Neutrosophic Sets and Systems, Vol. 76, 2025
University of New Mexico

Neutrosophic Set-Based PSNN-TOPSIS Framework for Multi-Attribute Decision Making: Applications in Evaluating the Quality of Environmental Art Design in Green Building Contexts

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Abstract: With the continuous advancement of urbanization and the continuous development of landscape design concepts, green landscape design under the green building system has become the main direction of future landscape design development, playing an important role in creating a beautiful, comfortable, and ecological modern urban landscape. In the future, it is necessary to further strengthen research on green landscape design, reflecting the relevant requirements of green building concepts in energy conservation, water conservation, land conservation, etc., so that urban landscape design can break away from noise and restlessness, and return to the essence of nature and ecology. The quality evaluation of environmental art design from the perspective of green buildings could be looked at as multiple-attribute decision-making (MADM). The TOPSIS technique is a useful technique to put up with the MADM. The probabilistic simplified Neutrosophic set (PSNSs) makes it easy to express uncertain information during the quality evaluation of environmental art design from the perspective of green buildings. In this study, the CRITIC technique is put forward to obtain the attribute weights, and the probabilistic simplified neutrosophic number TOPSIS (PSNN-TOPSIS) technique is put forward for MADM. Finally, a numerical example for quality evaluation of environmental art design from the perspective of green buildings is employed to verify the PSNN-TOPSIS technique with comparative analysis.

Keywords: Multiple-attributes decision-making (MADM); probabilistic simplified neutrosophic sets (PSNSs); TOPSIS technique; quality evaluation of environmental art design

1. Introduction

MADM is the decision-making process that prioritizes alternative solutions in line with existing decision information in a certain way[1, 2]. Its theory and models are widely used in different fields such as venture capital decision-making, project evaluation, and industrial sector development evaluation [3]. In recent decades, MADM has been widely applied to engineering, the economy, technology, and the military. The quality evaluation of environmental art design from the perspective of green buildings is a MADM. Recently, the TOPSIS model [4, 5] was employed to put forward the MADM. Fuzzy sets were introduced by Zadeh [6] in 1965 as a concept to handle the uncertainties and ambiguities in the real world. Unlike traditional binary sets, fuzzy sets allow their elements to have partial membership in the set, represented by values between 0 and 1. In a fuzzy set, each element has a degree of membership to a specific set, enabling fuzzy set theory to more precisely express the various states between complete membership and non-membership. This theory is widely applied in fields such as fuzzy logic and artificial intelligence, leading to various extensions and applications of fuzzy sets **[7-10].** When addressing the evaluation issues in environmental art design, especially under the context of green buildings, the evaluation process often involves complex, multi-faceted decision-making that needs to consider multiple factors. Therefore, the method combining PSNSs [11] with the TOPSIS technique [4] offers significant advantages. **Firstly**, the incorporation of PSNSs [11] enables the decision model to effectively handle information with uncertainties and ambiguities. This type of set is particularly suited for expressing and managing criteria that are difficult to quantify or vague, such as aesthetic appeal of the environment or social impacts, which are subjective factors. They provide a mechanism that allows decision-makers to consider various possible scenarios and different levels of information certainty during the evaluation process. **Secondly**, the application of the TOPSIS method [4] provides a clear and intuitive framework by calculating the distances of each option from the ideal and negative solutions for ranking and selection. The intuitiveness and computational simplicity of this method make it highly suitable for multi-attribute decision analysis, especially when combined with PSNSs. TOPSIS can then more comprehensively consider and evaluate the influences of various environments and situations. **By combining these two techniques**, it is possible to greatly enhance the accuracy and reliability of decisions. The uncertainty handling capability provided by PSNSs allows TOPSIS to better reflect complex real-world conditions in practical applications, thereby offering more scientific and rational decision support. This method is not only applicable to evaluating highly uncertain and complex environmental art design projects but also flexibly meets various decision-making needs, enhancing decision adaptability and flexibility. **In summary**, by integrating PSNSs with TOPSIS, a powerful decision-making tool can be created. This not only improves the efficiency in handling complex environmental evaluation issues but also ensures more accurate and high-quality decisions in the fields of green building and urban planning. This combination provides a new perspective and method, helping decision-makers better understand and grasp key information when facing diverse and multi-level evaluation criteria, thus making more rational and sustainable decision choices.

Thus, the PSNSs [11] are employed as a technique for characterizing uncertain information during the quality evaluation of environmental art design from the perspective of green buildings. In this study, the CRITIC technique [12] is put forward to obtain the attribute weights under PSNSs and the PSNN-TOPSIS model is put forward to solve the MADM with PSNSs. Finally, a numerical study for quality evaluation of environmental art design from the perspective of green buildings is put forward to validate the PSNN-TOPSIS model. The main research motivations of this study are constructed: (1) the TOPSIS model is extended to PSNSs; (2) CRITIC technique is put forward to obtain the attribute weights; (3) the PSNN-TOPSIS model is put forward to solve the MADM with PSNSs; (4) Finally, a numerical study for quality evaluation of environmental art design from the perspective of green buildings is put forward to validate the PSNN-TOPSIS technique with comparative analysis.

The overall structure is put forward: The PSNSs are conducted in Sect. 2. The PSNN-TOPSIS model is put forward MADM in Sect. 3. A numerical example of quality evaluation of environmental art design from the perspective of green buildings is employed to prove the PSN-TOPSIS technique in Sect. 4 with comparative analysis. Sect. 5 ends with a conclusion.

