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Comprehensive Evaluation of EGM and Fuzzy TOPSIS-IPA: A Case Study of the Aesthetic Preference of Landscape Paintings from the Taiwan Region

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Abstract: This paper presents a comprehensive evaluation of EGM and fuzzy TOPSIS-IPA. The Evaluation Grid Method (EGM) of Miryoku Engineering was applied to study the aesthetic cognitive preferences of landscape paintings from the Taiwan region. This paper also summarizes the different aspects of the aesthetic literacy of people from the Taiwan region and proposes the attractive factors of paintings. Besides, the golden ratio scale semantics, that is, the traditional subjective consciousness model was replaced with the equal-ratio aesthetic scale semantics, and fuzzy satisfaction and importance were used as the basis for evaluation. Fuzzy Importance-Performance Analysis (IPA) was used to understand the public's views on landscape paintings from the Taiwan region. The fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is used to rank affordable objects according to their proximity to the ideal target, evaluate their relative merits, and analyze the public's preferences and evaluation criteria. This study aimed to better understand the Taiwan region's people's awareness and aesthetic literacy of paintings, while also providing a reference for subsequent researchers and popularizing artistic products.

Keywords: Aesthetic literacy; Landscape painting from the Taiwan region; Miryoku Engineering; Evaluation Grid Method (EGM); Fuzzy IPA; Fuzzy TOPSIS.

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1. Introduction

This study aims to perform a comprehensive evaluation of EGM and fuzzy TOPSIS-IPA, with the aesthetic preference of landscape paintings from the Taiwan region as the study subject. Through in-depth interviews with experts and conducting perceptual qualitative research using the Evaluation Grid Method (EGM), we identified the key factors that influence aesthetic preferences, thereby identifying the attractive elements of

landscape paintings from the Taiwan region. Using fuzzy satisfaction and importance as the basis for evaluation, fuzzy Importance-Performance Analysis (IPA) was used to understand the public's perception of paintings from the Taiwan region. The fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method was used to sort affordable objects according to their proximity to ideal targets, evaluate their relative merits, and analyze the different preferences and evaluation standards of the public. This helps in understanding the public's level of knowledge and appreciation for paintings from the Taiwan region. This study aimed to better understand the Taiwan region's people's awareness and aesthetic literacy of paintings, while also providing a reference for subsequent researchers and popularizing artistic products.

The increasing global spread of aesthetic trends has led to a growing acceptance of aesthetic literature in Taiwan. As a result, more and more people in the Taiwan region are now interested in understanding how beauty impacts their personal lives. Landscape paintings from the Taiwan region have a unique regional charm, not only focusing on natural landscapes but also the local cultural landscape and the impact of human activities on the natural environment. Different aesthetic preferences can affect one's preference for landscape paintings. Aesthetic literacy includes the ability to appreciate artworks, understanding and acceptance of different artistic styles, and awareness of artistic creation techniques. These differences in aesthetic literacy may lead to different preferences for landscape paintings from the Taiwan region.

In addition, the golden proportional scale refers to an objective measure of aesthetic balance, contrasting with the traditional subjective approach. In this context, we opted for the equal-ratio aesthetic scale, breaking away from conventional methods like the IPA questionnaire. Instead, we adopted the fuzzy TOPSIS-IPA quality model. Utilizing landscape paintings by this article's author, Chin-Chin Kuo, a questionnaire was distributed both online and on paper to gauge the perceptions and preferences of people from the Taiwan region regarding paintings. A total of 311 valid IPA questionnaires were obtained to analyze the preferences and evaluation criteria of the public. The results of the analysis can provide valuable references for artists, art enthusiasts, and cultural policymakers. By understanding the public's preferences for landscape paintings from the Taiwan region, it becomes possible to develop new artistic and cultural offerings, enriching people's diverse aesthetic sensibilities. Additionally, research has been conducted on the significance of the golden ratio scale [1,2].

