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Retraction

Retracted: TOPSIS Method for Teaching Effect Evaluation of College English with Interval-Valued Intuitionistic Fuzzy Information

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] F. Wang, "TOPSIS Method for Teaching Effect Evaluation of College English with Interval-Valued Intuitionistic Fuzzy Information," *Journal of Mathematics*, vol. 2021, Article ID 5517198, 9 pages, 2021.

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Research Article

TOPSIS Method for Teaching Effect Evaluation of College English with Interval-Valued Intuitionistic Fuzzy Information

Fengling Wang

School of Foreign Languages, Xianyang Normal University, Xianyang 712000, Shaanxi, China

Correspondence should be addressed to Fengling Wang; wangfengling6@126.com

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Teaching effect evaluation of College English is frequently considered as a multiattribute group decision-making (MAGDM) issue. Thus, a novel MAGDM method is needed to tackle it. Depending on the classical TOPSIS method and interval-valued intuitionistic fuzzy sets (IVIFSs), this paper designs a novel intuitive distance-based IVIF-TOPSIS method for teaching effect evaluation of College English. First of all, a related literature review is conducted. Furthermore, some necessary theories related to IVIFSs are briefly reviewed. In addition, the weights of attribute are decided objectively by using the CRITIC method. Afterwards, relying on novel distance measures between IVIFSs, the conventional TOPSIS method is extended to the IVIFSs to calculate closeness degree of each alternative from the interval-valued intuitionistic fuzzy positive ideal solution (IVIF-PIS). Finally, an empirical example about teaching effect evaluation of College English and some comparative analyses have been given. The results show that the designed method is useful for teaching effect evaluation of College English.

1. Introduction

Since the process of making decision is filled with uncertainty and ambiguity [1–7], in order to cope with the accuracy of decision-making [8–14], Zadeh [15] defined the fuzzy sets (FSs). Atanassov [16] defined the concept of intuitionistic fuzzy sets (IFSs). Liu et al. [17] built some intuitionistic fuzzy BM fused operators with Dombi operations. Gupta et al. [18] extended the fuzzy entropy to IFSs. He et al. [19] integrated the power averaging with IFSs. Garg [20] presented a method related to MAGDM on the basis of intuitionistic fuzzy multiplicative preference and defined several geometric operators. Chen et al. [21] developed TOPSIS method and similarity measures under IFSs. Rouyendegh [22] used the ELECTRE method in IFSs to tackle some MCDM issues. Gan and Luo [23] used the hybrid method with DEMATEL and IFSs. Jin et al. [24] defined two GDM methods which can obtain the normalized intuitionistic fuzzy priority weights from IFPRs on the basis of the order consistency and the multiplicative consistency. Xiao et al. [25] defined the intuitionistic fuzzy Taxonomy method. Zhao et al. [26] defined TODIM method for IF-MAGDM based on CPT. Cali and Balaman [27] extended ELECTRE I with VIKOR method in IFSs to reflect the decision-makers' preferences. Hao et al. [28] presented a theory of decision field for IFSs. Gupta et al. [29] modified the SIR method and combined it with IFSs. Li et al. [30] gave a grey target decision-making with IFNs. Gou et al. [31] defined some exponential operational law for IFNs. Khan and Lohani [32] defined similarity measure about IFNs. Bao et al. [33] defined prospect theory and evidential reasoning method under IFSs. Oztaysi et al. [34] solved the research proposals evaluation for grant funding using IVIFSs. Sahu et al. [35] defined the hierarchical clustering of IVIFSs. Xian et al. [36] defined combined weighted averaging operator for GDM under IVIFSs. Zhang et al. [37] defined the programming technique for MAGDM based on Shapley values and incomplete information. Zhang [38] proposed some Frank aggregation operators under IVIFSs. An et al. [39] gave the project delivery system selection with IVIF-MAGDM method. Zeng et al. [40] solved IVIF-MADM based on nonlinear programming methodology and TOPSIS method. Zhao et al. [41] defined the CPT-TODIM method for interval-valued intuitionistic fuzzy MAGDM. Wang and

Mendel [42] solved the aggregation methodology for IVIF-MADM with a prioritization of criteria.

TOPSIS was initially developed by Hwang and Yoon [43] to solve MAGDM issues. Compared with other MAGDM, TOPSIS method can consider the distances degree of every alternative from PIS and NIS. This method has been used in various fuzzy settings [44–49]. This paper's goal is to use TOPSIS method in IVIFSs and build a new decision-making model for actual MADM problems. Thus, the motivation of this study is the following: (1) the weights of attributes are decided objectively by CRITIC method; (2) an empirical example about teaching effect evaluation of College English and some comparative analyses have been given. In order to do so, the reminder of this paper is organized as follows: Some concepts of IVIFSs are reviewed in Section 2. The improved TOPSIS method is defined with IVIFSs and the calculating steps is simply listed in Section 3. An empirical application about teaching effect evaluation of College English is given to show the superiority of this designed approach and some comparative analyses are given to prove the merits of such method in Section 4. At last, we make an overall conclusion of such work in Section 5.

2. Preliminaries

2.1. IVIFSs

Definition 1 (see [50]). The interval-valued IFS (IVIFS) on X is

$$I=\{\langle x,\widetilde{\mu}_I(x),\widetilde{\nu}_I(x)\rangle,|x\in X\},\tag{1}$$

where $\widetilde{\mu}_I(x)\subset[0,1]$ is named as "membership degree of I" and $\widetilde{\nu}_I(x)\subset[0,1]$ is called "non-membership degree of I," and $\widetilde{\mu}_I(x)$ and $\widetilde{\nu}_I(x)$ meet the following condition: $0\le \sup\widetilde{\mu}_I(x)+\sup\widetilde{\nu}_I(x)\le 1$, $\forall x\in X$. For convenience, we call $I=([\mu^L,\mu^R],[\nu^L,\nu^R])$ an IVIFN.