2. Literature Review

The concept of green building design emphasizes creating a healthy and comfortable living environment while achieving maximum resource conservation and environmental pollution control, and these requirements are closely related to the natural environment[13]. Therefore, in environmental art design based on green design concepts, designers must adhere to the principle of authenticity, respect the true laws of natural development, and carry out the comprehensive design of indoor and outdoor environments with the goal of natural protection, to achieve harmonious unity between the living environment and the natural environment. In addition, environmental art design has a significant impact on the surrounding environment of buildings[14]. Therefore, to fully implement the concept of green building design, designers also need to comprehensively consider various factors such as architectural style, local climate, customs, history, and culture. On the premise of ensuring that it will not cause too much impact on the surrounding environment, specific environmental art design can be carried out to achieve a true restoration of the surrounding environment of the building[15]. Modern environmental art design pays more attention to the overall artistic and aesthetic aspects of indoor and outdoor environments. Therefore, in actual design, designers often use unnecessary decorative materials in pursuit of better environmental visual effects. This not only causes serious resource waste but also seriously violates the concept of green building design[16]. Therefore, under the influence of the concept of green building design, environmental art design still needs to adhere to the principle of conservation, and apply renewable clean energy and recyclable materials as much as possible in the design process. At the same time, resource conservation is listed as the core design principle, striving to create the best living environment with minimal resource consumption[17, 18]. For example, in indoor environmental design, designers can use small green plants as decorations, which can purify the indoor air environment, bring residents a sense of closeness to nature, and also reduce energy consumption during the operation and use of the building, achieving better green environmental protection effects. Although the concept of green building design attaches great importance to environmental protection and energy conservation, environmental art design still serves people (residents). Only by meeting the needs of residents can environmental art design truly play its role[19]. Therefore, in environmental art design based on the concept of green building design, designers also need to adhere to the principle of comfort, prioritize meeting the living and living needs of residents, and comprehensively optimize the indoor and outdoor environment to improve the livability and comfort of the living environment. After meeting this premise, other design requirements such as environmental protection, energy conservation, and visual aesthetics should be considered. Green buildings, as a new concept in the field of modern architecture, have significant differences in design concepts from traditional environmental art design concepts[20-22]. However, their pursuit of environmental protection and energy-saving effects is similar to the design ideas of many ancient buildings in China[23]. For example, in the northwest region, due to the dry climate, long sunshine hours, and large temperature differences, locals choose to use plateau terrain to dig cave dwellings for residential purposes, in order to achieve a warm winter and cool summer effect, while also effectively improving indoor air humidity; In Inner Mongolia and other regions, local nomadic ethnic groups have designed felt bags as residences based on climate characteristics such as strong winds and low temperatures. Therefore, in environmental art design, designers can also seek inspiration from traditional Chinese architecture and integrate the energy-saving and environmental protection design ideas of traditional architecture with modern architectural design concepts, so as to further improve the energy-saving and environmental protection of environmental art design[24]. For example, the popular covered earth buildings in foreign countries are modernized based on cave dwellings. In summary, the promotion of green buildings has had a significant impact on environmental art design[25]. In the future, environmental art design must fully implement the concept of green building design, adhere to principles such as conservation and comfort, and adopt appropriate design strategies in spatial layout, lighting systems, ventilation systems, etc., in order to fully meet people's needs for the living environment.

3. Preliminaries

Wang et al. [26] put forward the SVNSs

Definition 1 [26]. The SVNSs is put forward:

$$CC=\left\{\left(\theta, CT(\theta), CI(\theta), CF(\theta)\right) \middle| \theta \in \Theta\right\} \tag{1}$$

where $CT(\theta), CI(\theta), CF(\theta)$ is membership, indeterminacy-membership and falsity-membership, $CT(\theta), CI(\theta), CF(\theta) \in [0,1]$, $0 \le CT(\theta)+CI(\theta)+CF(\theta) \le 3$.

Altun, Sahin and Guler [11] put forward the PSNSs.

Definition 2[11]. The PSNSs is put forward:

$$PC=\left\{\begin{pmatrix} \theta, CT(\theta)\left(PCT(\theta)\right), \\ CI(\theta)\left(PCI(\theta)\right), \\ CF(\theta)\left(PCF(\theta)\right) \end{pmatrix} \middle| \theta \in \Theta\right\} \tag{2}$$

where $CT(\theta), CI(\theta), CF(\theta)$ is truth-membership, indeterminacy-membership and falsity-membership, $CT(\theta), CI(\theta), CF(\theta) \in [0,1]$, $0 \le CT(\theta)+CI(\theta)+CF(\theta) \le 3$, $0 \le PCT(\theta), PCI(\theta), PCF(\theta) \le 1$, the $PCT(\theta), PCI(\theta), PCF(\theta)$ is possibility values of $CT(\theta), CI(\theta), CF(\theta)$. The probabilistic simplified neutrosophic number (PSNN) is listed as $PC=\left(CT(PCT), CI(PCI), CF(PCF)\right)$.

Definition 3[11]. Let $PC_1 = \left(CT_1\left(PCT_1\right), CI_1\left(PCI_1\right), CF_1\left(PCF_1\right)\right)$, $PC_2 = \left(CT_2\left(PCT_2\right), CI_2\left(PCI_2\right), CF_2\left(PCF_2\right)\right)$, the basic operations are put forward:

(1) $PC_1 \oplus PC_2 = \left(\begin{array}{l} CT_1 + CT_2 - CT_1 \cdot CT_2 \left(2!\dfrac{PCT_1 \cdot PCT_2}{PCT_1 + PCT_2}\right), \\ CI_1 \cdot CI_2 \left(2!\dfrac{PCI_1 \cdot PCI_2}{PCI_1 + PCI_2}\right), CF_1 \cdot CF_2 \left(2!\dfrac{PCF_1 \cdot PCF_2}{PCF_1 + PCF_2}\right) \end{array}\right);$