Figure 1. Exhibition in Tainan Cultural Center, 2022 (Painted by Chin-Chin Kuo)

2. Literature review

Art has permeated human existence throughout history, evident in various forms and styles spanning from primitive cave paintings in Europe to Renaissance religious frescoes, Indian Buddhist art, and Chinese tomb

murals. In the 19th century, a new chapter unfolded in the realm of painting, marked by the emergence of realistic naturalism styles which gained popularity in the first half of the century. Departing from earlier conventions, landscape painting evolved from its former ancillary role to attain independence and establish itself as a distinct style. In the latter half of the 19th century, the emphasis on capturing light, shadow, and color in outdoor scenes gained prominence, largely due to advocates like Claude Monet (1840–1926). This movement laid the foundation for Impressionism, which prioritized spontaneous sketching and greatly influenced the trajectory of modern landscape painting [3]. Therefore, in this diversified art and design environment, Taiwan region's emerging artists began to display more painting strategies and use special techniques to attract viewers. Some people may prefer abstract or semi-abstract styles, focusing on the atmosphere and emotional expression of the painting, while others may prefer realistic landscapes, focusing on details and realism. Factors such as individual cultural background, regional differences, and life experience may influence Taiwan region's preferences for landscape painting. For example, people who grew up in coastal areas may be more interested in ocean paintings. People who live in the mountains may prefer landscape paintings. At the same time, factors such as gender, age, education, taste, and personality may also have an impact on an individual's aesthetic literacy and preference for landscape painting.

According to the ancient Greek philosopher Aristotle (384–322 B.C.), the essence of art is imitation. He believed that art is not only a faithful imitation but also an idealization. Aristotle's strong interest in the natural world never diminished. He believed that the world of our senses or real life is the real world because the movement of things and the test of logic need to be revealed in the real world. The same is true for landscape paintings. It is the representational nature of art that allows us to derive pleasure from it because we can learn from artistic representation. This shows the importance of art in life [4]. The 18th-century German philosopher Immanuel Kant discussed the cognitive aspects of landscape painting in his work "Critique of Judgment" and proposed a famous new perspective on art theory and aesthetics, which gave landscape painting a profound influence [5]. He particularly emphasized that the origin of beauty comes from the rational reflection of human beings on nature and works of art. Kant believed that in landscape paintings, artists evoke the viewer's inner aesthetic experience through carefully planned compositions and color applications. He also emphasized that landscape paintings should be independent of practical purposes. Hegel [6] thought that beauty is an idea, and the most superficial objective existence in terms of idea is nature. In the solar system, pure and free unity, nature itself is beauty [2]. Ye [7] and You [8] proposed that aesthetic viewpoints compiled from Western art are generally used as the benchmark for judging beauty, and Eastern artistic aesthetics are rarely mentioned. Lin [9] also referred to the formal principle of beauty as the combination of sensory capture and rational judgment. Creators immerse themselves in the beauty of nature, absorbing it through their senses, and then employ Western aesthetic structures to craft an Eastern natural aesthetic. Jian-Fu Gao, a key figure in the establishment of the Ling-Nan Painting School, held the belief that painting should derive from real-life materials to authentically mirror existence. He advocated for paintings to be both accessible and educational, urging the incorporation of modern techniques to convey elements such as light and shadow, perspective, space, and texture [10]. Jin-Ta Yuan [11], born in Changhua, Taiwan region in the late 1940s, is a representative figure of the new generation of Taiwan region painters. He learned the techniques and aesthetics of Chinese ink painting when he was a child and later went to New York to receive the baptism of modern art. His creative philosophy is "Appeal to intuition, be true to self-feeling, and express what you see, know, and think about in life (association, imagination, fantasy)" [11]. Yuan's works of diverse media demonstrate a personal freehand style with a strong humanistic heritage. Wu [13] found that aesthetic literacy varies significantly by sex, age, and education level, but not by residential area. Utilizing research methodologies can furnish investigators with tools to gauge aesthetic literacy levels effectively. While it is advantageous to conduct quick

assessments of aesthetic literacy, it is also crucial to recognize the importance of incorporating aesthetic elements into daily life, thereby promoting the aestheticization of everyday experiences.