Definition 2 (see [51]). Let $I_1=([\mu_1^L,\mu_1^R],[\nu_1^L,\nu_1^R])$ and $I_2=([\mu_2^L,\mu_2^R],[\nu_2^L,\nu_2^R])$ be two IVIFNs; the operation formula of them can be defined:

$$\begin{aligned}
I_1\oplus I_2&=\left(\left[\mu_1^L+\mu_2^L-\mu_1^L\mu_2^L,\mu_1^R+\mu_2^R-\mu_1^R\mu_2^R\right],\left[\nu_1^L\nu_2^L,\nu_1^R\nu_2^R\right]\right),\\
I_1\otimes I_2&=\left(\left[\mu_1^L\mu_2^L,\mu_1^R\mu_2^R\right],\left[\nu_1^L+\nu_2^L-\nu_1^L\nu_2^L,\nu_1^R+\nu_2^R-\nu_1^R\nu_2^R\right]\right),\\
\lambda I_1&=\left(\left[1-\left(1-\mu_1^L\right)^\lambda,1-\left(1-\mu_1^R\right)^\lambda\right],\left[\left(\nu_1^L\right)^\lambda,\left(\nu_1^R\right)^\lambda\right]\right),\quad \lambda>0,\\
I_1^\lambda&=\left(\left[\left(\mu_1^L\right)^\lambda,\left(\mu_1^R\right)^\lambda\right],\left[1-\left(1-\lambda_1^L\right)^\lambda,1-\left(1-\lambda_1^R\right)^\lambda\right]\right),\quad \lambda>0.
\end{aligned}\tag{2}$$

Definition 3 (see [52]). Let $I_1=([\mu_1^L,\mu_1^R],[\nu_1^L,\nu_1^R])$ and $I_2=([\mu_2^L,\mu_2^R],[\nu_2^L,\nu_2^R])$ be IVIFNs; the score and accuracy values of I_1 and I_2 can be defined:

$$\begin{aligned}
S(I_1)&=\frac{\mu_1^L+\mu_1^L\left(1-\mu_1^L-\nu_1^L\right)+\mu_1^R+\mu_1^R\left(1-\mu_1^R-\nu_1^R\right)}{2},\\
S(I_2)&=\frac{\mu_2^L+\mu_2^L\left(1-\mu_2^L-\nu_2^L\right)+\mu_2^R+\mu_2^R\left(1-\mu_2^R-\nu_2^R\right)}{2},\\
H(I_1)&=\frac{\mu_1^L+\nu_1^L+\mu_1^R+\nu_1^R}{2},\\
H(I_2)&=\frac{\mu_2^L+\nu_2^L+\mu_2^R+\nu_2^R}{2}.
\end{aligned}\tag{3}$$

For two IVIFNs I_1 and I_2, according to Definition 3, we have the following:

(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 [53]). Let $I_1=([\mu_1^L,\mu_1^R],[\nu_1^L,\nu_1^R])$ and $I_2=([\mu_2^L,\mu_2^R],[\nu_2^L,\nu_2^R])$ be IVIFNs; the Euclidean distance between two IVIFNs can be given as follows:

$$\operatorname{IVIFED}(I_1,I_2)=\sqrt{\frac{1}{4}\left[\left(\mu_1^L-\mu_2^L\right)^2+\left(\mu_1^R-\mu_2^R\right)^2+\left(\nu_1^L-\nu_2^L\right)^2+\left(\nu_1^R-\nu_2^R\right)^2\right]}.\tag{4}$$

2.2. Two Aggregation Operators under IVIFSs. Under the IVIFSs, some fused operators will be introduced in this section, including IVIFWA fused operator and IVIFWG fused operator.

Definition 5 (see [54]). Let $I_j=([\mu_{I_j}^L,\mu_{I_j}^R],[\nu_{I_j}^L,\nu_{I_j}^R])$ $(j=1,2,\ldots,n)$ be a set of IVIFNs; the IFWA operator is

$$\begin{aligned}
\operatorname{IVIFWA}_\omega(I_1,I_2,\ldots,I_n)&=\mathop{\oplus}_{j=1}^{n}\left(\omega_j I_j\right)\\
&=\left(\left[1-\prod_{j=1}^{n}\left(1-\mu_{I_j}^L\right)^{\omega_j},1-\prod_{j=1}^{n}\left(1-\mu_{I_j}^R\right)^{\omega_j}\right],\left[\prod_{j=1}^{n}\left(\nu_{I_j}^L\right)^{\omega_j},\prod_{j=1}^{n}\left(\nu_{I_j}^R\right)^{\omega_j}\right]\right),
\end{aligned}\tag{5}$$

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

Definition 6 (see [51]). Let $I_j = ([\mu_{I_j}^L, \mu_{I_j}^R], [\nu_{I_j}^L, \nu_{I_j}^R])$ ($j = 1, 2, \ldots, n$) be a set of IVIFNs; the IVIFWG operator is

$$\begin{aligned} \mathrm{IVIFWG}_\omega (I_1, I_2, \ldots, I_n) &= \overset{n}{\underset{j=1}{\otimes}} \left(I_j\right)^{\omega_j} \\ &= \left(\left[\prod_{j=1}^{n} \left(\mu_{I_j}^L\right)^{\omega_j}, \prod_{j=1}^{n} \left(\mu_{I_j}^R\right)^{\omega_j} \right], \left[1 - \prod_{j=1}^{n} \left(1 - \nu_{I_j}^L\right)^{\omega_j}, 1 - \prod_{j=1}^{n} \left(1 - \nu_{I_j}^R\right)^{\omega_j} \right] \right), \end{aligned} \tag{6}$$

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

3. TOPSIS Method for IVIF-MAGDM with the CRITIC Method

In this section, we build the IVIF-TOPSIS method for MAGDM. The calculating steps of the designed method can be described subsequently. Let $R = \{R_1, R_2, \ldots, R_n\}$ be the group of attributes, and let $r = \{r_1, r_2, \ldots, r_n\}$ be the weight of attributes R_j, where $r_j \in [0, 1]$, $j = 1, 2, \ldots, n$, $\sum_{j=1}^{n} r_j = 1$.

Assume that $H = \{H_1, H_2, \ldots, H_l\}$ is 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. $Q = (q_{ij})_{m\times n}$ is the matrix with IVIFNs, where q_{ij} means F_i for R_j. Subsequently, the specific calculating steps will be depicted.