(2) $PC_1 \otimes PC_2 = \left(\begin{array}{l} CT_1 \cdot CT_2 \left(2!\dfrac{PCT_1 \cdot PCT_2}{PCT_1 + PCT_2}\right), \\ CI_1 + CI_2 - CI_1 \cdot CI_2 \left(2!\dfrac{PCI_1 \cdot PCI_2}{PCI_1 + PCI_2}\right), \\ CF_1 + CF_2 - CF_1 \cdot CF_2 \left(2!\dfrac{PCF_1 \cdot PCF_2}{PCF_1 + PCF_2}\right) \end{array}\right);$

(3) $\lambda PC = \left(1-\left(1-CT\right)^{\lambda}\left(PCT\right), \left(CI\right)^{\lambda}\left(PCI\right), \left(CF\right)^{\lambda}\left(PCF\right)\right), \lambda > 0;$

(4) $\left(PC\right)^{\lambda} = \left(\left(CT\right)^{\lambda}\left(PCT\right), 1-\left(1-CI\right)^{\lambda}\left(PCI\right), 1-\left(1-CF\right)^{\lambda}\left(PCF\right)\right), \lambda > 0.$

Definition 4[11]. Let $PC_1 = \left(CT_1\left(PCT_1\right), CI_1\left(PCI_1\right), CF_1\left(PCF_1\right)\right)$ and $PC_2 = \left(CT_2\left(PCT_2\right), CI_2\left(PCI_2\right), CF_2\left(PCF_2\right)\right)$, the probabilistic simplified Neutrosophic number Logarithmic distance (PSNNLD) between $PC_1 = \left(CT_1\left(PCT_1\right), CI_1\left(PCI_1\right), CF_1\left(PCF_1\right)\right)$ and $PC_2 = \left(CT_2\left(PCT_2\right), CI_2\left(PCI_2\right), CF_2\left(PCF_2\right)\right)$ is constructed:

$$
\begin{aligned}
&PSNNLD\left(PC_1, PC_2\right) \\
&= \frac{1}{3}\left(\begin{array}{l}
\left(CT_1 \times PCT_1\right)\log \dfrac{\left(CT_1 \times PCT_1\right)}{\dfrac{\left(CT_1 \times PCT_1\right)+\left(CT_2 \times PCT_2\right)}{2}} \\
+\left(CT_2 \times PCT_2\right)\log \dfrac{\left(CT_2 \times PCT_2\right)}{\dfrac{\left(CT_1 \times PCT_1\right)+\left(CT_2 \times PCT_2\right)}{2}} \\
+\left(CI_1 \times PCI_1\right)\log \dfrac{\left(CI_1 \times PCI_1\right)}{\dfrac{\left(CI_1 \times PCI_1\right)+\left(CI_2 \times PCI_2\right)}{2}} \\
+\left(CI_2 \times PCI_2\right)\log \dfrac{\left(CI_2 \times PCI_2\right)}{\dfrac{\left(CI_1 \times PCI_1\right)+\left(CI_2 \times PCI_2\right)}{2}} \\
+\left(CF_1 \times PCF_1\right)\log \dfrac{\left(CF_1 \times PCF_1\right)}{\dfrac{\left(CF_1 \times PCF_1\right)+\left(CF_2 \times PCF_2\right)}{2}} \\
+\left(CF_2 \times PCF_2\right)\log \dfrac{2\left(CF_2 \times PCF_2\right)}{\dfrac{\left(CF_1 \times PCF_1\right)+\left(CF_2 \times PCF_2\right)}{2}}
\end{array}\right)
\end{aligned} \tag{3}
$$

4. Methodology

The PSNN-TOPSIS is put forward for MADM under PSNSs with completely unknown weight. Let $CA=\{CA_1, CA_2, \cdots, CA_m\}$ be alternatives, and $CG=\{CG_1, CG_2, \cdots, CG_n\}$ be attributes with weight cw, where $cw_j \in [0,1]$ $\sum_{j=1}^{n} cw_j = 1$. Suppose that the decision information is depicted with PSNNs $CR=\left(CR_{ij}\right)_{m\times n}=\begin{pmatrix} CT_{ij}\left(PCT_{ij}\right), \\ CI_{ij}\left(PCI_{ij}\right), CF_{ij}\left(PCF_{ij}\right)\end{pmatrix}_{m\times n}$. Then, PSNN-TOPSIS technique is put forward MADM with the CRITIC technique (See Figure 1).

