IEEE Access
Multidisciplinary : Rapid Review : Open Access Journal

Received 25 June 2024, accepted 30 July 2024, date of publication 2 August 2024, date of current version 12 August 2024.

Digital Object Identifier 10.1109/ACCESS.2024.3437760

RESEARCH ARTICLE

An Interactive Data-Driven Multiple-Attribute Decision-Making Technique With Interval-Valued Intuitionistic Fuzzy Information for Satisfaction Evaluation of Public Art in Urban Squares

RONGHUA KE [1], CHENHUANG LIN [2], AND YUNLAI ZHANG [2]
[1]School of Art and Design, Guangdong University of Science and Technology, Dongguan, Guangdong 523668, China
[2]College of Fine Arts, Weifang University, Weifang, Shandong 261061, China

Corresponding author: Ronghua Ke (dgsmx@163.com)

ABSTRACT For the design of public spaces in most cities' squares, media art forms should be actively adopted in popular culture, and effective media forms such as television and imaging should also be invested. The best way to effectively create a square atmosphere is to choose the best media art, find the simplest communication approaches, improve its simplicity, directness, attraction, and further popularize the form of popular art. The satisfaction evaluation of public art in urban squares is multiple-attribute decision-making (MADM). In this study, the interval-valued intuitionistic fuzzy (IVIF) Hamacher interactive power weighted averaging (IVIFHIPWA) approach is implemented based on the IVIF Hamacher interactive weighted averaging (IVIFHIWA) approach and power average (PA) approach. Then, the IVIFHIPWA approach is employed to put up with MADM with IVIFSs. Finally, numerical example for satisfaction evaluation of public art in urban squares is employed to test the IVIFHIPWA. Thus, the major contributions of this research are concluded: (1) IVIFHIPWA approach is constructed in light with IVIFHIWA and PA approach; (2) IVIFHIPWA approach is put forward MADM with IVIFSs; (3) numerical example for satisfaction evaluation of public art in urban squares has been put forward the IVIFHIPWA approach.

INDEX TERMS Multiple-attribute decision-making (MADM), IVIFSs, IVIFHIPWA approach, satisfaction evaluation.

I. INTRODUCTION

The formation of the concept of public art first appeared in the United States from the 1950s to the 1960s. Recognizing the important role of public art in people's lives, the United States immediately established the National Art Foundation and began to support the development of public art programs [1], [2], [3]. At this time, many artists participated in this activity, such as Picasso, Calder, and others. At the same time, in this context, representative and outstanding public art works have been created, promoting the smooth implementation of public art plans [4], [5], [6]. Afterwards, some major cities in the United States began to formulate relevant laws and regulations to ensure the smooth progress of public art [7], [8], [9]. Public art gradually entered urban construction, and some project planning began to consider incorporating public art [10]. Influenced by the United States, public art began to sprout in Europe and Asia in the mid-1960s and was constructed in urban public spaces [11]. The conformity of public space and urban regional culture with residents' behavioral habits reflects whether a square design is tailored to local conditions [12], [13], [14]. Classical squares with hard pavement or buildings as the main focus generally do not have green spaces, so caring for "people" is the primary consideration in

The associate editor coordinating the review of this manuscript and approving it for publication was Qi Zhou.

urban square design; The spirit of "place" in modern squares is mainly achieved through various facility configurations and functional zoning [15], [16]. Taking "people" as the main body, reflecting "humanization", making the square planning and design closer to people's lives. (1) The square should have hard paving for people's activities, while enriching the landscape layers and colors, and shielding the scorching sun in summer. The green area of the square should not be less than 25% of the total square area [17], [18]. (2) In addition to aesthetic public artworks such as sculptures, fountains, and sketches, there should also be service facilities such as seats, public toilets, and water dispensers in the square. The square design should achieve reasonable layout, complete functions, and beautiful environment to fully meet the different needs of citizens [19], [20]. (3) To organize traffic flow lines based on urban planning and ensure pedestrian safety, it is necessary to handle the traffic relationship with surrounding roads. Except for transportation squares, other squares generally restrict the passage of motor vehicles [21], [22]. The creation of public art is based on public affinity, integrated with the scene, allowing works to penetrate into social life, weakening the barriers between the subject and object, and keeping people's inner feelings in a happy and positive state [23], [24]. While appreciating works, people can also participate in them, allowing citizens and creators to interact and exchange psychological and emotional practices [25]. Only in this way can the development of public art in cities be promoted. Interactivity is the true intention of achieving public participation, it is a means and a prerequisite for public participation. The balance between personal innovation and public will is the two fundamental points that public art creation must strive to find. Based on these two fundamental points, we can create public art that both parties are satisfied with. Participation is a part of creation and a subsequent enhancement of creation [26], [27]. Artists engaged in public art need to listen to the opinions of the public, understand the different needs of citizens, understand the social situation, and create works that conform to public opinion according to local conditions [28], [29], [30].

MADM is a prevalent and significant issue in the realm of economic analysis [31], [32], [33]. Numerous real-life management problems, including logistics location selection, medical service evaluation and supplier selection, can be effectively addressed through the lens of MADM [34], [35], [36], [37], [38]. As a vital subfield within modern decision-making, MADM approaches have garnered substantial attention from more and more scholars [39], [40], [41], [42], [43]. In recent decades, notable advancements have been made in MADM research, and these approaches have found extensive practical applications in various decision-making scenarios [44], [45], [46], [47]. In order to manage uncertain data, Zadeh [48] administrated fuzzy sets (FSs). Atanassov [49] administrated the intuitionistic FSs (IFSs). Atanassov and Gargov [50] constructed the interval-valued IFSs (IVIFSs). Mao [51] constructed the IVIFHIPA approach and Du and Yang [52] put forward the IVIFHIPG approach. However, both the IVIFHIPA approach and IVIFHIPG approach have not taken into account the weight information. Additionally, there has been no previous adoption of interactive Hamacher approach [53] and PA approach [54] to develop a MADM model for the satisfaction evaluation of public art in urban squares. Hence, this study extends the application of interactive Hamacher approach [53] and PA approach [54]. Subsequently, an IVIFHIPWA approach is implemented based on the IVIFHIWA approach and PA approach. Several desirable properties of the IVIFHIPWA approach are examined. The IVIFHIPWA approach is then employed for MADM under IVIFSs. Finally, numerical example is presented to evaluate the satisfaction of public art in urban squares using the IVIFHIPWA approach. Therefore, the objectives and motivations of this study are outlined: (1) Construction of IVIFHIPWA approach based on IVIFHIWA approach and PA approach; (2) Proposal of IVIFHIPWA approach to address MADM problems under IVIFSs; (3) Demonstration of IVIFHIPWA approach through numerical example for the satisfaction evaluation of public art in urban squares.

The framework of this study is structured: Part 2 introduces the IVIFSs. Part 3 presents the IVIFHIPWA methodology. Part 4 proposes a MADM based on IVIFHIPWA approach under IVIFSs. Part 5 offers illustrative example that applies IVIFHIPWA approach to evaluate the satisfaction of public art in urban squares. Finally, Part 6 concludes the paper with final remarks.

II. PRELIMINARIES

The IVIFSs is implemented [55].

Definition 1 ([55]): The IVIFSs is implemented:

$$RS = \{\langle \theta, RM(\theta), SN(\theta) \rangle | \theta \in X\} \tag{1}$$

where $RM(\theta) \subset [0, 1]$ is membership, $SN(\theta) \subset [0, 1]$ is non-membership, $RM(\theta), SN(\theta)$ meets decision condition: $0 \leq \sup RM(\theta) + \sup SN(\theta) \leq 1, \forall \theta \in X$. Then, we denote $RS = ([RL, RR], [SL, SR])$ is IVIFN.