Step 1. Build each DM's matrix $Q^{(k)} = (q_{ij}^k)_{m\times n}$ with IVIFNs and calculate the overall IVIF decision matrix $Q = (q_{ij})_{m\times n}$.

$$\begin{aligned} Q^{(k)} &= \left[q_{ij}^k\right]_{m\times n} = \begin{bmatrix} q_{11}^k & q_{12}^k & \cdots & q_{1n}^k \\ q_{21}^k & q_{22}^k & \cdots & q_{2n}^k \\ \vdots & \vdots & \vdots & \vdots \\ q_{m1}^k & q_{m2}^k & \cdots & q_{mn}^k \end{bmatrix}, \\ Q &= \left[q_{ij}\right]_{m\times n} = \begin{bmatrix} q_{11} & q_{12} & \cdots & q_{1n} \\ q_{21} & q_{22} & \cdots & q_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ q_{m1} & q_{m2} & \cdots & q_{mn} \end{bmatrix}, \\ q_{ij} &= \left(\left[1 - \prod_{k=1}^{l} \left(1 - \mu_{q_{ij}^k}^L\right)^{d_k}, 1 - \prod_{k=1}^{l} \left(1 - \mu_{q_{ij}^k}^R\right)^{d_k} \right], \left[\prod_{k=1}^{l} \left(\nu_{q_{ij}^k}^L\right)^{d_k}, \prod_{k=1}^{l} \left(\nu_{q_{ij}^k}^R\right)^{d_k} \right] \right), \end{aligned} \tag{7}$$

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

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

$$q_{ij}^N = \begin{cases} \left(\left[\mu_{ij}^L, \mu_{ij}^R\right], \left[\nu_{ij}^L, \nu_{ij}^R\right]\right), & Z_j \text{ is a benefit criterion}, \\ \left(\left[\nu_{ij}^L, \nu_{ij}^R\right], \left[\mu_{ij}^L, \mu_{ij}^R\right]\right), & Z_j \text{ is a cost criterion}. \end{cases} \tag{8}$$

Step 3. Employ CRITIC method to determine the weighting of attributes.

CRiteria Importance Through Intercriteria Correlation (CRITIC) method [55] will be proposed in this part, which is utilized to decide attributes' weights.

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

$$\mathrm{IVIFCC}_{jr} = \frac{\sum_{i=1}^{m} \left(S\left(q_{ij}^N\right) - S\left(q_j^N\right)\right)\left(S\left(q_{ir}^N\right) - S\left(q_r^N\right)\right)}{\sqrt{\sum_{i=1}^{m} \left(S\left(q_{ij}^N\right) - S\left(q_j^N\right)\right)^2} \sqrt{\sum_{i=1}^{m} \left(S\left(q_{ir}^N\right) - S\left(q_r^N\right)\right)^2}}, \quad j, r = 1, 2, \ldots, n, \tag{9}$$

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) Obtain attributes' standard deviation.

$$\mathrm{IVIFSD}_j = \sqrt{\frac{1}{m-1}\sum_{i=1}^{m}\left(S\left(q_{ij}^N\right) - S\left(q_j^N\right)\right)^2}, \quad j = 1, 2, \ldots, n, \tag{10}$$

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

(3) Obtain the attributes' weights.

$$r_j = \frac{\mathrm{IVIFSD}_j \sum_{t=1}^{n}\left(1 - \mathrm{IVIFCC}_{jt}\right)}{\sum_{j=1}^{n}\left(\mathrm{IVIFSD}_j \sum_{t=1}^{n}\left(1 - \mathrm{IVIFCC}_{jt}\right)\right)}, \quad j = 1, 2 \ldots, n, \tag{11}$$

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

Step 4. Define the interval-valued intuitionistic fuzzy PIS (IVIF-PIS) A_j^+ and the interval-valued intuitionistic fuzzy NIS (IVIF-NIS) A_j^- as

$$\begin{aligned}\mathrm{IVIFPIS}_j &= \left(\left[\mu_j^{L+}, \mu_j^{R+}\right], \left[\nu_j^{L+}, \nu_j^{R+}\right]\right),\\ \mathrm{IVIFNIS}_j &= \left(\left[\mu_j^{L+}, \mu_j^{R+}\right], \left[\nu_j^{L+}, \nu_j^{R+}\right]\right),\end{aligned} \tag{12}$$

where$\mathrm{IVIFPIS}_j = ([\max_j(\mu_{ij}^L), \max_j(\mu_{ij}^R)], [\min_j(\nu_{ij}^L), \min_j(\nu_{ij}^R)])$ and $\mathrm{IVIFNIS}_j = ([\min_j(\mu_{ij}^L), \min_j(\mu_{ij}^R)], [\max_j(\nu_{ij}^L), \max_j(\nu_{ij}^R)])$.

Step 5. Compute the positive distances d_i^+ between each alternative and IVIF-PIS and the negative distances d_i^- between each alternative and IVIF-NIS as

$$\begin{aligned}d_i^+ &= \sum_{j=1}^{n} r_j \mathrm{IVIFED}\left(q_{ij}^N, A_j^+\right), \quad i = 1, 2, \ldots, m,\\ d_i^- &= \sum_{j=1}^{n} r_j \mathrm{IVIFED}\left(q_{ij}^N, A_j^-\right), \quad i = 1, 2, \ldots, m,\end{aligned} \tag{13}$$

where $\mathrm{IVIFED}(q_{ij}^N, A_j^+)$ and $\mathrm{IVIFED}(q_{ij}^N, A_j^-)$ denote the IVIF Euclidean distances given in Definition 4, and r_j is the weight of attributes.

Step 6. Compute each alternative's closeness degree from IVIF-PIS as

$$C_i = \frac{d_i^-}{d_i^- + d_i^+}, \quad i = 1, 2, \ldots, m. \tag{14}$$

Step 7. According to the value, C_i $(i = 1, 2, \ldots, m)$. The highest value of C_i $(i = 1, 2, \ldots, m)$ is the optimal alternative which is designed.