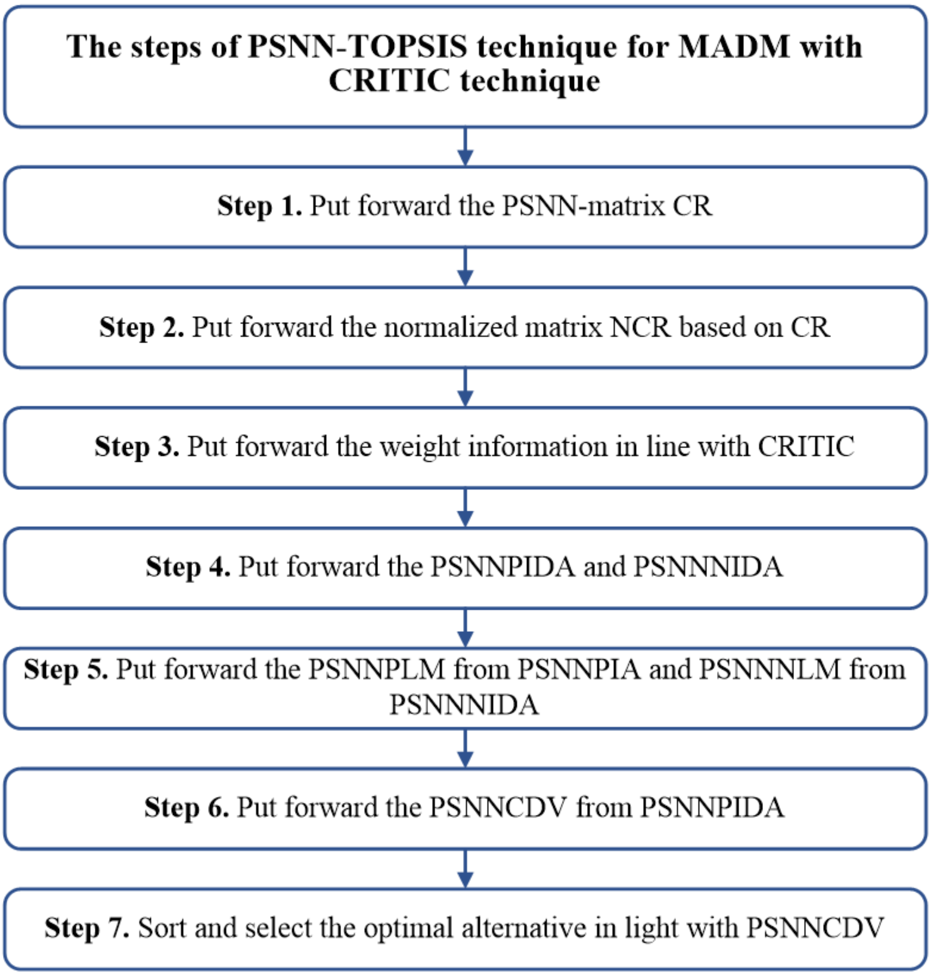

Figure 1. PSNN-TOPSIS framework for MADM with CRITIC technique

Step 1. Put forward PSNN-matrix $CR=\left(CR_{ij}\right)_{m\times n}=\begin{pmatrix} CT_{ij}\left(PCT_{ij}\right), \\ CI_{ij}\left(PCI_{ij}\right), CF_{ij}\left(PCF_{ij}\right) \end{pmatrix}_{m\times n}$.

Step 2. Put forward the normalized matrix $NCR=\left[NCR_{ij}\right]_{m\times n}$ based on $CR=\left(CR_{ij}\right)_{m\times n}$.

$$
\begin{aligned}
&NCR_{ij}=\left(CT_{ij}^{N}\left(PCT_{ij}^{N}\right), CI_{ij}^{N}\left(PCI_{ij}^{N}\right), CF_{ij}^{N}\left(PCF_{ij}^{N}\right)\right) \\
&=\begin{cases} \left(CT_{ij}\left(PCT_{ij}\right), CI_{ij}\left(PCI_{ij}\right), CF_{ij}\left(PCF_{ij}\right)\right), & CG_{j} \text{ is the benefit attributes} \\ \left(CF_{ij}\left(PCF_{ij}\right), 1-CI_{ij}\left(1-PCI_{ij}\right), CT_{ij}\left(PCT_{ij}\right)\right), & CG_{j} \text{ is the cost attributes} \end{cases}
\end{aligned} \tag{4}
$$

Step 3. Put forward the weight information in line with CRITIC.

The CRITIC technique [27] is utilized to put forward the weight information. The compute steps of CRITIC technique are designed[28].

(1) Depending on PSNN-matrix $NCR = \left[NCR_{ij} \right]_{m \times n}$, $NCR_{ij} = \left(CT_{ij}^{N}\left(PCT_{ij}^{N}\right), CI_{ij}^{N}\left(PCI_{ij}^{N}\right), CF_{ij}^{N}\left(PCF_{ij}^{N}\right) \right)$, the PSNN correlation coefficient (PSNNCC) for attributes is put forward.

$$PSNNCC_{jt} = \frac{\sum_{i=1}^{m}\left(SV\left(NCR_{ij}\right) - SV\left(NCR_{j}\right)\right)\left(SV\left(NCR_{it}\right) - SV\left(NCR_{t}\right)\right)}{\sqrt{\sum_{i=1}^{m}\left(SV\left(NCR_{ij}\right) - SV\left(NCR_{j}\right)\right)^{2}}\sqrt{\sum_{i=1}^{m}\left(SV\left(NCR_{it}\right) - SV\left(NCR_{t}\right)\right)^{2}}},$$

$$j, t = 1, 2, \ldots, n, \quad (5)$$

where

$$SV\left(NCR_{j}\right) = \frac{1}{m}\sum_{i=1}^{m} SV\left(NCR_{ij}\right) = \frac{CT_{ij}^{N} \cdot PCT_{ij}^{N} + CI_{ij}^{N} \cdot PCI_{ij}^{N} + CF_{ij}^{N} \cdot PCF_{ij}^{N}}{3m}$$ and

$$SV\left(NCR_{it}\right) = \frac{1}{m}\sum_{i=1}^{m} SV\left(NCR_{it}\right) = \frac{CT_{it}^{N} \cdot PCT_{it}^{N} + CI_{it}^{N} \cdot PCI_{it}^{N} + CF_{it}^{N} \cdot PCF_{it}^{N}}{3m}.$$

(2) Put forward PSNN standard deviation (PSNNSD) for attributes.

$$PSNNSD_{j} = \sqrt{\frac{1}{m-1}\sum_{i=1}^{m}\left(SV\left(NCR_{ij}\right) - SV\left(NCR_{j}\right)\right)^{2}} \quad (6)$$

where $SV\left(NCR_{j}\right) = \frac{1}{m}\sum_{i=1}^{m} SV\left(NCR_{ij}\right)$.