Human beings have an instinctive preference and attachment to beauty and the natural environment in which they grow. In this diverse environment of art and design, many Taiwan region's artists have begun to prioritize the strategic presentation of painting art. However, some creators rely excessively on market trends and packaging instead of enhancing the aesthetic and educational concepts of Taiwan region's art. In addition to the imagery, historical connotations, customs, humanistic development, and aesthetic perspectives of the Taiwan region's landscape paintings, there are not many studies on the correlation between symbolic sensibility and charm elements. Therefore, this study focuses on applying EGM, FIPA, and FTOPSIS through similarity to ideal solutions to clarify the relationship between the meaning, style, and emotional imagery of landscape painting from the Taiwan region. By analyzing artwork, the author distills the influences that shape Taiwan residents' preferences for landscape paintings, furnishing a foundation for further discourse and investigation in this realm.

3. Research models and methods

3.1. Evaluation Grid Method (EGM)

In 1991, a Japanese scholar, Masato Ujigawa, gathered many scholars to join the psychological perspective and launched the "Miryoku Engineering" study. Miryoku Engineering centers on understanding consumers' interests and hobbies, delving into their personal perceptions to uncover genuine inner needs. Acting as a liaison between designers and consumers, Miryoku Engineering aims to facilitate communication and collaboration in creating appealing products and experiences. The Equal-ratio Grading Method (EGM) plays a pivotal role in Miryoku Engineering, serving as a consumer preference-based design tool. It provides a platform for operators and consumers to engage in dialogue, jointly exploring ways to enhance attractiveness and facilitate learning.

To analyze EGM's attractive factors, we conducted in-depth interviews to stimulate subject responses. By exploring participants' diverse emotions and perspectives, we gained insights into the topic's original concept. Guiding participants towards clearer analyses, researchers distilled responses into concrete and abstract reasons, revealing genuine preferences and thoughts. Integrating credible evaluations and opinions, we constructed a network diagram to visualize interconnected factors. Finally, we drew an EGM structure diagram. This method distinguished itself by capturing abstract feelings difficult to articulate conventionally.

3.2. Fuzzy Importance-Performance Analysis (FIPA)

Martilla and James introduced the "attention-performance level" analysis model in 1977, later applied to quality measurement by Marr (1986). Importance-Performance Analysis (IPA) is commonly utilized in satisfaction surveys to gauge creators' views on work performance. It assesses satisfaction and importance, forming the basis for a two-dimensional matrix diagram. This matrix is divided into four quadrants for visualization. Quadrant 1: Projects located in this quadrant indicate that the satisfaction and importance scores of the population are higher than the overall average, suggesting they are essential for maintaining competitive advantage. Quadrant 2: A project located in this quadrant means that the viewer's satisfaction score for this project is higher than the overall average, but the attention score is lower than the overall average. This means that the project may be receiving too much resources. Quadrant 3: Projects in this quadrant have lower satisfaction and importance scores compared to the overall average. They are deemed low priority and do not require immediate improvement efforts. Quadrant 4: Items located in this quadrant indicate that the viewer's

satisfaction with the item is lower than the overall average, but the attention score is higher than the overall average. The analysis model is illustrated in **Figure 1**.

This study is different from the traditional equal-spaced semantic questionnaire, breaking away from the traditional discrete type and using the mode as the standard for evaluating quality. In the satisfaction survey, for Fuzzy Importance-Performance Analysis (FIPA), the golden ratio scale (equal ratio beauty scale) of the unequal interval semantic questionnaire was used to distinguish the liking ratio of adjacent semantics and demonstrate the weighted emphasis on the visual importance of aesthetics. The corresponding triangular fuzzy golden ratio scale is shown in **Table 1**, and the semantics of the triangular fuzzy golden ratio scale were adopted (**Figure 2)**.