4. The Empirical Example and Comparative Analysis

4.1. Empirical Example. With the increasing development of economy and more frequent communication between countries, English, as an international language, has more important position and plays a greater role. Accordingly, the requirements for English teaching and learning become higher. Although experts and scholars have been trying to reform the English teaching approaches, the result is not satisfactory. In particular, the recent increasing enrollment has challenged the teaching of College English greatly. The increasing number of students and the lack of faculties lead to the larger number of students in English class. So how to improve the quality of large-class English teaching is the great concern of teachers and students, which is also the ultimate purpose of this research. It is evident that the traditional teacher-centered teaching approach cannot meet the demands of the development. At this moment, the popular cooperative learning approach has gained wide attention. Cooperative learning theories and methods have been researched deeply and are adopted widely in many countries all over the world. The core of the cooperative learning is the group work. It emphasizes the student as center and the teacher as designer, instructor, monitor, etc. By means of such instruments as questionnaires, tests, interviews, and classroom observations, the research on the effect of cooperative learning on the large-class College English teaching is conducted. The result of the research shows that the cooperative learning theories and methods are suitable for the large-class English teaching and are helpful to improve the quality of the teaching. The cooperative learning's heterogeneous group, positive interdependence, individual accountability and group work, and so forth make the classroom atmosphere relaxed and greatly improve students' positivity of participation and interest in learning. Students make great progress not only in academic performance but also in communication skills, self-confidence, self-esteem, and so forth. Through this research, some disadvantages of cooperative learning in large-class College English teaching are found, such as students' inadequate preparations for the group work and unequal opportunities and time for participation of group members. On the basis of these findings in the research, some pedagogical implications are put forward to improve the effect of cooperative learning and the quality of large-class College English teaching. In this chapter, an empirical application about teaching effect evaluation of College English will be provided by making use of IVIF-TOPSIS method. There are five potential College English teaching methods F_i $(i = 1, 2, 3, 4, 5)$ preparing to evaluate their investment environment. In order to assess the effect of College English teaching methods 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 assessment information through four subsequent attributes: ① R_1 denotes teaching attitude; ② R_2 denotes the teaching methods; ③ R_3 denotes student feedback; ④ R_4 denotes peer recognition. The decision-making matrices are given in Tables 1–3.

Then, we shall use the defined TOPSIS method for teaching effect evaluation of College English.:

Step 1. Based on the decision-making information $Q^{(k)} = (q_{ij}^k)_{m\times n}$ $(i = 1, 2, \ldots, m, j = 1, 2, \ldots, n)$ given in

Table 1: Decision-making information given by H_1.

	R_1	R_2	R_3	R_4
F_1	([0.16, 0.22], [0.65, 0.78])	([0.33, 0.42], [0.50, 0.58])	([0.24, 0.30], [0.65, 0.70])	([0.47, 0.55], [0.40, 0.45])
F_2	([0.32, 0.40], [0.55, 0.60])	([0.17, 0.25], [0.70, 0.75])	([0.71, 0.80], [0.14, 0.20])	([0.60, 0.70], [0.25, 0.30])
F_3	([0.43, 0.47], [0.50, 0.53])	([0.32, 0.40], [0.55,0.60])	([0.57, 0.62], [0.30, 0.38])	([0.29, 0.36], [0.58, 0.64])
F_4	([0.32, 0.39], [0.41, 0.61])	([0.27, 0.36], [0.57, 0.64])	([0.34, 0.40], [0.50, 0.60])	([0.32, 0.40], [0.55, 0.60])
F_5	([0.25, 0.30], [0.55, 0.70])	([0.44, 0.48], [0.50, 0.52])	([0.62, 0.70], [0.25, 0.30])	([0.60, 0.65], [0.30, 0.35])

Table 2: Decision-making information given by H_2.

	R_1	R_2	R_3	R_4
F_1	([0.36, 0.41], [0.56, 0.59])	([0.41, 0.45], [0.50, 0.55])	([0.74, 0.80], [0.15, 0.20])	([0.52, 0.62], [0.32, 0.38])
F_2	([0.70, 0.80], [0.15, 0.20])	([0.36, 0.40], [0.57, 0.60])	([0.59, 0.65], [0.30, 0.35])	([0.66, 0.75], [0.20, 0.25])
F_3	([0.55, 0.62], [0.27, 0.38])	([0.29, 0.35], [0.60, 0.65])	([0.57, 0.62], [0.32, 0.38])	([0.60, 0.65], [0.30, 0.35])
F_4	([0.28, 0.46], [0.50, 0.54])	([0.53, 0.60], [0.35, 0.40])	([0.68, 0.75], [0.20, 0.25])	([0.35, 0.40], [0.55, 0.60])
F_5	([0.52, 0.60], [0.35, 0.40])	([0.46, 0.52], [0.40, 0.48])	([0.41, 0.52], [0.40, 0.48])	([0.58, 0.63], [0.30, 0.37])

Table 3: Decision-making information given by H_3.

	R_1	R_2	R_3	R_4
F_1	([0.59, 0.62], [0.26, 0.38])	([0.63, 0.70], [0.25, 0.30])	([0.37, 0.45], [0.50, 0.55])	([0.55, 0.60], [0.32, 0.40])
F_2	([0.65, 0.75], [0.20, 0.25])	([0.35, 0.40], [0.55, 0.60])	([0.70, 0.80], [0.10, 0.20])	([0.52, 0.62], [0.30, 0.38])
F_3	([0.37, 0.40], [0.53, 0.60])	([0.42, 0.48], [0.50, 0.52])	([0.19, 0.25], [0.70, 0.75])	([0.59, 0.65], [0.30, 0.35])
F_4	([0.61, 0.65], [0.30, 0.35])	([0.38, 0.42], [0.52, 0.58])	([0.62, 0.70], [0.25, 0.30])	([0.37, 0.45], [0.55, 0.60])
F_5	([0.35, 0.45], [0.50, 0.55])	([0.61, 0.65], [0.30, 0.35])	([0.36, 0.40], [0.55, 0.60])	([0.55, 0.62], [0.28, 0.38])

Tables 1–3 and the expert's weights$h = (0.35, 0.32, 0.33)$, 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 (10), and the computing results are listed in Table 4.

Step 2. All the attributes are beneficial attributes; thus, this step is omitted.

Step 3. Decide the attribute weights r_j $(j = 1, 2, \ldots, n)$ by CRITIC method as listed in Table 5.