(3) Put forward the weight information.

$$cw_{j} = \frac{PSNNSD_{j}\sum_{t=1}^{n}\left(1 - PSNNCC_{jt}\right)}{\sum_{j=1}^{n}\left(PSNNSD_{j}\sum_{t=1}^{n}\left(1 - PSNNCC_{jt}\right)\right)} \quad (7)$$

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

Step 4. Put forward the PSNN positive ideal decision alternative (PSNNPIDA) and PSNN negative ideal decision alternative (PSNNNIDA) [28]:

$$PSNNPIDA = \left\{PSNNPIDA_{j}\right\}, j = 1, 2, \ldots, n. \quad (8)$$

$$PSNNNIDA = \left\{PSNNNIDA_{j}\right\}, j = 1, 2, \ldots, n. \quad (9)$$

$$PSNNPIDA_j = \begin{pmatrix} CT_j^{+N}\left(PCT_j^{+N}\right), \\ CI_j^{+N}\left(PCI_j^{+N}\right), CF_j^{+N}\left(PCF_j^{+N}\right) \end{pmatrix}, \qquad j = 1, 2, \ldots, n. \tag{10}$$

$$PSNNNIDA_j = \begin{pmatrix} CT_j^{-N}\left(PCT_j^{-N}\right), \\ CI_j^{-N}\left(PCI_j^{-N}\right), VC_j^{-N}\left(PCF_j^{-N}\right) \end{pmatrix}, \qquad j = 1, 2, \ldots, n. \tag{11}$$

$$\begin{aligned} & SV\left(CT_j^{+N}\left(PCT_j^{+N}\right), CI_j^{+N}\left(PCI_j^{+N}\right), CF_j^{+N}\left(PCF_j^{+N}\right)\right) \\ & = \max_i SV\left(CT_{ij}^{N}\left(PCT_{ij}^{N}\right), CI_{ij}^{N}\left(PCI_{ij}^{N}\right), CF_{ij}^{N}\left(PCF_{ij}^{N}\right)\right) \end{aligned} \tag{12}$$

$$\begin{aligned} & SV\left(CT_j^{-N}\left(PCT_j^{-N}\right), CI_j^{-N}\left(PCI_j^{-N}\right), VC_j^{-N}\left(PCF_j^{-N}\right)\right) \\ & = \min_i SV\left(CT_{ij}^{N}\left(PCT_{ij}^{N}\right), CI_{ij}^{N}\left(PCI_{ij}^{N}\right), CF_{ij}^{N}\left(PCF_{ij}^{N}\right)\right) \end{aligned} \tag{13}$$

where

$$\begin{aligned} & SV\left(CT_j^{+N}\left(PCT_j^{+N}\right), CI_j^{+N}\left(PCI_j^{+N}\right), CF_j^{+N}\left(PCF_j^{+N}\right)\right) \\ & = \frac{CT_j^{+N} \cdot PCT_j^{+N} + CI_j^{+N} \cdot PCI_j^{+N} + CF_j^{+N} \cdot PCF_j^{+N}}{3} \end{aligned} \tag{14}$$

$$\begin{aligned} & SV\left(CT_j^{-N}\left(PCT_j^{-N}\right), CI_j^{-N}\left(PCI_j^{-N}\right), VC_j^{-N}\left(PCF_j^{-N}\right)\right) \\ & = \frac{CT_j^{-N} \cdot PCT_j^{-N} + CI_j^{-N} \cdot PCI_j^{-N} + CF_j^{-N} \cdot PCF_j^{-N}}{3} \end{aligned} \tag{15}$$

$$\begin{aligned} & SV\left(CT_{ij}^{N}\left(PCT_{ij}^{N}\right), CI_{ij}^{N}\left(PCI_{ij}^{N}\right), CF_{ij}^{N}\left(PCF_{ij}^{N}\right)\right) \\ & = \frac{CT_{ij}^{N} \cdot PCT_{ij}^{N} + CI_{ij}^{N} \cdot PCI_{ij}^{N} + CF_{ij}^{N} \cdot PCF_{ij}^{N}}{3} \end{aligned} \tag{16}$$

Step 5. Put forward the PSNN positive Logarithmic distance (PSNNPLM) from PSNNPIA and PSNN negative Logarithmic distance (PSNNNLM) from PSNNNIDA:

$$PSNNPLM\left(CA_i, PSNNPIDA\right) = \sum_{j=1}^{n} cw_j \left(PSNNLD\left(CA_i, PSNNPIDA_j\right)\right)$$

$$= \frac{1}{3}\sum_{j=1}^{n} cw_j \left(\begin{array}{l} \left(CT_{ij}^{N} \times PCT_{ij}^{N}\right)\log \dfrac{\left(CT_{ij}^{N} \times PCT_{ij}^{N}\right)}{\dfrac{\left(CT_{ij}^{N} \times PCT_{ij}^{N}\right)+\left(CT_{j}^{+N} \times PCT_{j}^{+N}\right)}{2}} \\ +\left(CT_{j}^{+N} \times PCT_{j}^{+N}\right)\log \dfrac{\left(CT_{j}^{+N} \times PCT_{j}^{+N}\right)}{\dfrac{\left(CT_{ij}^{N} \times PCT_{ij}^{N}\right)+\left(CT_{j}^{+N} \times PCT_{j}^{+N}\right)}{2}} \\ \left(CI_{ij}^{N} \times PCI_{ij}^{N}\right)\log \dfrac{\left(CI_{ij}^{N} \times PCI_{ij}^{N}\right)}{\dfrac{\left(CI_{ij}^{N} \times PCI_{ij}^{N}\right)+\left(CI_{j}^{+N} \times PCI_{j}^{+N}\right)}{2}} \\ +\left(CI_{j}^{+N} \times PCI_{j}^{+N}\right)\log \dfrac{\left(CI_{j}^{+N} \times PCI_{j}^{+N}\right)}{\dfrac{\left(CI_{ij}^{N} \times PCI_{ij}^{N}\right)+\left(CI_{j}^{+N} \times PCI_{j}^{+N}\right)}{2}} \\ \left(CF_{ij}^{N} \times PCF_{ij}^{N}\right)\log \dfrac{\left(CF_{ij}^{N} \times PCF_{ij}^{N}\right)}{\dfrac{\left(CF_{ij}^{N} \times PCF_{ij}^{N}\right)+\left(CF_{j}^{+N} \times PCF_{j}^{+N}\right)}{2}} \\ +\left(CF_{j}^{+N} \times PCF_{j}^{+N}\right)\log \dfrac{\left(CF_{j}^{+N} \times PCF_{j}^{+N}\right)}{\dfrac{\left(CF_{ij}^{N} \times PCF_{ij}^{N}\right)+\left(CF_{j}^{+N} \times PCF_{j}^{+N}\right)}{2}} \end{array} \right) \quad (17)$$