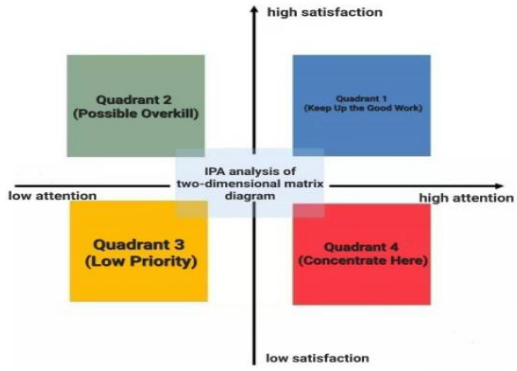

Figure 1. IPA of two-dimensional matrix diagram

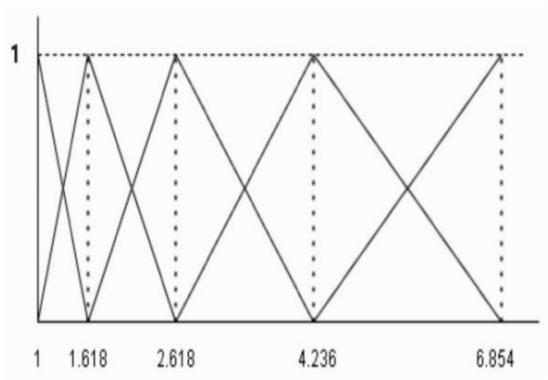

Figure 2. Semantics of the triangular fuzzy golden ratio scale

3.3. Fuzzy TOPSIS (FTOPSIS)

TOPSIS ranking method approaching the ideal solution or the ideal point method was first proposed in 1981. The TOPSIS is a method of ranking limited evaluation objects based on their proximity to idealized goals and evaluates the relative merits of existing objects. Fuzzy TOPSIS is TOPSIS that introduces fuzzy theory and has wider application. Its calculation steps are summarized below.

Step 1: Establish a standardized fuzzy evaluation matrix based on IPA and fuzzy golden ratio scale semantics (**Table 1**) $R = (r_{ij})$. Among them, the column represents the evaluation criteria, and the row represents the evaluation plan.

Table 1. Triangular Fuzzy Golden Section Ratio Scale

Like	(4.236,6.854,6.854)
Must-be	(2.618,4.236,6.854)
Neutral	(1.618,2.618,4.236)
Live with	(1,1.618,2.618)
Dislike	(1,1,1.618)

Step 2: Convert the semantic variables into a triangular fuzzy belonging function $r_{ij} = (a_{ij}, b_{ij}, c_{ij})$. **Table 1** shows the IPA fuzzy evaluation values of the *i*th scheme for *j* evaluation properties.

Step 3: Calculate the distance scale, that is, calculate the distance between each target and the ideal solution and the anti-ideal solution. The distance scale can be calculated through the Euclidean metric, where the positive ideal solution A^* and the negative ideal solution A^- are $A^* = (v_1^*, \cdots, v_n^*),\ v_j^* = max\, v_{ij}; A^- = (v_1^-, \cdots, v_n^-),\ v_j^- = min\, v_{ij};\ j = 1, \cdots, n;\ i = 1, \ldots, m$. The distance from the target to the ideal solution A^* and the anti-ideal solution A^- is $d_i^+ = \sum_{j=1}^{n} d(v_{ij}, v_j^*),\ d_i^- = \sum_{j=1}^{n} d(v_{ij}, v_j^-)$,

where the distance function d is $d(s,k) = \sqrt{\frac{1}{3}[(s_1 - k_1)^2 + (s_2 - k_2)^2 + (s_3 - k_3)^2]}$, where $s = (s_1,s_2,s_3)$, $k = (k_1,k_2,k_3)$

Step 4: Arrange the priorities and calculate the closeness to the ideal solution (CC_i) . By finding the distance between the positive and the negative ideal solution to each solution, the close coefficient (CC_i) of each solution to the positive ideal solution can be calculated. The CC_i value ranges from 0 and 1, with values closer to 1 indicating a higher priority for the ith plan and vice versa, with $CC_i = \frac{d_i^-}{d_i^- + d_i^+}$.

4. Data analysis results

4.1. Miryoku Engineering's network diagram of attractive factors

First, a focus group was created, which consisted of highly engaged individuals, including designers art and design academic experts. This was followed by in-depth interviews (qualitative) and questionnaire distribution (quantitative). The EGM of Miryoku Engineering facilitated inductive analysis, identifying four original reasons: "composition form," "style expression," "color imagery," and "vitality display." Additionally, seven specific charm factors and six abstract charm factors were identified.

Based on these findings, a charm network for landscape paintings from the Taiwan region was established (**Figure 3**), serving as the thematic foundation. Subsequently, interviews with experts informed the creation of spider chart results, summarizing the factors evaluating the creative attributes of landscape paintings from the Taiwan region. These factors include "color expression," "landscape realism," "presentation of power and beauty," "presentation of lush plants," "presentation of a sense of emptiness," "presentation of a sense of tranquility," "presentation of changes in light and shadow," and "presentation of a sense of slowness" as the eight necessary elements of charm.