Step 4. Calculate the IVIF-PIS A_j^+ and the IVIF-NIS A_j^- according to equations (20) and (21).

$$A_j^+ = \left\{ \begin{array}{l} (0.6862, 0.1569), (0.4924, 0.2844), \\ (0.4413, 0.1625), (0.5054, 0.2042) \end{array} \right\},$$
$$A_j^- = \left\{ \begin{array}{l} (0.3169, 0.2763), (0.1986, 0.5885), \\ (0.2051, 0.3945), (0.3078, 0.4041) \end{array} \right\}. \tag{15}$$

Step 5. Compute the distances d_i^+ and d_i^-; the results are as follows:

$$\begin{aligned} d_1^+ &= 0.1823, d_2^+ = 0.1978, d_2^+ = 0.1043, d_2^+ = 0.2123, d_2^+ = 0.2213; \\ d_1^- &= 0.1246, d_2^- = 0.1623, d_2^- = 0.2509, d_2^- = 0.1366, d_2^- = 0.1735. \end{aligned} \tag{16}$$

Step 6. Compute each alternative's closeness degree C_i from IVIF-PIS by equation (14); the results are as follows:

$$\begin{aligned} C_1 &= 0.3709, \\ C_2 &= 0.4982, \\ C_3 &= 0.6976, \\ C_4 &= 0.3869, \\ C_5 &= 0.3916. \end{aligned} \tag{17}$$

Step 7. Relying on C_i, all the alternatives can be ordered, and the higher the value of C_i is, the best alternative selected will be. Evidently, the order is $F_3 > F_2 > F_5 > F_4 > F_1$ and F_3 is the optimal College English teaching method.

4.2. Comparison Analysis. In this section, our defined method is compared with some other methods to show its superiority.

First of all, our defined method is compared with IVIFWA and IVIFWG operators [54]. For the IVIFWA operator, the calculating result is $S(F_1) = 0.0795, S(F_2) = 0.1508, S(F_3) = 0.3435, S(F_4) = 0.0498, S(F_5) = 0.0421$. Thus, the ranking order is $F_3 > F_2 > F_1 > F_4 > F_5$. For the

Table 4: The overall matrix with IVIFNs.

	R_1	R_2	R_3	R_4
F_1	([0.5265, 0.5879], [0.2908, 0.4079])	([0.4478, 0.5187], [0.3848, 0.4723])	([0.5356, 0.6149], [0.4550, 0.3636])	([0.4872, 0.5702], [0.4127, 0.4153])
F_2	([0.5623, 0.6406], [0.3011, 0.3594])	([0.3034, 0.3589], [0.5872, 0.6411])	([0.6589, 0.7498], [0.1660, 0.2502])	([0.5875, 0.6829], [0.2511, 0.3171])
F_3	([0.4125, 0.4685], [0.4625, 0.5315])	([0.3638, 0.4299], [0.5243, 0.5701])	([0.5273, 0.5805], [0.3471, 0.4195])	([0.5144, 0.5866], [0.3420, 0.4134])
F_4	([0.4759, 0.5699], [0.3497, 0.4301])	([0.4333, 0.5053], [0.4275, 0.4947])	([0.5314, 0.6012], [0.3298, 0.3988])	([0.3010, 0.3678], [0.5677, 0.6322])
F_5	([0.3160, 0.4106], [0.5152, 0.5894])	([0.4702, 0.5165], [0.4317, 0.4835])	([0.5080, 0.5864], [0.3567, 0.4136])	([0.4932, 0.5582], [0.3658, 0.4418])

Table 5: The attributes weights r_j.

	R_1	R_2	R_3	R_4
r_j	0.2778	0.2192	0.2612	0.2418

Table 6: Evaluation results of these methods.

Methods	Ranking order	The best alternative	The worst alternative
IVIFWA operator [54]	$F_3 > F_2 > F_1 > F_4 > F_5$	F_3	F_5
IVIFWG operator [54]	$F_3 > F_2 > F_4 > F_5 > F_1$	F_3	F_1
IVIF-VIKOR method [56]	$F_3 > F_2 > F_4 > F_1 > F_5$	F_3	F_5
IVIF-CODAS method [57]	$F_3 > F_2 > F_4 > F_5 > F_1$	F_3	F_1
The developed method	$F_3 > F_2 > F_5 > F_4 > F_1$	F_3	F_1

IVIFWG operator, the calculating result is $S(F_1) = -0.0116$, $S(F_2) = 0.1239$, $S(F_3) = 0.3213$, $S(F_4) = 0.0368$, $S(F_5) = 0.0087$. So the ranking order is $F_3 > F_2 > F_4 > F_5 > F_1$.

Furthermore, our defined method is compared with the IVIF-VIKOR method [56]. Then we can obtain the calculating result. The closest ideal score values are the following: $CI^*(F_1) = 0.9034$, $CI^*(F_2) = 0.6714$, $CI^*(F_3) = 0.0000$, $CI^*(F_4) = 0.9854$, and $CI^*(F_5) = 0.9509$; and the farthest worst score values are the following: $CI^-(F_1) = 0.0134$, $CI^-(F_2) = 0.3467$, $CI^-(F_3) = 1.0000$, $CI^-(F_4) = 0.0176$, and $CI^-(F_5) = 0.0000$. Then the alternatives' relative closeness is calculated as follows: $DRC_1 = 0.9859$, $DRC_2 = 0.6656$, $DRC_3 = 0.0000$, $DRC_4 = 0.9796$, and $DRC_5 = 1.0000$. Hence, the order is $F_3 > F_2 > F_4 > F_1 > F_5$.

In the end, our defined method is also compared with IVIF-CODAS method [57]. Then we can have the calculating result. The total assessment score (AS) of each alternative is calculated as follows: $AS_1 = -0.8023$, $AS_2 = 0.1650$, $AS_3 = 1.4827$, $AS_4 = -0.3976$, and $AS_5 = -0.4436$. Therefore, the order is $F_3 > F_2 > F_4 > F_5 > F_1$.

Eventually, the results of these methods are in Table 6.

From Table 6, it is evident that the best alternative is F_3, while the worst alternative is F_1 in most situations. In other words, these methods' order is slightly different. Different methods can tackle MAGDM from different angles.