$$PSNNNLM\left(CA_i, PSNNNIDA\right) = \sum_{j=1}^{n} cw_j \left(PSNNLD\left(CA_i, PSNNNIDA_j\right)\right)$$

$$= \frac{1}{3}\sum_{j=1}^{n} cw_j \begin{pmatrix} \left(CT_{ij}^{N} \times PCT_{ij}^{N}\right)\log \dfrac{\left(CT_{ij}^{N} \times PCT_{ij}^{N}\right)}{\dfrac{\left(CT_{ij}^{N} \times PCT_{ij}^{N}\right)+\left(CT_{j}^{-N} \times PCT_{j}^{-N}\right)}{2}} \\ +\left(CT_{j}^{-N} \times PCT_{j}^{-N}\right)\log \dfrac{\left(CT_{j}^{-N} \times PCT_{j}^{-N}\right)}{\dfrac{\left(CT_{ij}^{N} \times PCT_{ij}^{N}\right)+\left(CT_{j}^{-N} \times PCT_{j}^{-N}\right)}{2}} \\ \left(CI_{ij}^{N} \times PCI_{ij}^{N}\right)\log \dfrac{\left(CI_{ij}^{N} \times PCI_{ij}^{N}\right)}{\dfrac{\left(CI_{ij}^{N} \times PCI_{ij}^{N}\right)+\left(CI_{j}^{-N} \times PCI_{j}^{-N}\right)}{2}} \\ +\left(CI_{j}^{-N} \times PCI_{j}^{-N}\right)\log \dfrac{\left(CI_{j}^{-N} \times PCI_{j}^{-N}\right)}{\dfrac{\left(CI_{ij}^{N} \times PCI_{ij}^{N}\right)+\left(CI_{j}^{-N} \times PCI_{j}^{-N}\right)}{2}} \\ \left(CF_{ij}^{N} \times PCF_{ij}^{N}\right)\log \dfrac{\left(CF_{ij}^{N} \times PCF_{ij}^{N}\right)}{\dfrac{\left(CF_{ij}^{N} \times PCF_{ij}^{N}\right)+\left(CF_{j}^{-N} \times PCF_{j}^{-N}\right)}{2}} \\ +\left(CF_{j}^{-N} \times PCF_{j}^{-N}\right)\log \dfrac{\left(CF_{j}^{-N} \times PCF_{j}^{-N}\right)}{\dfrac{\left(CF_{ij}^{N} \times PCF_{ij}^{N}\right)+\left(CF_{j}^{-N} \times PCF_{j}^{-N}\right)}{2}} \end{pmatrix} \quad (18)$$

Step 6. Put forward the PSNN close degree values (PSNNCDV) from PSNNPIDA.

$$\begin{aligned} & PSNNCDV\left(CA_i, PSNNPIDA\right) \\ & = \frac{PSNNPLM\left(CA_i, PSNNNIDA\right)}{\begin{pmatrix} PSNNPLM\left(CA_i, PSNNNIDA\right) \\ +PSNNPLM\left(CA_i, PSNNPIDA\right) \end{pmatrix}} \\ & = \frac{\sum_{j=1}^{n} cw_j \left(PSNNLD\left(CA_i, PSNNNIDA_j\right)\right)}{\begin{pmatrix} \sum_{j=1}^{n} cw_j \left(PSNNLD\left(CA_i, PSNNNIDA_j\right)\right) \\ +\sum_{j=1}^{n} cw_j \left(PSNNLD\left(CA_i, PSNNPIDA_j\right)\right) \end{pmatrix}} \end{aligned} \quad (19)$$

Step 7. In light with $PSNNCDV\left(CA_i, PSNNPIDA\right)$. The larger $PSNNCDV\left(CA_i, PSNNPIDA\right)$, the better alternative is.