Definition 2 ([56]): Let $RS_1 = ([RL_1, RR_1], [SL_1, SR_1])$ and $RS_2 = ([RL_2, RR_2], [SL_2, SR_2])$ be IVIFNs, the operational laws are administrated:

$$RS_1 \oplus RS_2 = \left(\begin{array}{c} \left[\begin{array}{c} RL_1 + RL_2 - RL_1 RL_2, \\ RR_1 + RR_2 - RR_1 RR_2 \end{array} \right], \\ [SL_1 SL_2, SR_1 SR_2] \end{array} \right) \tag{2}$$

$$RS_1 \otimes RS_2 = \left(\begin{array}{c} [RL_1 RL_2, RR_1 RR_2], \\ \left[\begin{array}{c} SL_1 + SL_2 - SL_1 SL_2, \\ SR_1 + SR_2 - SR_1 SR_2 \end{array} \right] \end{array} \right) \tag{3}$$

$$\lambda RS_1 = \left(\begin{array}{c} \left[1 - (1 - RL_1)^{\lambda}, 1 - (1 - RR_1)^{\lambda} \right], \\ \left[(SL_1)^{\lambda}, (SR_1)^{\lambda} \right] \end{array} \right), \quad \lambda > 0 \tag{4}$$

$$RS_1^{\lambda} = \left(\begin{array}{c} \left[(RL_1)^{\lambda}, (RR_1)^{\lambda}\right], \\ \left[1-(1-SL_1)^{\lambda}, 1-(1-SR_1)^{\lambda}\right] \end{array} \right), \lambda > 0 \tag{5}$$

From Def. 2, the properties are administrated.

$$\begin{aligned} (1)\ RS_1 \oplus RS_2 &= RS_2 \oplus RS_1, RS_1 \otimes RS_2 \\ &= RS_2 \otimes RS_1, \left((RS_1)^{\lambda_1}\right)^{\lambda_2} = (RS_1)^{\lambda_1\lambda_2}; \\ (2)\ \lambda\,(RS_1 \oplus RS_2) &= \lambda RS_1 \oplus \lambda RS_2,\ (RS_1 \otimes RS_2)^{\lambda} \\ &= (RS_1)^{\lambda} \otimes (RS_2)^{\lambda}; \\ (3)\ \lambda_1 RS_1 \oplus \lambda_2 RS_1 &= (\lambda_1+\lambda_2)\, RS_1,\ (RS_1)^{\lambda_1} \otimes (RS_1)^{\lambda_2} \\ &= (RS_1)^{(\lambda_1+\lambda_2)}. \end{aligned}$$

Definition 3 ([57]): Let $RS_1 = ([RL_1, RR_1], [SL_1, SR_1])$ and $RI_2 = ([RL_2, RR_2], [SL_2, SR_2])$ be IVIFNs, the score value and accuracy value of RS_1 and RS_2 are established: (6)–(9), shown at the bottom of the next page.

For two IVIFNs RS_1 and RS_2, from Definition 3, then

$$\begin{aligned} &(1)\ \textit{if}\ SV(RS_1) < SV(RS_2),\ \ RS_1 < RS_2; \\ &(2)\ \textit{if}\ SV(RS_1) > SV(RS_2), RS_1 > RS_{22}; \\ &(3)\ \textit{if}\ SV(RS_1) = SV(RS_2), AV(RS_1) < AV(RS_2), \\ &RS_1 < RS_2; \\ &(4)\ \textit{if}\ SV(RS_1) = SV(RS_2), AV(RS_1) = AV(RS_2), \\ &RS_1 = RS_2. \end{aligned}$$

Definition 4 ([58]): Let $RS_1 = ([RL_1, RR_1], [SL_1, SR_1])$ and $RS_2 = ([RL_2, RR_2], [SL_2, SR_2])$ be IVIFNs, the IVIFN Euclidean distance (IVIFNED) is administrated:

$$IVIFNED(RS_1, RS_2) = \sqrt{\frac{1}{4}\left[\begin{array}{l} (RL_1 - RL_2)^2 + (RR_1 - RR_2)^2 \\ +(SL_1 - SL_2)^2 + (SR_1 - SR_2)^2 \end{array} \right]} \tag{10}$$

Garg et al. [53] constructed the improved Hamacher approach for IVIFS.

Definition 5 ([53]): Let $RS_1 = ([RL_1, RR_1], [SL_1, SR_1])$ and $RS_2 = ([RL_2, RR_2], [SL_2, SR_2])$ be IVIFNs, $r\xi > 1$, the operational rules for IVIFNs are constructed:

$$RS_1 \oplus RS_2 = \left(\begin{array}{c} \left[\begin{array}{c} \dfrac{\prod_{si=1}^{2}(1+(r\xi-1)\,RL_i) - \prod_{si=1}^{2}(1-RL_i)}{\prod_{si=1}^{2}(1+(r\xi-1)\,RL_i) - (r\xi-1)\prod_{si=1}^{2}(1-RL_i)}, \\ \dfrac{\prod_{si=1}^{2}(1+(r\xi-1)\,RR_i) - \prod_{si=1}^{2}(1-RR_i)}{\prod_{si=1}^{2}(1+(r\xi-1)\,RR_i) - (r\xi-1)\prod_{si=1}^{2}(1-RR_i)} \end{array} \right], \\ \left[\begin{array}{c} \dfrac{r\xi\prod_{si=1}^{2}(1-RL_i) - r\xi\prod_{si=1}^{2}(1-RL_i-SL_i)}{\prod_{si=1}^{2}(1+(r\xi-1)\,RL_i) - (r\xi-1)\prod_{si=1}^{2}(1-RL_i)}, \\ \dfrac{r\xi\prod_{si=1}^{2}(1-RR_i) - r\xi\prod_{si=1}^{2}(1-RR_i-SR_i)}{\prod_{si=1}^{2}(1+(r\xi-1)\,WR_i) - (r\xi-1)\prod_{si=1}^{2}(1-RR_i)} \end{array} \right] \end{array} \right);$$

$$RS_1 \otimes RS_2 = \left(\begin{array}{c} \left[\begin{array}{c} \dfrac{r\xi\prod_{si=1}^{2}(1-RL_i) - r\xi\prod_{si=1}^{2}(1-RL_i-SL_i)}{\prod_{si=1}^{2}(1+(r\xi-1)\,RL_i) - (r\xi-1)\prod_{si=1}^{2}(1-RL_i)}, \\ \dfrac{r\xi\prod_{si=1}^{2}(1-RR_i) - r\xi\prod_{si=1}^{2}(1-RR_i-SR_i)}{\prod_{si=1}^{2}(1+(r\xi-1)\,RR_i) - (r\xi-1)\prod_{si=1}^{2}(1-RR_i)} \end{array} \right], \\ \left[\begin{array}{c} \dfrac{\prod_{si=1}^{2}(1+(r\xi-1)\,RL_i) - \prod_{si=1}^{2}(1-RL_i)}{\prod_{si=1}^{2}(1+(r\xi-1)\,RL_i) - (r\xi-1)\prod_{si=1}^{2}(1-RL_i)}, \\ \dfrac{\prod_{si=1}^{2}(1+(r\xi-1)\,RR_i) - \prod_{si=1}^{2}(1-RR_i)}{\prod_{si=1}^{2}(1+(r\xi-1)\,RR_i) - (r\xi-1)\prod_{si=1}^{2}(1-RR_i)} \end{array} \right] \end{array} \right);$$

$$\lambda RS_1 = \left(\begin{array}{c} \left[\begin{array}{c} \dfrac{(1+(r\xi-1)\,RL_i)^{\lambda} - (1-RL_i)^{\lambda}}{(1+(r\xi-1)\,RL_i)^{\lambda} + (r\xi-1)\,(1-RL_i)^{\lambda}}, \\ \dfrac{(1+(r\xi-1)\,RR_i)^{\lambda} - (1-RR_i)^{\lambda}}{(1+(r\xi-1)\,RR_i)^{\lambda} + (r\xi-1)\,(1-RR_i)^{\lambda}} \end{array} \right], \\ \left[\begin{array}{c} \dfrac{r\xi(1-RL_i)^{\lambda} - r\xi(1-RL_i-SL_i)^{\lambda}}{(1+(r\xi-1)\,RL_i)^{\lambda} + (r\xi-1)\,(1-RL_i)^{\lambda}}, \\ \dfrac{r\xi(1-RR_i)^{\lambda} - r\xi(1-RR_i-SR_i)^{\lambda}}{(1+(r\xi-1)\,RR_i)^{\lambda} + (r\xi-1)\,(1-RR_i)^{\lambda}} \end{array} \right] \end{array} \right);$$

$$(RS_1)^{\lambda} = \left(\begin{bmatrix} \frac{r\xi(1-RL_i)^{\lambda} - r\xi(1-RL_i-SL_i)^{\lambda}}{(1+(r\xi-1)RL_i)^{\lambda}+(r\xi-1)(1-RL_i)^{\lambda}}, \\ \frac{r\xi(1-RR_i)^{\lambda} - r\xi(1-RR_i-SR_i)^{\lambda}}{(1+(r\xi-1)RR_i)^{\lambda}+(r\xi-1)(1-RR_i)^{\lambda}} \end{bmatrix}, \begin{bmatrix} \frac{(1+(r\xi-1)RL_i)^{\lambda} - (1-RL_i)^{\lambda}}{(1+(r\xi-1)RL_i)^{\lambda}+(r\xi-1)(1-RL_i)^{\lambda}}, \\ \frac{(1+(r\xi-1)RR_i)^{\lambda} - (1-RR_i)^{\lambda}}{(1+(r\xi-1)RR_i)^{\lambda}+(r\xi-1)(1-RR_i)^{\lambda}} \end{bmatrix} \right).$$

A. IVIFHIPWA APPROACH

Then, the IVIFHIWA approach is introduced [53].