5. Conclusion

With the development of multimedia technology and the wide use of the Internet and computer, College English teaching is becoming more and more multimodal. The rapid development of information technology promotes the change in the ways of communication and the education idea. However, the traditional teaching mode is not adapted to the requirements of the times. This paper offers an effective solution for this issue, since it designs a novel intuitive distance based IVIF-TOPSIS method to build the teaching effect evaluation of College English. Then a numerical example has been given to confirm that this novel method is reasonable. What is more, to verify the validity and feasibility of the developed method, some comparative analysis is also given. However, the main drawback of this paper is that the numbers of DMs and attributes are small, and interdependency of attributes is not taken into consideration, which may limit the application scope of the developed method to some extent. Thus, the highlights of this study are the following: (1) the weights of attributes are derived objectively by CRITIC method; (2) an empirical example about teaching effect evaluation of College English and some comparative analyses have been given to show the effectiveness of the designed IVIF-TOPSIS method in MAGDM issues. In our future works, the designed model and algorithm will be needful and meaningful to apply to solve other real MADM or MAGDM problems [58–62], and the designed methods can also be extended to other uncertain settings [63–68].

Data Availability

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

Conflicts of Interest

The author declares that there are no conflicts of interest.

References

[1] D.-F. Li and S.-P. Wan, "Fuzzy heterogeneous multiattribute decision making method for outsourcing provider selection," *Expert Systems with Applications*, vol. 41, no. 6, pp. 3047–3059, 2014.

[2] S. Wang, G. Wei, J. Wu, C. Wei, and Y. Guo, "Model for selection of hospital constructions with probabilistic linguistic GRP method," *Journal of Intelligent & Fuzzy Systems*, vol. 40, no. 1, pp. 1245–1259, 2021.

[3] M. Zhao, G. Wei, J. Wu, Y. Guo, and C. Wei, "TODIM method for multiple attribute group decision making based on cumulative prospect theory with 2-tuple linguistic neutrosophic sets," *International Journal of Intelligent Systems*, vol. 36, no. 3, pp. 1199–1222, 2021.

[4] Y. Zhang, G. Wei, Y. Guo, and C. Wei, "TODIM method based on cumulative prospect theory for multiple attribute group decision-making under 2-tuple linguistic Pythagorean fuzzy environment," *International Journal of Intelligent Systems*, 2021.

[5] G. Wei, J. Lu, C. Wei, and J. Wu, "Probabilistic linguistic GRA method for multiple attribute group decision making," *Journal of Intelligent & Fuzzy Systems*, vol. 38, no. 4, pp. 4721–4732, 2020.

[6] R. M. Zulqarnain, X. L. Xin, H. Garg, and W. A. Khan, "Aggregation operators of Pythagorean fuzzy soft sets with their application for green supplier chain management," *Journal of Intelligent & Fuzzy Systems*, vol. 40, no. 3, pp. 5545–5563, 2021.

[7] J. Wang, H. Gao, and M. Lu, "Approaches to strategic supplier selection under interval neutrosophic environment," *Journal of Intelligent & Fuzzy Systems*, vol. 37, no. 2, pp. 1707–1730, 2019.

[8] M. Keshavarz Ghorabaee, M. Amiri, E. K. Zavadskas, and J. Antucheviciene, "A new hybrid fuzzy MCDM approach for evaluation of construction equipment with sustainability considerations," *Archives of Civil and Mechanical Engineering*, vol. 18, no. 1, pp. 32–49, 2018.

[9] G. Wei, J. Wu, Y. Guo, J. Wang, and C. Wei, "An extended COPRAS model for multiple attribute group decision making based on single-valued neutrosophic 2-tuple linguistic environment," *Technological and Economic Development of Economy*, pp. 1–16, 2021.

[10] A. Mardani, M. Nilashi, E. K. Zavadskas, S. R. Awang, H. Zare, and N. M. Jamal, "Decision making methods based on fuzzy aggregation operators: three decades review from 1986 to 2017," *International Journal of Information Technology & Decision Making*, vol. 17, no. 2, pp. 391–466, 2018.

[11] M. Zhao, G. Wei, C. Wei, and Y. Guo, "CPT-TODIM method for bipolar fuzzy multi-attribute group decision making and its application to network security service provider selection," *International Journal of Intelligent Systems*, 2021.

[12] Z. Jiang, G. Wei, J. Wu, and X. Chen, "CPT-TODIM method for picture fuzzy multiple attribute group decision making and its application to food enterprise quality credit evaluation," *Journal of Intelligent & Fuzzy Systems*, 2021.

[13] T. He, G. Wei, J. Lu, C. Wei, and R. Lin, "Pythagorean 2-tuple linguistic VIKOR method for evaluating human factors in construction project management," *Mathematics*, vol. 7, no. 12, p. 1149, 2019.

[14] T.-Y. Chen, C.-H. Chang, and J.-F. Rachel Lu, "The extended QUALIFLEX method for multiple criteria decision analysis based on interval type-2 fuzzy sets and applications to medical decision making," *European Journal of Operational Research*, vol. 226, no. 3, pp. 615–625, 2013.

[15] L. A. Zadeh, "Fuzzy sets," *Information and Control*, vol. 8, no. 3, pp. 338–353, 1965.

[16] K. T. Atanassov, "Intuitionistic fuzzy sets," *Fuzzy Sets and Systems*, vol. 20, no. 1, pp. 87–96, 1986.

[17] P. Liu, J. Liu, and S.-M. Chen, "Some intuitionistic fuzzy Dombi Bonferroni mean operators and their application to multi-attribute group decision making," *Journal of the Operational Research Society*, vol. 69, no. 1, pp. 1–24, 2018.

[18] P. Gupta, H. D. Arora, and P. Tiwari, "Generalized entropy for intuitionistic fuzzy sets," *Malaysian Journal of Mathematical Sciences*, vol. 10, pp. 209–220, 2016.

[19] Y. He, Z. He, and H. Huang, "Decision making with the generalized intuitionistic fuzzy power interaction averaging operators," *Soft Computing*, vol. 21, no. 5, pp. 1129–1144, 2017.

[20] H. Garg, "Generalized intuitionistic fuzzy multiplicative interactive geometric operators and their application to multiple criteria decision making," *International Journal of Machine Learning and Cybernetics*, vol. 7, no. 6, pp. 1075–1092, 2016.