5. Data Analysis and Results

5.1. Data Analysis

Although environmental art design has high requirements for the materials, texture, and color of building decoration materials, with the continuous development of technology, various green building decoration materials have become more and more common, and the application of green building decoration materials in environmental art design has also become more widespread. From the perspective of energy-saving and environmental protection effects, the current application of green building materials in environmental art design can be mainly divided into two categories. One type is to use new building materials to achieve better environmental and energy-saving effects, such as double-layer insulated glass, heat absorbing louvers, photovoltaic panels, etc. These materials themselves do not have outstanding energy-saving and environmental protection characteristics, but through reasonable use in building decoration and decoration design, they can greatly save energy consumption and environmental pollution in buildings. Another type is to combine nanomaterials with traditional building materials to improve material performance and enable materials to have industrial production characteristics. This can not only avoid material waste, but also enhance the technological sense of the indoor and outdoor environment of the building, thereby enhancing the ornamental value of the living environment. In environmental art design, if designers can flexibly apply these two types of green materials, the overall environment of the building will be more in line with the requirements of green buildings. In China's building materials market, there are many green building materials that can solve many problems and contribute to the development of environmental green design concepts. The characteristic of green materials is to reduce energy consumption and minimize the impact on the natural ecological environment. And among material recyclers, green materials are very environmentally friendly, which traditional materials do not have. In environmental green design, the use of green materials fully meets the requirements of environmental design. The application of green materials in environmental design ensures people's health without considering the pollution caused by materials to the environment. Therefore, when conducting environmental art design, we must try to choose green materials as much as possible, which is also a way to achieve the green concept. In today's rapidly developing economy, energy is an extremely important issue. Currently, China's industry is developing rapidly, and energy is also being consumed rapidly. People's production and living environment, as well as the natural environment, have been severely damaged, resulting in less and less energy. To solve the problem of energy consumption, it is necessary to save energy as much as possible and improve energy utilization efficiency. Energy conservation can be achieved from various aspects, such as temperature control, light utilization, water resource recycling, and sound insulation. Doors and windows have a significant impact on indoor temperature control. When designing, designers should pay attention to the material of doors and windows, so as to minimize energy consumption in the environment and maintain the most comfortable temperature. The utilization of water resources is also something we need to consider. China's per capita water resources are very low, so improving the utilization rate of water resources is extremely important. When designing, designers must consider the recycling of wastewater and the collection of rainwater to minimize water waste. In summary. In environmental art design, the application of green design concepts is very important. Its reasonable application brings us a healthy, comfortable, and suitable living environment space. Currently, this aspect is still in the development stage in China. We must increase our research and practice efforts to create a beautiful and healthy living environment for ourselves. The quality evaluation of environmental art design from the perspective of green buildings is MADM. In this work, the PSNN-TOPSIS is put forward quality evaluation of environmental art design from the perspective of green buildings. Five environmental art design schemes from the perspective of green buildings $CA_i\left(i=1,2,3,4,5\right)$ are assessed with four attributes: ①VG_1 is sustainable sites of environmental art design schemes from the perspective of green buildings; ②VG_2 is materials and resources of environmental art design schemes from the perspective of green buildings; ③VG_3 is indoor environmental quality of environmental art design schemes from the perspective of green buildings; ④VG_4 is design comfort of environmental art design schemes from the perspective of green buildings. Then, the PSNN-TOPSIS put forward a quality evaluation of environmental art design from the perspective of green buildings with PSNSs.

Step 1. Put forward the decision matrix with PSNSs. The evaluation result is shown in **Table 1.**

Table 1. The PSNN information

Alternative	CG_1	CG_2
CA_1	{0.37(0.5),0.42(0.2),0.65(0.3)}	{0.83(0.3),0.74(0.3),0.25(0.4)}
CA_2	{0.48(0.4),0.27(0.5),0.54(0.1)}	{0.16(0.2),0.76(0.1),0.42(0.7)}
CA_3	{0.47(0.2),0.52(0.7),0.62(0.1)}5	{0.65(0.4),0.23(0.2),0.51(0.4)}
CA_4	{0.69(0.3),0.86(0.3),0.27(0.4)}	{0.32(0.3),0.84(0.4),0.34(0.3)}
CA_5	{0.43(0.1),0.54(0.6),0.89(0.3)}	{0.39(0.4),0.58(0.1),0.63(0.5)}

Alternative	CG_3	CG_4
CA_1	{0.71(0.4),0.46(0.5),0.49(0.1)}	{0.24(0.3),0.30(0.4),0.52(0.3)}
CA_2	{0.52(0.5),0.23(0.3),0.57(0.2)}	{0.31(0.2),0.52(0.3),0.27(0.5)}
CA_3	{0.28(0.6),0.56(0.2),0.31(0.2)}	{0.48(0.3),0.89(0.6),0.48(0.1)}
CA_4	{0.46(0.7),0.49(0.2),0.18(0.1)}	{0.79(0.3),0.32(0.2),0.18(0.5)}
CA_5	{0.21(0.6),0.38(0.1),0.62(0.3)}	{0.27(0.8),0.46(0.1),0.64(0.1)}

Step 2. Put forward the normalized matrix $NCR=\left[NCR_{ij}\right]_{5\times 4}$. Because these attributes are benefit, thus, $NCR=\left[NCR_{ij}\right]_{5\times 4}$ is same to $CR=\left[CR_{ij}\right]_{5\times 4}$.

Table 2. The normalized PSNN-matrix through PSNNs

Alternative	CG_1	CG_2
CA_1	{0.37(0.5),0.42(0.2),0.65(0.3)}	{0.83(0.3),0.74(0.3),0.25(0.4)}
CA_2	{0.48(0.4),0.27(0.5),0.54(0.1)}	{0.16(0.2),0.76(0.1),0.42(0.7)}
CA_3	{0.47(0.2),0.52(0.7),0.62(0.1)}5	{0.65(0.4),0.23(0.2),0.51(0.4)}
CA_4	{0.69(0.3),0.86(0.3),0.27(0.4)}	{0.32(0.3),0.84(0.4),0.34(0.3)}
CA_5	{0.43(0.1),0.54(0.6),0.89(0.3)}	{0.39(0.4),0.58(0.1),0.63(0.5)}

Alternative	CG_3	CG_4
CA_1	{0.71(0.4),0.46(0.5),0.49(0.1)}	{0.24(0.3),0.30(0.4),0.52(0.3)}
CA_2	{0.52(0.5),0.23(0.3),0.57(0.2)}	{0.31(0.2),0.52(0.3),0.27(0.5)}
CA_3	{0.28(0.6),0.56(0.2),0.31(0.2)}	{0.48(0.3),0.89(0.6),0.48(0.1)}
CA_4	{0.46(0.7),0.49(0.2),0.18(0.1)}	{0.79(0.3),0.32(0.2),0.18(0.5)}
CA_5	{0.21(0.6),0.38(0.1),0.62(0.3)}	{0.27(0.8),0.46(0.1),0.64(0.1)}

Step 3. Put forward the weight information with CRITIC (See Table 3).

