.2305)	(0.5885, 0.1986)
F_4	(0.3489, 0.2305)	(0.5054, 0.2042)	(0.4086, 0.2719)	(0.3414, 0.2934)
F_5	(0.4413, 0.1625)	(0.5038, 0.2897)	(0.6862, 0.1569)	(0.3069, 0.4924)

Table 5: The normalized matrix with IFNS.

	R_1	R_2	R_3	R_4
F_1	(0.2418, 0.2458)	(0.4077, 0.2862)	(0.3169, 0.2763)	(0.3090, 0.3037)
F_2	(0.2051, 0.3945)	(0.4350, 0.2405)	(0.4065, 0.2756)	(0.2549, 0.2844)
F_3	(0.4026, 0.2353)	(0.3078, 0.4041)	(0.5858, 0.2305)	(0.1986, 0.5885)
F_4	(0.3489, 0.2305)	(0.5054, 0.2042)	(0.4086, 0.2719)	(0.2934, 0.3414)
F_5	(0.4413, 0.1625)	(0.5038, 0.2897)	(0.6862, 0.1569)	(0.4924, 0.3069)

Table 6: The attributes weights r_j.

	R_1	R_2	R_3	R_4
r_j	0.2607	0.2422	0.2780	0.2170

Table 7: GRC of every alternative from IFPIS.

Alternatives	R_1	R_2	R_3	R_4
F_1	0.6825	1.0000	0.3333	0.4095
F_2	0.5443	0.4343	0.4175	0.4943
F_3	0.7049	0.6825	1.0000	1.0000
F_4	0.5181	0.4943	0.4343	0.4831
F_5	1.0000	0.4343	0.4175	0.5181

Table 8: GRC of every alternative from IFNIS.

Alternatives	R_1	R_2	R_3	R_4
F_1	0.5172	0.3488	0.4167	0.4545
F_2	0.7895	1.0000	1.0000	0.8333
F_3	0.4412	0.3659	0.3333	0.3947
F_4	1.0000	0.5172	0.7143	1.0000
F_5	0.4286	0.4545	0.4839	0.4769

0.1416, $S(F_3) = 0.3355$, $S(F_4) = 0.0447$, and $S(F_5) = 0.0409$. Thus, the ranking order is $F_3 > F_2 > F_1 > F_4 > F_5$. For the IFWG, the calculating value is $S(F_1) = -0.0106$, $S(F_2) = 0.1229$, $S(F_3) = 0.3021$, $S(F_4) = 0.0358$, and $S(F_5) = 0.0087$. So, the ranking order is $F_3 > F_2 > F_4 > F_5 > F_1$.

In the end, the IF-GRA method is also compared with the IF-CODAS method [64]. Then, we can have the calculating result. The total assessment score (AS) of each alternative is calculated as follows: $AS_1 = -0.8032$, $AS_2 = 0.1435$, $AS_3 = 1.4843$, $AS_4 = -0.3809$, and $AS_5 = -0.4307$. Therefore, the order is $F_3 > F_2 > F_4 > F_5 > F_1$.

Obviously, the results of these existing methods are depicted in Table 11.

Table 9: IFPIS(ξ_i) and IFNIS(ξ_i) of every alternative.

Alternatives	IFPIS(ξ_i)	IFNIS(ξ_i)
F_1	0.5653	0.4146
F_2	0.4789	0.9398
F_3	0.8524	0.3746
F_4	0.4856	0.7449
F_5	0.6275	0.4866

Table 10: IFRRD of each alternative from IFPIS.

Alternatives	F_1	F_2	F_3	F_4	F_5
IFRRD(ξ_i)	0.5833	0.3348	0.6973	0.3986	0.5649

Table 11: Calculating results of these methods.

Methods	Order	The best alternative	The worst alternative
IFWA operator	$F_3 > F_2 > F_1 > F_4 > F_5$	F_3	F_5
IFWG operator	$F_3 > F_2 > F_4 > F_5 > F_1$	F_3	F_1
IF-VIKOR method	$F_3 > F_2 > F_4 > F_1 > F_5$	F_3	F_5
IF-CODAS method	$F_3 > F_2 > F_4 > F_5 > F_1$	F_3	F_1
The developed method	$F_3 > F_1 > F_5 > F_4 > F_2$	F_3	F_2

From Table 11, it is evidently that the best alternative is F_3. In other words, the ranking order is slightly different. Different methods can cope with MAGDM from different angles. IFWA and IFWG operators emphasize to fuse assessing information. The IF-VIKOR emphasizes the closest to PIS and the farthest to NIS. However, compared with the above methods, our designed method is more precise since it considers the degree of shape similarity of every alternative from PIS and NIS. Furthermore, compared with the IF-CODAS method, our designed method utilizes novel distance measures and CRITIC method. The novel distance measures can not only reflect IFSs more comprehensiveness but also take waver in IFSs into consideration and do not generate counterintuitive situations. The CRITIC method can minimize subjective randomness while the criteria weights are determined.

5. Conclusion

The rapid development of science and technology, and increasingly people rising consumer demand, is characterized by "knowledge" and "culture" of cultural creative industry arises at the historic moment. Culture creative industry mainly refers to culture as the foundation, taking innovation as the core, powered by ideas, using high-tech technology in promoting cultural resources for effective integration and utilization, through constant research and development and extensive application of knowledge industry, knowledge to produce high value-added products and services of the new industry. In the modern society, the foreign and the Chinese government gives great importance to the development of cultural creative industry. Meanwhile, from the eighteenth century British industrial revolution began, the human came into the industrial revolution; but with the development of computer, electronic science, and technology industry, the traditional manufacturing industry gradually declined, there has been a major shift in urban economic structure, industrial layout, and type of economy, and many cities on a large number of industrial building heritages choose to dismantle, abandoned, or transform and face a dilemma. In this case, the sustainable development theory makes cultural creative industry become a new way to redesign of old industrial building heritages. Theory of sustainable development for urban renewal must renew the city's overall memory and link the development of the city space and urban context inheritance (including the city's cultural landscape), so a lot of countries under the guidance of sustainable development theory of transforming urban heritage of the old industrial buildings for the city's cultural creative industry park realize the sustainable development of the cultural creative industrial park. Based on this, the author looked for cultural creative industrial park design development at home and abroad research, hoping to explore sustainable cultural creative industrial park for the future development in China, and promoting the cultural creative industry cluster of high speed. This paper offers the useful solution for such issue since it designs a novel intuitive distance-based IF-GRA method to build the evaluation system of development potentiality evaluation of cultural and creative garden. And then a numerical example is given to prove that such novel method is reasonable.

The main contribution of this paper can be summarized as follows: (1) the CRITIC method is built to derive the weight information of the attribute under IFSs; (2) this paper employs a novel combined distance measures; (3) this paper designs a novel intuitive distance-based IF-GRA method for MAGDM based on the CRITIC method; (4) a case study for development potentiality evaluation of cultural and creative garden is given to show the developed approach; and some comparative studies are provided with the existing methods, and (5) the proposed method can also contribute to the other evaluation issues.

In the future works, the designed model and algorithm could be needful and meaningful to solve other real MAGDM issues, and the designed methods could also be expanded to other uncertain setting [65–71].

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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