[21] S.-M. Chen, S.-H. Cheng, and T.-C. Lan, "Multicriteria decision making based on the TOPSIS method and similarity measures between intuitionistic fuzzy values," *Information Sciences*, vol. 367-368, pp. 279–295, 2016.

[22] B. D. Rouyendegh, "The intuitionistic fuzzy ELECTRE model," *International Journal of Management Science and Engineering Management*, vol. 13, no. 2, pp. 139–145, 2018.

[23] J. W. Gan and L. Luo, "Using DEMATEL and intuitionistic fuzzy sets to identify critical factors influencing the recycling rate of end-of-life vehicles in China," *Sustainability*, vol. 9, 2017.

[24] F. Jin, Z. Ni, H. Chen, and Y. Li, "Approaches to group decision making with intuitionistic fuzzy preference relations based on multiplicative consistency," *Knowledge-Based Systems*, vol. 97, pp. 48–59, 2016.

[25] L. Xiao, S. Zhang, G. Wei et al., "Green supplier selection in steel industry with intuitionistic fuzzy taxonomy method," *Journal of Intelligent & Fuzzy Systems*, vol. 39, no. 5, pp. 7247–7258, 2020.

[26] M. Zhao, G. Wei, C. Wei, and J. Wu, "Improved TODIM method for intuitionistic fuzzy MAGDM based on cumulative prospect theory and its application on stock investment selection," *International Journal of Machine Learning and Cybernetics*, vol. 12, no. 3, pp. 891–901, 2021.

[27] S. Cali and S. Y. Balaman, "A novel outranking based multi criteria group decision making methodology integrating ELECTRE and VIKOR under intuitionistic fuzzy

environment," *Expert Systems with Applications*, vol. 119, pp. 36–50, 2019.

[28] Z. Hao, Z. Xu, H. Zhao, and R. Zhang, "Novel intuitionistic fuzzy decision making models in the framework of decision field theory," *Information Fusion*, vol. 33, pp. 57–70, 2017.

[29] P. Gupta, M. K. Mehlawat, N. Grover, and W. Chen, "Modified intuitionistic fuzzy SIR approach with an application to supplier selection," *Journal of Intelligent & Fuzzy Systems*, vol. 32, no. 6, pp. 4431–4441, 2017.

[30] P. Li, J. Liu, S. F. Liu, X. Su, and J. Wu, "Grey target method for intuitionistic fuzzy decision making based on grey incidence analysis," *Journal of Grey System*, vol. 28, pp. 96–109, 2016.

[31] X. J. Gou, Z. S. Xu, and Q. Lei, "New operational laws and aggregation method of intuitionistic fuzzy information," *Journal of Intelligent & Fuzzy Systems*, vol. 30, pp. 129–141, 2016.

[32] M. S. Khan and Q. M. D. Lohani, *A Similarity Measure for Atanassov Intuitionistic Fuzzy Sets and its Application to Clustering*, IEEE, New York, NY, USA, 2016.

[33] T. Bao, X. Xie, P. Long, and Z. Wei, "MADM method based on prospect theory and evidential reasoning approach with unknown attribute weights under intuitionistic fuzzy environment," *Expert Systems with Applications*, vol. 88, pp. 305–317, 2017.

[34] B. Oztaysi, S. C. Onar, K. Goztepe, and C. Kahraman, "Evaluation of research proposals for grant funding using interval-valued intuitionistic fuzzy sets," *Soft Computing*, vol. 21, no. 5, pp. 1203–1218, 2017.

[35] M. Sahu, A. Gupta, and A. Mehra, "Hierarchical clustering of interval-valued intuitionistic fuzzy relations and its application to elicit criteria weights in MCDM problems," *Opsearch*, vol. 54, no. 2, pp. 388–416, 2017.

[36] S. Xian, Y. Dong, and Y. Yin, "Interval-valued intuitionistic fuzzy combined weighted averaging operator for group decision making," *Journal of the Operational Research Society*, vol. 68, no. 8, pp. 895–905, 2017.

[37] W. Zhang, Y. Ju, and X. Liu, "Interval-valued intuitionistic fuzzy programming technique for multicriteria group decision making based on Shapley values and incomplete preference information," *Soft Computing*, vol. 21, no. 19, pp. 5787–5804, 2017.

[38] Z. Zhang, "Interval-valued intuitionistic fuzzy frank aggregation operators and their applications to multiple attribute group decision making," *Neural Computing and Applications*, vol. 28, no. 6, pp. 1471–1501, 2017.

[39] X. An, Z. Wang, H. Li, and J. Ding, "Project delivery system selection with interval-valued intuitionistic fuzzy set group decision-making method," *Group Decision and Negotiation*, vol. 27, no. 4, pp. 689–707, 2018.

[40] S. Zeng, S.-M. Chen, and K.-Y. Fan, "Interval-valued intuitionistic fuzzy multiple attribute decision making based on nonlinear programming methodology and TOPSIS method," *Information Sciences*, vol. 506, pp. 424–442, 2020.

[41] M. Zhao, G. Wei, C. Wei, J. Wu, and Y. Wei, "Extended CPT-TODIM method for interval-valued intuitionistic fuzzy MAGDM and its application to urban ecological risk assessment," *Journal of Intelligent & Fuzzy Systems*, vol. 40, no. 3, pp. 4091–4106, 2021.

[42] W. Wang and J. M. Mendel, "Interval-valued intuitionistic fuzzy aggregation methodology for decision making with a prioritization of criteria," *Iranian Journal of Fuzzy Systems*, vol. 16, pp. 115–127, 2019.

[43] C. L. Hwang and K. Yoon, *Multiple Attribute Decision Making Methods and Applications*, Springer, Berlin, Germany, 1981.

[44] W. G. Yang and Y. J. Wu, "A novel TOPSIS method based on improved grey relational analysis for multiattribute decision-making problem," *Mathematical Problems in Engineering*, vol. 2019, Article ID 8761681, 10 pages, 2019.

[45] M. Yucesan, S. Mete, F. Serin, E. Celik, and M. Gul, "An integrated best-worst and interval type-2 fuzzy TOPSIS methodology for green supplier selection," *Mathematics*, vol. 7, 2019.