Definition 6 ([53]): Let $RS_{sj} = ([RL_{sj}, RR_{sj}], [SL_{sj}, SR_{sj}])$ $(sj = 1, 2, 3, \cdots, n)$ be IVIFNs, $r\xi > 0$ and IVIFHIWA is introduced:

$$IVIFHIWA_{r\omega}(RS_1, RS_2, \cdots, RS_n) = \mathop{\oplus}_{sj=1}^{n} r\omega_{sj} RS_{sj} =$$
$$\left(\begin{bmatrix} \frac{\prod_{sj=1}^{n}(1+(r\xi-1)RL_j)^{r\omega_j} - \prod_{sj=1}^{n}(1-RL_j)^{r\omega_j}}{\prod_{sj=1}^{n}(1+(r\xi-1)RL_j)^{r\omega_j} - (r\xi-1)\prod_{sj=1}^{n}(1-RL_j)^{r\omega_j}}, \\ \frac{\prod_{sj=1}^{n}(1+(r\xi-1)RR_j)^{r\omega_j} - \prod_{sj=1}^{n}(1-RR_j)^{r\omega_j}}{\prod_{sj=1}^{n}(1+(r\xi-1)RR_j)^{r\omega_j} - (r\xi-1)\prod_{sj=1}^{n}(1-RR_j)^{r\omega_j}} \end{bmatrix}, \begin{bmatrix} \frac{r\xi\prod_{sj=1}^{n}(1-RL_j)^{r\omega_j} - r\xi\prod_{sj=1}^{n}(1-RL_j-SL_j)^{r\omega_j}}{\prod_{sj=1}^{n}(1+(r\xi-1)RL_j)^{r\omega_j} - (r\xi-1)\prod_{sj=1}^{n}(1-RL_j)^{r\omega_j}}, \\ \frac{r\xi\prod_{sj=1}^{n}(1-RR_j)^{r\omega_j} - r\xi\prod_{sj=1}^{n}(1-RR_j-SR_j)^{r\omega_j}}{\prod_{sj=1}^{n}(1+(r\xi-1)RR_j)^{r\omega_j} - (r\xi-1)\prod_{sj=1}^{n}(1-RR_j)^{r\omega_j}} \end{bmatrix} \right) \quad (11)$$

where $r\omega = (r\omega_1, r\omega_2, \cdots, r\omega_n)^T$ be weight values of RS_{sj}, $r\omega_{sj} > 0$, $\sum_{sj=1}^{n} r\omega_{sj} = 1$.

The IVIFHIWA approach has three properties [53].

Theorem 1 (Idempotency): If $RS_{sj} = ([RL_{sj}, RR_{sj}], [SL_{sj}, SR_{sj}])$ are equal, i.e. $RS_{sj} = RS$ for all sj, then

$$IVIFHIWA_{r\omega}(RS_1, RS_2, \cdots, RS_n) = RS \quad (12)$$

Theorem 2 (Boundedness): Let $RS_{sj} = ([RL_{sj}, RR_{sj}], [SL_{sj}, SR_{sj}])$ be a family of IVIFNs, and let

$$RS^- = \min_{sj} RS_{sj}, \; RS^+ = \max_{sj} RS_{sj}$$

Then

$$RS^- \le IVIFHIWA_{r\omega}(RS_1, RS_2, \cdots, RS_n) \le RS^+ \quad (13)$$

Theorem 3 (Monotonicity): Let RS_{sj} $(sj = 1, 2, 3, \cdots, n)$ and RS'_{sj} $(sj = 1, 2, 3, \cdots, n)$ be IVIFNs, if $RS_j \le RS'_j$, for all j, then

$$IVIFHIWA_{r\omega}(RS_1, RS_2, \cdots, RS_n) \le IVIFHIWA_{r\omega}(RS'_1, RS'_2, \cdots, RS'_n) \quad (14)$$

Theorem 4 (Commutativity): Let RS_{sj} and $RS'_{sj}(sj = 1, 2, \cdots, n)$ be IVIFNs, then

$$IVIFHIWA_{r\omega}(RS_1, RS_2, \cdots, RS_n) = IVIFHIWA_{r\omega}(RS'_1, RS'_2, \cdots, RS'_n) \quad (15)$$

where RS'_{sj} $(sj = 1, 2, \cdots, n)$ is any permutation of RS_{sj}.

Definition 7 ([54]): The PA approach is administrated:

$$PA(ra_1, ra_2, \cdots, ra_n) = \frac{\sum_{sj=1}^{n}(1+ST(ra_{sj}))ra_{sj}}{\sum_{sj=1}^{n}(1+ST(ra_{sj}))} \quad (16)$$

where

$$ST(ra_{sj}) = \sum_{\substack{si=1 \\ si \ne sj}}^{n} Sup(ra_{sj}, ra_{si}),$$

and $Sup(ra, rb)$ is support for ra from rb, which meets some properties: (1)$Sup(ra, rb) \in [0, 1]$;(2)$Sup(ra, rb) = Sup(rb, ra)$; (3) $Sup(ra, rb) \ge Sup(rx, ry)$, if $|ra - rb| < |rx - ry|$.

Then, IVIFHIPWA approach is constructed based on IVIFHIWA approach [53] and PA approach [54]

Definition 8: Let $RS_{sj} = ([RL_{sj}, RR_{sj}], [SL_{sj}, SR_{sj}])$ $(sj = 1, 2, \cdots, n)$ be IVIFN, and IVIFHIPWA is constructed:

$$IVIFHIPWA_{r\omega}(RS_1, RS_2, \cdots, RS_n)$$

$$SV(RS_1) = \frac{RL_1 + RL_1(1 - RL_1 - SL_1) + RR_1 + RR_1(1 - RR_1 - SR_1)}{2} \quad (6)$$

$$SV(RI_2) = \frac{RL_2 + RL_2(1 - RL_2 - SL_2) + RR_2 + RR_2(1 - RR_2 - SR_2)}{2} \quad (7)$$

$$AV(RS_1) = \frac{RL_1 + SL_1 + RR_1 + SR_1}{2}, \quad (8)$$

$$AV(RS_2) = \frac{RL_2 + SL_2 + RR_2 + SR_2}{2} \quad (9)$$

TABLE 1. IVIFN-matrix.

Alternatives	SU_1	SU_2
RU_1	([0.21,0.53], [0.17,0.47])	([0.19,0.23], [0.46,0.72])
RU_2	([0.35,0.73], [0.15,0.25])	([0.32,0.54], [0.25,0.46])
RU_3	([0.14,0.72], [0.23,0.26])	([0.42,0.58], [0.16,0.42])
RU_4	([0.45,0.52], [0.32,0.43])	([0.34,0.59], [0.22,0.45])
RU_5	([0.38,0.51], [0.21,0.49])	([0.35,0.64], [0.26,0.36])

Alternatives	SU_3	SU_4
RU_1	([0.28,0.57], [0.12,0.43])	([0.25,0.65], [0.26,0.34])
RU_2	([0.18,0.36], [0.22,0.64])	([0.63,0.84], [0.13,0.15])
RU_3	([0.52,0.56], [0.31,0.43])	([0.41,0.51], [0.38,0.47])
RU_4	([0.24,0.64], [0.25,0.32])	([0.38,0.64], [0.32,0.36])
RU_5	([0.27,0.39], [0.52,0.61])	([0.23,0.51], [0.43, 0.47])

$$= \bigoplus_{sj=1}^{n} \frac{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}{\sum_{sj=1}^{n} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} RS_{sj} \tag{17}$$

where $r\omega = (r\omega_1, r\omega_2, \cdots, r\omega_n)^T$ be weight of RS_{sj} and $r\omega_{sj} > 0$, $\sum_{sj=1}^{n} r\omega_{sj} = 1$.$T\left(RS_{sj}\right) = \sum_{\substack{si=1\\si\neq sj}}^{n} r\omega_{si} Sup\left(RS_{sj}, RS_{si}\right)$, and $Sup\left(RS_{sj}, RS_{si}\right)$ is support for RS_j from RS_i meets the conditions: (1) $Sup\left(RS_{sj}, RS_{si}\right) \in [0,1]$; (2) $Sup\left(RS_{sj}, RS_{si}\right) = Sup\left(RS_{si}, RS_{sj}\right)$; (3) $Sup\left(RS_{sj}, RS_{st}\right) \geq Sup\left(RS_{ss}, RS_{sk}\right)$, if $IVIFED\left(RS_{sj}, RS_{si}\right) \geq IVIFED\left(RS_{ss}, RS_{sk}\right)$, where IVIFNED is distance measure.