Table 3. The attributes weight values

	CG_1	CG_2	CG_3	CG_4
weight	0.1833	0.3410	0.2778	0.2079

Step 4. Put forward the PSNNPIDA and PSNNNIDA (See Table 4).

Table 4. The PSNNPIDA and PSNNNIDA

	CG_1	CG_2
PSNNPIDA	{0.69(0.3),0.86(0.3),0.27(0.4)}	{0.83(0.3),0.74(0.3),0.25(0.4)}
PSNNNIDA	{0.37(0.5),0.42(0.2),0.65(0.3)}	{0.16(0.2),0.76(0.1),0.42(0.7)}
	CG_3	CG_4
PSNNPIDA	{0.71(0.4),0.46(0.5),0.49(0.1)}	{0.79(0.3),0.32(0.2),0.18(0.5)}

PSNNNIDA	{0.21(0.6),0.38(0.1),0.62(0.3)}	{0.24(0.3),0.30(0.4),0.52(0.3)}

Step 5. Put forward the PSNNPLM from PSNNPIDA and PSNNNLM from PSNNNIDA (See Table 5):

Table 5. The $PSNNPLM\left(CA_i, PSNNPIDA\right)$ and $PSNNPLM\left(CA_i, PSNNNIDA\right)$

	$PSNNPLM\left(CA_i, PSNNPIDA\right)$	$PSNNPLM\left(CA_i, PSNNNIDA\right)$
CA_1	0.4587	0.5592
CA_2	0.5833	0.6454
CA_3	0.8097	0.6444
CA_4	0.8103	0.6176
CA_5	0.4856	0.6253

Step 6. Put forward the PSNNCDV from PSNNPIDA.

Table 6. The PSNNCDV from PSNNPIDA

Techniques	PSNNCDV
CA_1	0.5494
CA_2	0.5253
CA_3	0.4432
CA_4	0.4325
CA_5	0.5629

Step 7. In light of PSNNCDV, the order is $CA_5 > CA_1 > CA_2 > CA_3 > CA_5$ and CA_5 is optimal for community home-based elderly care services centers (See Table 7).

Table 7. The order

Techniques	Order

VA_1	2
VA_2	3
VA_3	4
VA_4	5
VA_5	1

5.2. Comparative analysis

The PSNN-TOPSIS is compared with PSNNWA and PSNNWG techniques [11], PSNN-GRA technique[28], and PNN-PROMETHEE technique [11]. The results are constructed in Table 8.

Table 8. Order for different techniques

Techniques	Order	The optimal choice
PSNNWA technique [11]	$CA_5 > CA_1 > CA_2 > CA_3 > CA_5$	CA_5
PSNNWG technique [11]	$CA_5 > CA_1 > CA_3 > CA_2 > CA_5$	CA_5
PSNN-GRA technique[28]	$CA_5 > CA_1 > CA_2 > CA_3 > CA_5$	CA_5
PSNN-PROMETHEE[11]	$CA_5 > CA_1 > CA_2 > CA_3 > CA_5$	CA_5
PSNN-TOPSIS method	$CA_5 > CA_1 > CA_2 > CA_3 > CA_5$	CA_5

In light with WS coefficients [29, 30], the WS coefficient between PSNNWA technique and PSNNWG technique [11], PSNN-GRA technique[28], PNN-PROMETHEE model [11] and PSNN-TOPSIS model is 1.0000, 0.8169, 1.0000, 1.0000, respectively. Thus, From Table 8, it is obvious that order of these models is slightly different, but these models have same best community home-based elderly care services center and worst community home-based elderly care services center. This verifies the PSN-TOPSIS technique is reasonable and effective.

6. Conclusions

Environmental art design mainly refers to the use of scientific and reasonable methods for environmental design and development in a certain environment. In the process of environmental art design, it is necessary to consider factors such as layout, architecture, sculpture, and the cost, materials, and environmental carrying capacity of various public facilities. Combined with various influencing factors, it is necessary to plan the environment reasonably and scientifically. Not only does it need to be aesthetically pleasing, but it is also necessary to fully consider various factors in planning and design, and design environmental art according to the ecological concept of harmonious coexistence of nature. In environmental art design, the concept of green design emerged around the 1980s, mainly focusing on issues related to the environment, pollution, and energy. Its main goal is to perfectly integrate the environment and art, and integrate green concepts into environmental art, maximizing the performance of the environment, linking environmental protection, social development, and harmonious human survival, eliminating the contradictions between the three, and making our human lives in an environmentally friendly and green environment. From the current situation, the direction of environmental art and design development is the green concept. The quality evaluation of environmental art design from the perspective of green buildings could be looked at as the MADM. In this study, the CRITIC technique [12] is put forward to obtain the attribute weights under PSNSs, and the PSNN-TOPSIS model is put forward to solve the MADM with PSNSs. Finally, a numerical study for quality evaluation of environmental art design from the perspective of green buildings is put forward to validate the PSNN-TOPSIS model. The main research motivations of this study are constructed: (1) the TOPSIS model is extended to PSNSs; (2) CRITIC technique is put forward to obtain the attribute weights; (3) the PSNN-TOPSIS model is put forward to solve the MADM with PSNSs; (4) Finally, a numerical study for quality evaluation of environmental art design from the perspective of green buildings is put forward to validate the PSNN-TOPSIS technique with comparative analysis. In future research directions, (1) the application of the constructed techniques under PSNSs shall be discussed through other decision techniques [31-36] and more and more other uncertain environments [31-39]; (2) It is a worthwhile research topic to apply prospect theory to MAGDM in the 2TLNNs environment[40-43].

Acknowledgment

The work was supported by the Ministry of Education Industry-University Cooperation Collaborative Education Project 2020, the Annual research topic of the Qingdao Double Hundred Research Project 2021, and Qingdao Social Science Planning Invention Project, 2022.

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Received: July 24, 2024. Accepted: Oct 22, 2024