[46] R. Zamani and R. Berndtsson, "Evaluation of CMIP5 models for west and southwest Iran using TOPSIS-based method," *Theoretical and Applied Climatology*, vol. 137, no. 1-2, pp. 533–543, 2019.

[47] S. Rouhani, M. Ghazanfari, and M. Jafari, "Evaluation model of business intelligence for enterprise systems using fuzzy TOPSIS," *Expert Systems with Applications*, vol. 39, no. 3, pp. 3764–3771, 2012.

[48] R. M. Zulqarnain, X. L. Xin, I. Siddique, W. Asghar Khan, and M. A. Yousif, "TOPSIS method based on correlation coefficient under Pythagorean fuzzy soft environment and its application towards green supply chain management," *Sustainability*, vol. 13, no. 4, p. 1642, 2021.

[49] R. M. Zulqarnain, X. L. Xin, M. Saqlain, W. A. Khan, and F. Feng, "TOPSIS method based on the correlation coefficient of interval-valued intuitionistic fuzzy soft sets and aggregation operators with their application in decision-making," *Journal of Mathematics*, vol. 2021, Article ID 6656858, 16 pages, 2021.

[50] K. T. Atanassov, "Operators over interval valued intuitionistic fuzzy sets," *Fuzzy Sets and Systems*, vol. 64, no. 2, pp. 159–174, 1994.

[51] Z. Xu and R. R. Yager, "Some geometric aggregation operators based on intuitionistic fuzzy sets," *International Journal of General Systems*, vol. 35, no. 4, pp. 417–433, 2006.

[52] H.-W. Liu and G.-J. Wang, "Multi-criteria decision-making methods based on intuitionistic fuzzy sets," *European Journal of Operational Research*, vol. 179, no. 1, pp. 220–233, 2007.

[53] E. Szmidt and J. Kacprzyk, "Distances between intuitionistic fuzzy sets," *Fuzzy Sets and Systems*, vol. 114, no. 3, pp. 505–518, 2000.

[54] Z.-X. Su, G.-P. Xia, and M.-Y. Chen, "Some induced intuitionistic fuzzy aggregation operators applied to multi-attribute group decision making," *International Journal of General Systems*, vol. 40, no. 8, pp. 805–835, 2011.

[55] D. Diakoulaki, G. Mavrotas, and L. Papayannakis, "Determining objective weights in multiple criteria problems: the critic method," *Computers & Operations Research*, vol. 22, no. 7, pp. 763–770, 1995.

[56] X. Zhao, S. Tang, S. Yang, and K. Huang, "Extended VIKOR method based on cross-entropy for interval-valued intuitionistic fuzzy multiple criteria group decision making," *Journal of Intelligent & Fuzzy Systems*, vol. 25, no. 4, pp. 1053–1066, 2013.

[57] F. B. Yeni and G. Özçelik, "Interval-valued atanassov intuitionistic fuzzy CODAS method for multi criteria group decision making problems," *Group Decision and Negotiation*, vol. 28, no. 2, pp. 433–452, 2019.

[58] T. He, G. Wei, J. Lu, J. Wu, C. Wei, and Y. Guo, "A novel EDAS based method for multiple attribute group decision making with Pythagorean 2-tuple linguistic information," *Technological and Economic Development of Economy*, vol. 26, no. 6, pp. 1125–1138, 2020.

[59] E. K. Zavadskas, Z. Stevic, I. Tanackov, and O. Prentkovskis, "A novel multicriteria approach—rough step-wise weight assessment ratio analysis method (R-SWARA) and its

application in logistics," *Studies in Informatics and Control*, vol. 27, pp. 97–106, 2018.

[60] S. H. Zolfani, M. Yazdani, and E. K. Zavadskas, "An extended stepwise weight assessment ratio analysis (SWARA) method for improving criteria prioritization process," *Soft Computing*, vol. 22, pp. 7399–7405, 2018.

[61] T. He, G. Wei, J. Wu, and C. Wei, "QUALIFLEX method for evaluating human factors in construction project management with Pythagorean 2-tuple linguistic information," *Journal of Intelligent & Fuzzy Systems*, vol. 40, no. 3, pp. 4039–4050, 2021.

[62] J. Li, L. Wen, G. Wei, J. Wu, and C. Wei, "New similarity and distance measures of Pythagorean fuzzy sets and its application to selection of advertising platforms," *Journal of Intelligent & Fuzzy Systems*, vol. 40, no. 3, pp. 5403–5419, 2021.

[63] K. Liang and D. Li, "A direct method of interval Banzhaf values of interval cooperative games," *Journal of Systems Science and Systems Engineering*, vol. 28, no. 3, pp. 382–391, 2019.

[64] T. He, S. Zhang, G. Wei, R. Wang, J. Wu, and C. Wei, "CODAS method for 2-tuple linguistic Pythagorean fuzzy multiple attribute group decision making and its application to financial management performance assessment," *Technological and Economic Development of Economy*, vol. 26, no. 4, pp. 920–932, 2020.

[65] F. Lei, G. Wei, J. Wu, C. Wei, and Y. Guo, "QUALIFLEX method for MAGDM with probabilistic uncertain linguistic information and its application to green supplier selection," *Journal of Intelligent & Fuzzy Systems*, vol. 39, no. 5, pp. 6819–6831, 2020.

[66] G.-F. Yu, W. Fei, and D.-F. Li, "A compromise-typed variable weight decision method for hybrid multiattribute decision making," *IEEE Transactions on Fuzzy Systems*, vol. 27, no. 5, pp. 861–872, 2019.

[67] G. Wei, Y. He, F. Lei, J. Wu, C. Wei, and Y. Guo, "Green supplier selection with an uncertain probabilistic linguistic MABAC method," *Journal of Intelligent & Fuzzy Systems*, vol. 39, no. 3, pp. 3125–3136, 2020.

[68] X. Xiong, P. Zhou, Y. Yin, T. C. E. Cheng, and D. Li, "An exact branch-and-price algorithm for multitasking scheduling on unrelated parallel machines," *Naval Research Logistics (NRL)*, vol. 66, no. 6, pp. 502–516, 2019.