In line with Def. 8, we can get the result:

Theorem 5: The aggregated value with IVIFHIPWA approach is IVIFN, $r\xi > 1$ where (18), as shown at the bottom of page 8, where $r\omega = (r\omega_1, r\omega_2, \cdots, r\omega_n)^T$ be weight ofRS_{sj} and$r\omega_{sj} > 0$, $\sum_{sj=1}^{n} r\omega_{sj} = 1$.

$$ST\left(RS_{sj}\right) = \sum_{\substack{si=1\\si\neq sj}}^{n} r\omega_{si} Sup\left(RS_{sj}, RS_{si}\right), \text{ and } Sup\left(RS_{sj}, RS_{si}\right)$$

is support for RS_j from RS_i meets the conditions: (1) $Sup\left(RS_{sj}, RS_{si}\right) \in [0,1]$; (2) $Sup\left(RS_{sj}, RS_{si}\right) = Sup\left(RS_{si}, RS_{sj}\right)$; (3) $Sup\left(RS_{sj}, RS_{st}\right) \geq Sup\left(RS_{ss}, RS_{sk}\right)$, if $IVIFED\left(RS_{sj}, RS_{si}\right) \geq IVIFED\left(RS_{ss}, RS_{sk}\right)$, where IVIFNED is distance measure.

Proof: When $n = 1$ and $\frac{r\omega_1(1+ST(RS_1))}{\sum_{sj=1}^{1} r\omega_1(1+ST(RS_j))} = \frac{1+T(RS_1)}{1+T(RS_1)} = 1$, we have: as shown in the equation at the bottom of page 8.

Thus, Eq. (18) is correct for $n = 1$. Assume that Eq. (18) is correct for $n = k$, we have: as shown in the equation at the bottom of page 9.

Then, when $n = k + 1$, we get: as shown in the equation at the bottom of pages 10 and 11.

The proof are true for $n = k + 1$; hence, results are true for all $n \in Z^+$ through mathematical induction.

The IVIFHIPWA approach has four properties.

Theorem 1 (Idempotency): If $RS_{sj} = \left(\left[RL_{sj}, RR_{sj}\right], \left[SL_{sj}, SR_{sj}\right]\right)$ are equal, i.e. $RS_{sj} = RS$ for all sj, then

$$IVIFHIWA_{r\omega}\left(RS_1, RS_2, \cdots, RS_n\right) = RS \tag{19}$$

TABLE 2. Normalized IVIFN matrix.

Alternatives	SU_1	SU_2
RU_1	([0.21,0.53], [0.17,0.47])	([0.19,0.23], [0.46,0.72])
RU_2	([0.35,0.73], [0.15,0.25])	([0.32,0.54], [0.25,0.46])
RU_3	([0.14,0.72], [0.23,0.26])	([0.42,0.58], [0.16,0.42])
RU_4	([0.45,0.52], [0.32,0.43])	([0.34,0.59], [0.22,0.45])
RU_5	([0.38,0.51], [0.21,0.49])	([0.35,0.64], [0.26,0.36])

Alternatives	SU_3	SU_4
RU_1	([0.28,0.57], [0.12,0.43])	([0.25,0.65], [0.26,0.34])
RU_2	([0.18,0.36], [0.22,0.64])	([0.63,0.84], [0.13,0.15])
RU_3	([0.52,0.56], [0.31,0.43])	([0.41,0.51], [0.38,0.47])
RU_4	([0.24,0.64], [0.25,0.32])	([0.38,0.64], [0.32,0.36])
RU_5	([0.27,0.39], [0.52,0.61])	([0.23,0.51], [0.43, 0.47])

TABLE 3. The NRS_i $(i = 1, 2, \cdots, 5)$.

Alternatives	NRS_i
RU_1	([0.34,0.41], [0.36,0.45])
RU_2	([0.27,0.24], [0.14,0.26])
RU_3	([0.16,0.31], [0.19,0.38])
RU_4	([0.27,0.36], [0.34,0.59])
RU_5	([0.21,0.37], [0.36,0.47])

Theorem 2 (Boundedness): Let $RS_{sj} = \left(\left[RL_{sj}, RR_{sj}\right], \left[SL_{sj}, SR_{sj}\right]\right)$ be a family of IVIFNs, and let

$$RS^{-} = \min_{sj} RS_{sj},\ RS^{+} = \max_{sj} RS_{sj}$$

Then

$$RS^{-} \leq IVIFHIWA_{r\omega}\left(RS_1, RS_2, \cdots, RS_n\right) \leq RS^{+} \quad (20)$$

Theorem 3 (Monotonicity): Let RS_{sj} $(sj = 1, 2, 3, \cdots, n)$ and RS'_{sj} $(sj = 1, 2, 3, \cdots, n)$ be IVIFNs, if $RS_j \leq RS'_j$, for

TABLE 4. The $SV(NRS_i)$ $(i = 1, 2, \cdots, 5)$.

Alternatives	$SV(NRS_i)$
RU_1	0.4547
RU_2	0.3947
RU_3	0.3351
RU_4	0.3767
RU_5	0.3648

TABLE 5. Orders for different approaches.

Approaches	Ranking
IVIFPWA approach[60]	$RU_1 \succ RU_2 \succ RU_4 \succ RU_5 \succ RU_3$
IVIFPWG approach[60]	$RU_1 \succ RU_2 \succ RU_4 \succ RU_5 \succ RU_3$
IVIFPWBM approach[61]	$RU_1 \succ RU_2 \succ RU_4 \succ RU_5 \succ RU_3$
IVIFPHWA approach[62]	$RU_1 \succ RU_2 \succ RU_4 \succ RU_5 \succ RU_3$
IVIFSSPWA approach [63]	$RU_1 \succ RU_2 \succ RU_4 \succ RU_5 \succ RU_3$
IVIFSSPWG approach[63]	$RU_1 \succ RU_2 \succ RU_4 \succ RU_5 \succ RU_3$
IVIFPWMSM approach [64]	$RU_1 \succ RU_2 \succ RU_4 \succ RU_5 \succ RU_3$

all j, then

$$IVIFHIWA_{r\omega}(RS_1, RS_2, \cdots, RS_n) \le IVIFHIWA_{r\omega}(RS'_1, RS'_2, \cdots, RS'_n) \quad (21)$$

Theorem 4 (Commutativity): Let RS_{sj} and RS'_{sj} $(sj = 1, 2, \cdots, n)$ be IVIFNs, then

$$IVIFHIWA_{r\omega}(RS_1, RS_2, \cdots, RS_n) = IVIFHIWA_{r\omega}(RS'_1, RS'_2, \cdots, RS'_n) \quad (22)$$

where RS'_{sj} is any permutation of RS_{sj}.

B. METHOD FOR MADM BASED ON IVIFHIHPWA APPROACH

Let $RU = \{RU_1, RU_2, \cdots, RU_m\}$ be alternatives, $SU = \{SU_1, SU_2, \cdots, SU_n\}$ be attributes. Let IVIFN-matrix $RS = (RS_{ij})_{m\times n}$, $RS_{ij} = ([RL_{ij}, RR_{ij}], [SL_{ij}, SR_{ij}])_{m\times n}$, where $r\omega = (r\omega_1, r\omega_2, \cdots, r\omega_n)^T$ be weight values of $SU = \{SU_1, SU_2, \cdots, SU_n\}$ and $r\omega_j > 0$, $\sum_{j=1}^{n} r\omega_j = 1$.The steps of IVIFHIHPWA approach for MADM are established(See Figure 1):

Step 1: Administrate the IVIFN-matrix $RS = (RS_{ij})_{m\times n}$, $RS_{ij} = ([RL_{ij}, RR_{ij}], [SL_{ij}, SR_{ij}])_{m\times n}$.

Step 2: Normalize the IVIFN-matrix $RS = (RS_{ij})_{m\times n}$ to $NRS = (NRS_{ij})_{m\times n}$.

$$NRS_{ij} = ([NRL_{ij}, NRR_{ij}], [NSL_{ij}, NSR_{ij}]) = \begin{cases} ([RL_{ij}, RR_{ij}], [SL_{ij}, SR_{ij}]), & SU_j \text{ is benefit criterion} \\ ([SL_{ij}, SR_{ij}], [RL_{ij}, RR_{ij}]), & SU_j \text{ is cost criterion} \end{cases} \quad (23)$$

Step 3. Implement the $NRS_i = ([NRL_i, NRR_i], [NSL_i, NSR_i])$ through IVIFHIHPWA approach: (24), as shown in the equation at the top of page 12, to implement the NRS_i $(i = 1, 2, 3, \cdots, m)$.

Step 4. Implement the $SV(NRS_i)$, $AV(NRS_i)(i = 1, 2, 3, \cdots, m)$.

Step 5. Rank the RU_i $(i = 1, 2, 3, \cdots, m)$ and choose optimal one through $SV\ (NRS_i)$, $AV\ (NRS_i)$.

III. NUMERICAL EXAMPLE AND COMPARATIVE ANALYSIS

A. NUMERICAL EXAMPLE

The development of public art cannot be separated from urban squares, because urban squares have a special position in public art. They are not only the window for the city to open up to the outside world, but also an objective reflection of the overall appearance and image of the city. Modern society is rapidly transitioning from industrial civilization to ecological civilization, and sustainable development concept has gained consensus worldwide, becoming the theoretical basis for development decision-making in various countries. Therefore, in this context, the success of public art design is directly related to improvement of overall city image and modernization and internationalization development. Therefore, it is

$$\begin{aligned}
&IVIFHIPWA_{r\omega}\left(RS_1, RS_2, \cdots, RS_n\right)\\
&= \mathop{\oplus}_{j=1}^{n} \frac{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}{\sum_{j=1}^{n} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} RS_{sj}\\
&= \left(\begin{array}{c}
\left[\begin{array}{c}
\dfrac{\prod_{sj=1}^{n}\left(1+(r\xi-1)HL_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))} - \prod_{sj=1}^{n}\left(1-RL_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))}}{\prod_{sj=1}^{n}\left(1+(r\xi-1)HL_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))} - (r\xi-1)\prod_{sj=1}^{n}\left(1-RL_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))}},\\
\dfrac{\prod_{sj=1}^{n}\left(1+(r\xi-1)RR_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))} - \prod_{sj=1}^{n}\left(1-RR_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))}}{\prod_{sj=1}^{n}\left(1+(r\xi-1)RR_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))} - (r\xi-1)\prod_{sj=1}^{n}\left(1-RR_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))}}
\end{array}\right],\\
\left[\begin{array}{c}
\dfrac{r\xi\prod_{sj=1}^{n}\left(1-RL_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))} - r\xi\prod_{sj=1}^{n}\left(1-RL_{sj}-SL_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))}}{\prod_{sj=1}^{n}\left(1+(r\xi-1)RL_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))} - (r\xi-1)\prod_{sj=1}^{n}\left(1-RL_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))}},\\
\dfrac{r\xi\prod_{sj=1}^{n}\left(1-RR_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))} - r\xi\prod_{sj=1}^{n}\left(1-RR_{sj}-SR_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))}}{\prod_{sj=1}^{n}\left(1+(r\xi-1)RR_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))} - (r\xi-1)\prod_{sj=1}^{n}\left(1-RR_{sj}\right)^{r\omega_{sj}(1+ST(RS_{sj}))/\sum_{sj=1}^{n} r\omega_{sj}(1+ST(RS_{sj}))}}
\end{array}\right]
\end{array}\right)
\end{aligned} \tag{18}$$

$$\begin{aligned}
&IVIFHIPWA_{r\omega}\left(RS_1\right)\\
&= \mathop{\oplus}_{sj=1}^{1} \frac{r\omega_{sj}\left(1+ST\left(RS_1\right)\right)}{\sum_{j=1}^{1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} RS_{sj}\\
&= RS_1 = \left(\left[RL_1, RR_1\right], \left[SL_1, SR_1\right]\right)\\
&= IVIFHIPWA_{r\omega}\left(RS_1, RS_2, \cdots, RS_n\right)\\
&= \mathop{\oplus}_{sj=1}^{n} \frac{r\omega_{sj}\left(1+ST\left(RS_1\right)\right)}{\sum_{j=1}^{1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} RS_{sj}\\
&= \left(\left[\begin{array}{c}
\dfrac{\left(1+(r\xi-1)RS_1\right)^1 - \left(1-RS_1\right)^1}{\left(1+(r\xi-1)RS_1\right)^1 - (r\xi-1)\left(1-RS_1\right)^1},\\
\dfrac{\left(1+(r\xi-1)RR_1\right)^1 - \left(1-RR_j\right)^1}{\left(1+(r\xi-1)RR_1\right)^1 - (r\xi-1)\left(1-RR_j\right)^1}
\end{array}\right], \left[\begin{array}{c}
\dfrac{r\xi\left(1-RL_1\right)^1 - r\xi\left(1-RL_j-SL_j\right)^1}{\left(1+(r\xi-1)RL_1\right)^1 - (r\xi-1)\left(1-RL_1\right)^1},\\
\dfrac{r\xi\left(1-RR_1\right)^1 - r\xi\left(1-RR_j-SR_j\right)^1}{\left(1+(r\xi-1)RR_1\right)^1 - (r\xi-1)\left(1-RR_1\right)^1}
\end{array}\right]\right)
\end{aligned}$$

particularly important to explore and research the topic of public art design. Urban squares are important component of urban public space and a window of urban culture. Urban squares could enhance the city image, improve the public space quality, and shape a good urban culture. With the rapid development of urbanization in China, many urban squares have been constructed, and many sculptures have become the main body of public art in squares. However, formalism and commercialization have also become the mainstream of urban square construction, and squares lack a pleasant scale. Public art is cultural phenomenon that emphasizes the public welfare and cultural welfare of art. It is also implemented through national and urban cultural policies. Public art is the return of art to life, and artists to the public. In recent years, urban planning and design have shifted from "material oriented" to emphasizing "people-oriented" in material form planning. Studying tourist satisfaction can evaluate the effectiveness of public art construction and use, Find the direction of construction, development, and transformation. Therefore, the research on credit risk assessment of technology-based enterprises is extremely important. The satisfaction evaluation of public art in urban squares is MADM. Five urban public art squares RU_i $(i = 1, 2, \cdots, 5)$ are chosen with four attributes: ①SU $_1$ is public art facilities in urban squares; ②SU_2 is traffic accessibility of urban squares; ③SU_3 is socio economic benefits of urban squares; ④SU_4 is comfort of urban squares. The five urban public art squares are evaluated through four attributes $(r\omega = (0.2_1, 0.3_2, 0.4, 0.1)^T)$ in the context of IVIFNs. Then, the IVIFHIHPWA approach is administrated to choose the optimal urban public art square under IVIFSs.

Step 1. Administrate the IVIFN-matrix $RS = \left(RS_{ij}\right)_{5\times 4}$ (Table 1).

Step 2. Transforming cost decision attributes into benefit ones (Table 2).

Step 3. The NRS_i $(i = 1, 2, \cdots, 5)$ is obtained in Table 3 based on the Table 2 and IVIFHIHPWA approach.

Step 5. Implement the $SV\ (NRS_i)$ $(i = 1, 2, \cdots, 5)$ (See Table 4):

Step 6. Rank all the urban public art squares RU_i through $SV\ (NRS_i)$ $(i = 1, 2, \cdots, 5)$: $RU_1 \succ RU_2 \succ RU_4 \succ RU_5 \succ RU_3$, and thus the most desirable urban public art square is RU_1.

B. COMPARATIVE ANALYSES

The IVIFHIHPWA approach is compared with IVIFPWA approach [59], IVIFPWG approach [59], IVIFPWBM approach [60], IVIFPGWBM approach [60], IVIFPHWA approach [61], IVIFSSPWA approach [62], IVIFSSPWG approach [62] and IVIFPWMSM approach [63]. The final orders are administrated in Table 5.

In light with WS coefficients [64], [65], the WS coefficient between the IVIFPWA approach [59], IVIFPWG approach [59], IVIFPWBM approach [60], IVIFPGWBM approach [60], IVIFPHWA approach [61], IVIFSSPWA approach [62], IVIFSSPWG approach [62], IVIFPWMSM approach [63] and the implemented

$$
\begin{aligned}
&IVIFHIPWA_{r\omega}\left(RS_1, RS_2, \cdots, RS_k\right)\\
&= \mathop{\oplus}_{sj=1}^{k} \frac{r\omega_{sj}\left(1+ST\left(RS_j\right)\right)}{\sum_{j=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} RS_{sj}\\
&= \left(\begin{bmatrix}
\dfrac{\prod_{sj=1}^{k}\left(1+(r\xi-1)RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - \prod_{sj=1}^{k}\left(1-RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{sj=1}^{k}\left(1+(r\xi-1)RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k}\left(1-RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}},\\
\dfrac{\prod_{sj=1}^{k}\left(1+(r\xi-1)RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - \prod_{sj=1}^{k}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{sj=1}^{k}\left(1+(r\xi-1)RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}
\end{bmatrix}, \right.\\
&\left. \begin{bmatrix}
\dfrac{r\xi\prod_{sj=1}^{k}\left(1-RL_{j}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - r\xi\prod_{sj=1}^{k}\left(1-RL_{sj}-SL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{j=1}^{k}\left(1+(r\xi-1)RL_{j}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k}\left(1-RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}},\\
\dfrac{r\xi\prod_{sj=1}^{k}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - r\xi\prod_{sj=1}^{k}\left(1-RR_{sj}-SR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{sj=1}^{k}\left(1+(r\xi-1)RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}
\end{bmatrix} \right)
\end{aligned}
$$

IVIFHIHPWA approach is 1.0000, 0.9713, 1.0000, 1.0000, 1.0000, 0.9713, 1.0000, respectively. Upon comparing the outcomes of the IVIFHIHPWA with existing approaches, it is observed that the calculated results exhibit slight differences, while the identification of the best and worst urban public art squares remains consistent. These diverse models effectively address MADM from various research perspectives. The IVIFHIHPWA approach possesses valuable characteristics and advantages, which include: (1) The implemented IVIFHIHPWA approach demonstrates the ability to capture both individual and overall uncertainties associated with IVIFNs. It boasts a simple structure, clear physical interpretation, and robust discriminatory capability. (2) The implemented IVIFHIHPWA approach specifically examines

$$
\begin{aligned}
& IVIFHIPWA_{r\omega}\left(RS_1, RS_2, \cdots, RS_{k+1}\right) \\
& = \bigoplus_{sj=1}^{k+1} \frac{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}{\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} RS_{sj} \\
& = \bigoplus_{sj=1}^{k} \frac{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}{\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} RS_{sj} + \frac{r\omega_{sj}\left(1+ST\left(RS_{k+1}\right)\right)}{\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} RS_{k+1} \\
& = \left(\begin{array}{l}
\left[\frac{\prod_{sj=1}^{k}\left(1+(r\xi-1) RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - \prod_{sj=1}^{k}\left(1-RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{sj=1}^{k}\left(1+(r\xi-1) RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k}\left(1-RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}, \right. \\
\left. \frac{\prod_{sj=1}^{k}\left(1+(r\xi-1) RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - \prod_{sj=1}^{k}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{sj=1}^{k}\left(1+(r\xi-1) RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}\right], \\
\left[\frac{r\xi\prod_{sj=1}^{k}\left(1-RL_{j}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - r\xi\prod_{sj=1}^{k}\left(1-RL_{sj}-SL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{j=1}^{k}\left(1+(r\xi-1) RL_{j}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k}\left(1-RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}, \right. \\
\left. \frac{r\xi\prod_{sj=1}^{k}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - r\xi\prod_{sj=1}^{k}\left(1-RR_{sj}-SR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{sj=1}^{k}\left(1+(r\xi-1) RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)\Big/\sum_{sj=1}^{k} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}\right]
\end{array}\right) \\
& \oplus \left(\begin{array}{l}
\left[\frac{\left(1+(r\xi-1) RL_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - \left(1-RL_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\left(1+(r\xi-1) RL_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} + (r\xi-1)\left(1-RL_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}, \right. \\
\left. \frac{\left(1+(r\xi-1) HR_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - \left(1-RR_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\left(1+(r\xi-1) HR_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} + (r\xi-1)\left(1-RR_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}\right], \\
\left[\frac{r\xi\left(1-RL_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - r\xi\left(1-RL_{i}-SL_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\left(1+(r\xi-1) RL_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} + (r\xi-1)\left(1-RL_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}, \right. \\
\left. \frac{r\xi\left(1-RR_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - r\xi\left(1-RR_{i}-SR_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\left(1+(r\xi-1) RR_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} + (r\xi-1)\left(1-RR_{k+1}\right)^{r\omega_{k+1}\left(1+ST\left(RS_{k+1}\right)\right)\Big/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}\right]
\end{array}\right)
\end{aligned}
$$

$$= \left(\left[\frac{\prod_{sj=1}^{k+1}\left(1+(r\xi-1)RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - \prod_{sj=1}^{k+1}\left(1-RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{sj=1}^{k+1}\left(1+(r\xi-1)RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k+1}\left(1-RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}, \frac{\prod_{sj=1}^{k+1}\left(1+(r\xi-1)RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - \prod_{sj=1}^{k+1}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{sj=1}^{k+1}\left(1+(r\xi-1)RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k+1}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}} \right], \left[\frac{r\xi\prod_{sj=1}^{k+1}\left(1-RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - r\xi\prod_{sj=1}^{k+1}\left(1-RL_{sj}-SL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{sj=1}^{k+1}\left(1+(r\xi-1)RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k+1}\left(1-RL_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}, \frac{r\xi\prod_{sj=1}^{k+1}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - r\xi\prod_{sj=1}^{k+1}\left(1-RR_{sj}-SR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}}{\prod_{sj=1}^{k+1}\left(1+(r\xi-1)RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)} - (r\xi-1)\prod_{sj=1}^{k+1}\left(1-RR_{sj}\right)^{r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)/\sum_{sj=1}^{k+1} r\omega_{sj}\left(1+ST\left(RS_{sj}\right)\right)}} \right] \right)$$

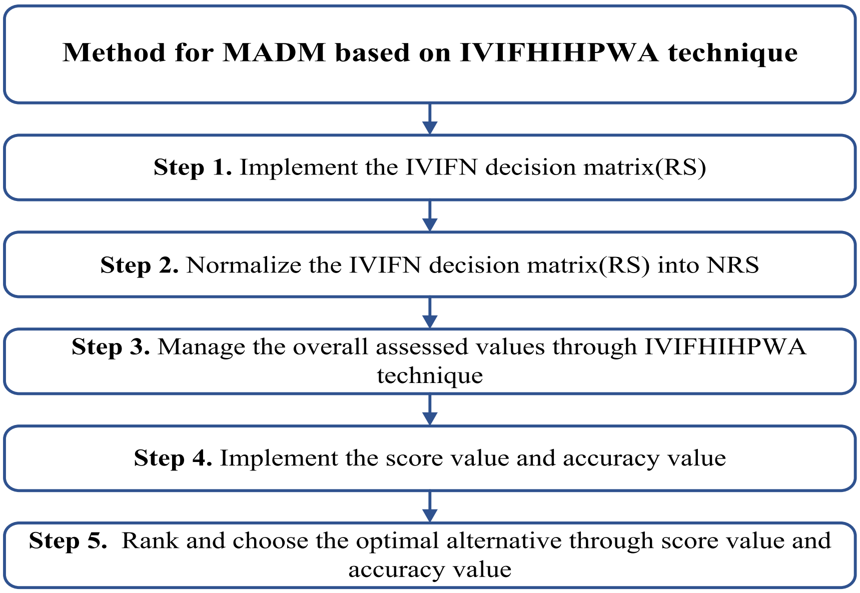

FIGURE 1. Method for MADM based on IVIFHIHPWA approach.

the interactions between membership and non-membership functions, providing a comprehensive understanding of these paired elements. Overall, the IVIFHIHPWA approach presents promising features and advantages, making it a viable and valuable methodology for MADM analysis.

IV. CONCLUSION

The development of public art cannot be separated from urban squares, because urban squares have a special position in public art. They are not only the window for the city to open up to the outside world, but also an objective reflection of the overall appearance and image of the city. Modern society is rapidly transitioning from industrial civilization to ecological civilization, and sustainable development concept has gained consensus worldwide, becoming the theoretical basis for development decision-making in various countries. Therefore, in this context, the success of public art design is directly related to the improvement of the overall city image and modernization and internationalization development. Therefore, it is particularly important to explore and research the topic of public art design. Thus, the satisfaction evaluation of public art in urban squares is MADM. In this

$$
\begin{aligned}
NRS_i &= \left(\left[NRL_i, NRR_i\right], \left[NSL_i, NSR_i\right]\right) \\
&= IVIFHIPWA_{r\omega}\left(NRS_{i1}, NRS_{i2}, \cdots, NRS_{in}\right) \\
&= \bigoplus_{j=1}^{n} \frac{r\omega_j\left(1+T\left(NRS_{ij}\right)\right)}{\sum_{j=1}^{n} r\omega_j\left(1+T\left(RS_{ij}\right)\right)} NRS_{ij} \\
&= \left(\begin{bmatrix}
\dfrac{\prod_{j=1}^{n}\left(1+(r\xi-1)NRL_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)} - \prod_{j=1}^{n}\left(1-NRL_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)}}{\prod_{j=1}^{n}\left(1+(r\xi-1)NRL_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)} - (r\xi-1)\prod_{j=1}^{n}\left(1-NRL_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)}}, \\
\dfrac{\prod_{j=1}^{n}\left(1+(r\xi-1)NRR_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)} - \prod_{j=1}^{n}\left(1-NRR_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)}}{\prod_{j=1}^{n}\left(1+(r\xi-1)NRR_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)} - (r\xi-1)\prod_{j=1}^{n}\left(1-NRR_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)}}
\end{bmatrix}, \right. \\
&\qquad \left. \begin{bmatrix}
\dfrac{r\xi\prod_{j=1}^{n}\left(1-NRL_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)} - r\xi\prod_{j=1}^{n}\left(1-NRL_j-NSL_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)}}{\prod_{j=1}^{n}\left(1+(r\xi-1)NRL_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)} - (r\xi-1)\prod_{j=1}^{n}\left(1-NRL_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)}}, \\
\dfrac{r\xi\prod_{j=1}^{n}\left(1-NRR_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)} - r\xi\prod_{j=1}^{n}\left(1-NRR_j-NSR_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)}}{\prod_{j=1}^{n}\left(1+(r\xi-1)NRR_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)} - (r\xi-1)\prod_{j=1}^{n}\left(1-NRR_{ij}\right)^{r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)\Big/\sum_{j=1}^{n} r\omega_j\left(1+ST\left(NRS_{ij}\right)\right)}}
\end{bmatrix}\right)
\end{aligned} \tag{24}
$$

study, IVIFHIPWA approach is implemented in light with IVIFHIWA approach and PA approach. Then, IVIFHIPWA approach is employed to put up with the MADM with IVIFSs. At last, numerical example for satisfaction evaluation of public art in urban squares is administrated to validate the IVIFHIPWA approach. Thus, the major contributions of this research are concluded: (1) IVIFHIPWA approach is implement based on IVIFHIWWA and PA approach; (2) IVIFHIPWA approach is put up with MADM with IVIFSs; (3) numerical example for satisfaction evaluation of public art in urban squares has been put forward IVIFHIPWA approach.

REFERENCES

[1] J. C. Semenza, "The intersection of urban planning, art, and public health: The Sunnyside Piazza," *Amer. J. Public Health*, vol. 93, no. 9, pp. 1439–1441, Sep. 2003.

[2] J. Sharp, V. Pollock, and R. Paddison, "Just art for a just city: Public art and social inclusion in urban regeneration," *Urban Stud.*, vol. 42, nos. 5–6, pp. 1001–1023, May 2005.

[3] S. Traub and M. Missong, "On the public provision of the performing arts," *Regional Sci. Urban Econ.*, vol. 35, no. 6, pp. 862–882, Nov. 2005.

[4] J. Lossau, "Public art. On the relationship between artists' perspectives and development policy expectations," *Geographische Zeitschrift*, vol. 94, no. 2, pp. 65–76, Jan. 2006.

[5] Z. Minty, "Post-apartheid public art in cape town: Symbolic reparations and public space," *Urban Stud.*, vol. 43, no. 2, pp. 421–440, Feb. 2006.

[6] J. K. Boles and K. Scheurer, "Beyond women, children, and families: Gender, representation, and public funding for the arts," *Social Sci. Quart.*, vol. 88, no. 1, pp. 39–50, Mar. 2007.

[7] H. Downey and J. F. Sherry, "Public art tourism: Atmospheric stories in city margins," *Ann. Tourism Res.*, vol. 101, Jul. 2023, Art. no. 103606.

[8] N. Keidar and D. Silver, "Urban policy assemblage: Outcomes and processes of public art policy assemblage," *Cities*, vol. 138, Jul. 2023, Art. no. 104365.

[9] F. Landau-Donnelly, "Ghostly murals: Tracing the politics of public art in Vancouver's Hogan's alley," *Environ. Planning C: Politics Space*, vol. 41, no. 6, pp. 1147–1165, Sep. 2023.

[10] S. Chen, K. Fu, B. Yang, and X. Lian, "Using light art installation in urban nightscapes to raise public awareness of carbon neutrality," *Sci. Commun.*, vol. 45, no. 3, pp. 414–427, Jun. 2023.

[11] C. G. Castellano and O. Raposo, "Public art and social media: Street art tourism, sociocultural agency and cultural production in contemporary Lisbon," *Community Develop. J.*, vol. 59, no. 3, pp. 533–552, Jul. 2024.

[12] L. Yang and Y. Tian, "Art design of urban public space based on marine culture," *J. Coastal Res.*, vol. 106, no. 1, pp. 427–430, Jul. 2020.

[13] A. Zitcer and S. M. Almanzar, "Public art, cultural representation, and the just city," *J. Urban Affairs*, vol. 42, no. 7, pp. 998–1013, Oct. 2020.

[14] S. Begum, J. Hossain, and J. Stevens, "Gender and public space: Mapping palimpsests of art, design, and agency in Shahbag, Dhaka," *Social Inclusion*, vol. 9, no. 4, pp. 143–157, Nov. 2021.

[15] L. Liyuan and L. Mengxue, "Study on interactive urban public art in the background of big data," in *Proc. 7th Int. Conf. Social Netw., Commun. Educ. (SNCE)*. Shenyang, China: Atlantis Press, 2017, pp. 523–526.

[16] Y. Li and L. Zhang, "Research on the art design of public space of rail transit," in *Proc. 4th Int. Conf. Educ., Manage. Comput. Technol. (ICEMCT)*. Hangzhou, China: Atlantis Press, 2017, pp. 256–259.

[17] A. J. Ashley, "Examining an alternative take on urban development: The alignment of public art and conservation to build Seattle's Olympic sculpture park," *J. Urban Hist.*, vol. 43, no. 3, pp. 493–516, May 2017.

[18] D. Jewesbury, "The great reimagining: Public art, urban space and the symbolic landscapes of a 'new' northern Ireland," *Urban Stud.*, vol. 54, pp. 1297–1300, Feb. 2017.

[19] H. Meng and Y. Sun, "Deconstruction of urban public space art design using intelligent sensor and information fusion," *J. Sensors*, vol. 2022, pp. 1–9, Oct. 2022.
[20] M. Reynolds, "Public art and urban redevelopment in Hollywood, California," *J. Planning Literature*, vol. 37, p. 605, Jan. 2022.
[21] Z. Xiao, "Fusion development of public art and urban environment design based on wireless sensor data fusion," *Mobile Inf. Syst.*, vol. 2022, pp. 1–10, Aug. 2022.
[22] S. Yu and H. Wang, "Prediction of urban street public space art design indicators based on deep convolutional neural network," *Comput. Intell. Neurosci.*, vol. 2022, pp. 1–12, May 2022.
[23] W. L. Lv and S. S. Xu, "The creation of contemporary public art—Five elements," in *Proc. 1st Int. Conf. Civil Eng., Archit. Building Mater. (CEABM)*. Haikou, China: Trans Tech Publication, 2011, pp. 4074–4077.
[24] Z. G. Li and J. Sun, "Public art and contemporary urban culture—Research of embodiment of core value of urban public art in the construction of urban culture," *Adv. Mater. Res.*, vols. 919–921, pp. 1634–1637, Apr. 2014.
[25] K. Gurney, "Zombie monument: Public art and performing the present," *Cities*, vol. 77, pp. 33–38, Jul. 2018.
[26] M. Zebracki and J. Luger, "Digital geographies of public art: New global politics," *Prog. Human Geography*, vol. 43, no. 5, pp. 890–909, Oct. 2019.
[27] T. D. Glover, S. Munro, I. Men, W. Loates, and I. Altman, "Skateboarding, gentle activism, and the animation of public space: CITE—A celebration of skateboard arts and culture at the Bentway," *Leisure Stud.*, vol. 40, no. 1, pp. 42–56, 2021.
[28] R. Ochoa, "The 'expo' and the post-'expo': The role of public art in urban regeneration processes in the late 20th century," *Sustainability*, vol. 14, no. 2, p. 11, 2022.
[29] R. Isto, "Representing the worker in postsocialist public space: Art and politics under neoliberalism," *Int. Labor Working-Class Hist.*, vol. 98, pp. 43–76, Nov. 2020.
[30] D. Refki, K. Mishkin, B. Avci, and S. Abdelkarim, "Using social return on investment to evaluate the public art exhibit breathing lights," *Poetics*, vol. 79, Apr. 2020, Art. no. 101401.
[31] M. M. Shahsavar, M. Akrami, Z. Kian, M. Gheibi, A. M. Fathollahi-Fard, M. Hajiaghaei-Keshteli, and K. Behzadian, "Bio-recovery of municipal plastic waste management based on an integrated decision-making framework," *J. Ind. Eng. Chem.*, vol. 108, pp. 215–234, Apr. 2022.
[32] G. Tian, W. Lu, X. Zhang, M. Zhan, M. A. Dulebenets, A. Aleksandrov, A. M. Fathollahi-Fard, and M. Ivanov, "A survey of multi-criteria decision-making techniques for green logistics and low-carbon transportation systems," *Environ. Sci. Pollut. Res.*, vol. 30, no. 20, pp. 57279–57301, Apr. 2023.
[33] L. Zhang, C. Zhang, G. Tian, Z. Chen, A. M. Fathollahi-Fard, X. Zhao, and K. Y. Wong, "A multi-criteria group-based decision-making method considering linguistic neutrosophic clouds," *Expert Syst. Appl.*, vol. 226, Sep. 2023, Art. no. 119936.
[34] S. Broumi, S. Mohanaselvi, T. Witczak, M. Talea, A. Bakali, and F. Smarandache, "Complex fermatean neutrosophic graph and application to decision making," *Decis. Making, Appl. Manag. Eng.*, vol. 6, no. 1, pp. 474–501, Apr. 2023.
[35] H. Komasi, S. H. Zolfani, and A. Nemati, "Evaluation of the social-cultural competitiveness of cities based on sustainable development approach," *Decis. Making, Appl. Manage. Eng.*, vol. 6, no. 1, pp. 583–602, Apr. 2023.
[36] D. Pamucar and S. Biswas, "A novel hybrid decision making framework for comparing market performance of metaverse crypto assets," *Decis. Making Adv.*, vol. 1, no. 1, pp. 49–62, Dec. 2023.
[37] A. Puška, A. Štilić, and I. Stojanović, "Approach for multi-criteria ranking of balkan countries based on the index of economic freedom," *J. Decis. Analytics Intell. Comput.*, vol. 3, no. 1, pp. 1–14, Dec. 2023.
[38] D. K. Tripathi, S. K. Nigam, P. Rani, and A. R. Shah, "New intuitionistic fuzzy parametric divergence measures and score function-based CoCoSo method for decision-making problems," *Decis. Making: Appl. Manage. Eng.*, vol. 6, no. 1, pp. 535–563, Apr. 2023.
[39] A. Shekhovtsov, B. Paradowski, J. Wieckowski, B. Kizielewicz, and W. Salabun, "Extension of the SPOTIS method for the rank reversal free decision-making under fuzzy environment," in *Proc. IEEE 61st Conf. Decis. Control (CDC)*, Dec. 2022, pp. 5595–5600.
[40] H. Sun, Z. Yang, Q. Cai, G. Wei, and Z. Mo, "An extended exp-TODIM method for multiple attribute decision making based on the Z-Wasserstein distance," *Expert Syst. Appl.*, vol. 214, Mar. 2023, Art. no. 119114.
[41] J. Wieckowski, B. Kizielewicz, B. Paradowski, A. Shekhovtsov, and W. Sałabun, "Application of multi-criteria decision analysis to identify global and local importance weights of decision criteria," *Int. J. Inf. Technol. Decis. Making*, vol. 22, no. 6, pp. 1867–1892, Nov. 2023.
[42] H. Zhang and G. Wei, "Location selection of electric vehicles charging stations by using the spherical fuzzy CPT-CoCoSo and D-CRITIC method," *Comput. Appl. Math.*, vol. 42, no. 1, p. 35, Feb. 2023.
[43] J. Wieckowski, B. Kizielewicz, and W. Sałabun, "Handling decision-making in intuitionistic fuzzy environment: PyIFDM package," *SoftwareX*, vol. 22, May 2023, Art. no. 101344.
[44] A. Baczkiewicz, B. Kizielewicz, A. Shekhovtsov, J. Watróbski, J. Wieckowski, and W. Salabun, "Towards an e-commerce recommendation system based on MCDM methods," in *Proc. Int. Conf. Decis. Aid Sci. Appl. (DASA)*, Dec. 2021, pp. 991–996.
[45] J. Wieckowski and L. Dobryakova, "A fuzzy assessment model for freestyle swimmers—A comparative analysis of the MCDA methods," in *Proc. 25th KES Int. Conf. Knowl.-Based Intell. Inf. Eng. Syst. (KES)*. Szczecin, Poland: Elsevier, 2021, pp. 4148–4157.
[46] J. Wieckowski, A. Shekhovtsov, and J. Watrobski, "A new approach to identifying of the optimal preference values in the MCDA model: Cat swarm optimization study case," in *Proc. 13th Int. KES Conf. Intell. Decision Technol. (KES-IDT)*. Cham, Switzerland: Springer, 2021, pp. 265–274.
[47] B. Kizielewicz, B. Paradowski, J. Wieckowski, and W. Salabun, "Towards the identification of MARCOS models based on intuitionistic fuzzy score functions," in *Proc. 17th Conf. Comput. Sci. Intell. Syst. (FedCSIS)*, Sep. 2022, pp. 789–798.
[48] L. A. Zadeh, "Fuzzy sets," in *Information and Control*. Amsterdam, The Netherlands: Elsevier, 1965, pp. 338–356.
[49] K. T. Atanassov, "Intuitionistic fuzzy sets," *Fuzzy Sets Syst.*, vol. 20, no. 1, pp. 87–96, Aug. 1986.
[50] K. Atanassov and G. Gargov, "Interval valued intuitionistic fuzzy-sets," *Fuzzy Sets Syst.*, vol. 31, pp. 343–349, Jul. 1989.
[51] C. Mao, "An advanced approach to operational quality evaluation for industry-finance integration enterprises based on integrated interval-valued intuitionistic fuzzy multi-attribute decision making," *J. Intell. Fuzzy Syst.*, vol. 46, no. 2, pp. 4127–4146, Feb. 2024.
[52] W. Du and F. Yang, "Optimizing market risk evaluation of small and medium sized enterprises through Hamacher interactive power geometric technique under uncertainty," *J. Intell. Fuzzy Syst.*, vol. 46, no. 4, pp. 7521–7537, Apr. 2024.
[53] H. Garg, N. Agarwal, and A. Tripathi, "Some improved interactive aggregation operators under interval-valued intuitionistic fuzzy environment and its application to decision making process," *Scientia Iranica*, vol. 24, no. 5, pp. 2581–2604, Oct. 2017.
[54] R. R. Yager, "The power average operator," *IEEE Trans. Syst., Man, Cybern. A, Syst. Humans*, vol. 31, no. 6, pp. 724–731, Jun. 2001.
[55] K. T. Atanassov, "Operators over interval valued intuitionistic fuzzy sets," *Fuzzy Sets Syst.*, vol. 64, no. 2, pp. 159–174, Jun. 1994.
[56] Z. Xu and R. R. Yager, "Some geometric aggregation operators based on intuitionistic fuzzy sets," *Int. J. Gen. Syst.*, vol. 35, no. 4, pp. 417–433, Aug. 2006.
[57] H.-W. Liu and G.-J. Wang, "Multi-criteria decision-making methods based on intuitionistic fuzzy sets," *Eur. J. Oper. Res.*, vol. 179, no. 1, pp. 220–233, May 2007.
[58] E. Szmidt and J. Kacprzyk, "Distances between intuitionistic fuzzy sets," *Fuzzy Sets Syst.*, vol. 114, pp. 505–518, Sep. 2000.
[59] Z. Xu, "Approaches to multiple attribute group decision making based on intuitionistic fuzzy power aggregation operators," *Knowl.-Based Syst.*, vol. 24, no. 6, pp. 749–760, Aug. 2011.
[60] P. Liu and H. Li, "Interval-valued intuitionistic fuzzy power Bonferroni aggregation operators and their application to group decision making," *Cogn. Comput.*, vol. 9, no. 4, pp. 494–512, Aug. 2017.
[61] P. Liu, "Multiple attribute group decision making method based on interval-valued intuitionistic fuzzy power Heronian aggregation operators," *Comput. Ind. Eng.*, vol. 108, pp. 199–212, Jun. 2017.
[62] P. Liu and P. Wang, "Some interval-valued intuitionistic fuzzy Schweizer–Sklar power aggregation operators and their application to supplier selection," *Int. J. Syst. Sci.*, vol. 49, no. 6, pp. 1188–1211, Apr. 2018.

[63] Z. Liu, F. Teng, P. Liu, and Q. Ge, "Interval-valued intuitionistic fuzzy power Maclaurin symmetric mean aggregation operators and their application to multiple attribute group decision-making," *Int. J. Uncertainty Quantification*, vol. 8, no. 3, pp. 211–232, 2018.

[64] W. Salabun and K. Urbaniak, "A new coefficient of rankings similarity in decision-making problems," in *Proc. 20th Annu. Int. Conf. Comput. Sci. (ICCS)*, Amsterdam, The Netherlands. Cham, Switzerland: Springer, 2020, pp. 632–645.

[65] W. Sałabun, J. Wątróbski, and A. Shekhovtsov, "Are MCDA methods benchmarkable? A comparative study of TOPSIS, VIKOR, COPRAS, and PROMETHEE II methods," *Symmetry*, vol. 12, no. 9, p. 1549, Sep. 2020.

RONGHUA KE was born in Guangdong, China, in January 1983. He received the Ph.D. degree in fine arts from Sangmyung University, South Korea. He is currently with Guangdong University of Science and Technology. His research interests include painting, public art, and digital art.

CHENHUANG LIN was born in Fujian, China, in 1991. He received the master's degree from Yunnan Arts University. He is currently working at the College of Fine Arts, Weifang University, Weifang, Shandong, China, with research focused on public art, sculpture, arts and crafts, and art education.

YUNLAI ZHANG was born in Zibo, Shandong, in September 1982. He received the Graduate degree from Sangmyung University, South Korea. He is currently with Weifang University. His research interest includes painting.