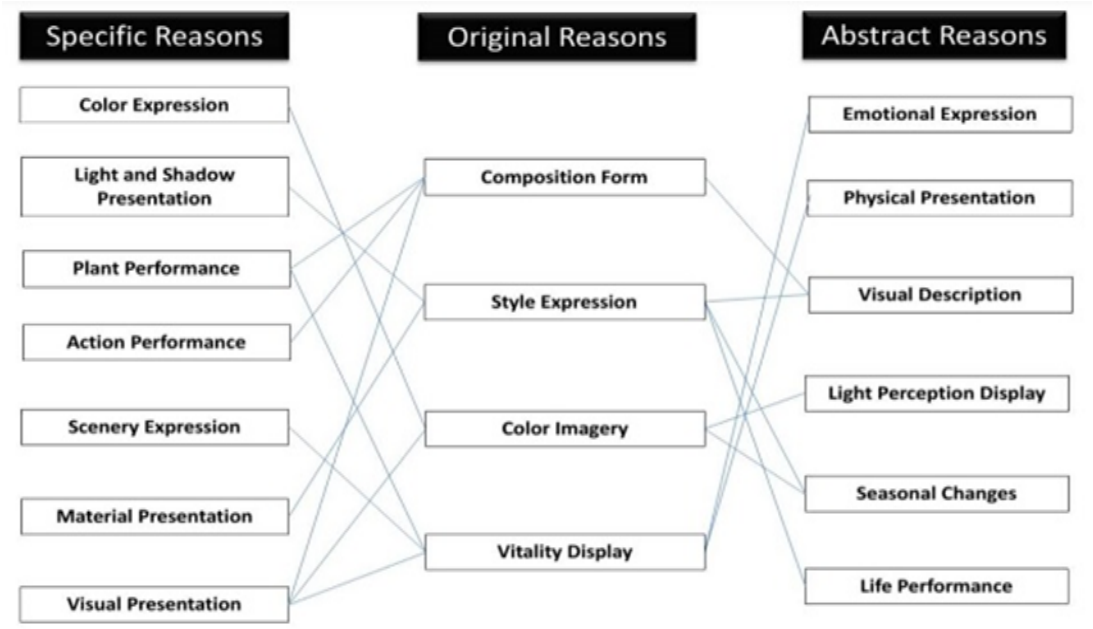

Figure 3. EGM diagram

4.2. Importance-Performance Analysis (IPA)

177 valid questionnaires were collected for IPA. The data obtained were analyzed using SPSS 17, and a reliability analysis was performed. After the questionnaire was collected, the Cronbach's Alpha value of the overall questionnaire was 0.858, indicating that the results were very reliable. The average fuzzy IPA evaluation matrix obtained is shown in **Table 2**.

Table 2. IPA Fuzzy Evaluation

Factors	Importance	Defuzzification	Satisfaction	Defuzzification
Color expression	(3.867,6.244,6.661)	5.264	(3.662,5.922,6.574)	5.118
Landscape realism	(3.211,5.177,6.139)	4.675	(3.625,5.863,6.574)	5.099
Presentation of power and beauty	(3.134,5.057,6.234)	4.684	(3.514,5.679,6.493)	5.004
Presentation of lush plants	(3.030,4.889,6.154)	4.592	(3.599,5.817,6.451)	5.025
Presentation of a sense of emptiness	(2.439,3.932,5.472)	3.956	(2.691,4.337,5.550)	4.121
Presentation of a sense of tranquility	(2.897,4.667,6.083)	4.490	(2.979,4.803,5.967)	4.473
Presentation of changes in light and shadow	(3.659,5.906,6.547)	5.103	(3.075,4.965,6.035)	4.555
Presentation of a sense of slowness	(2.545,4.100,5.598)	4.071	(2.800,4.526,6.024)	4.412

The fuzzy positive ideal solution (FPIS, A^*) and fuzzy negative ideal solution (FNIS, A^-) of IPA are shown in **Table 3**. The distance between each target from the positive and negative ideal solution is shown in **Table 4**. The CC_i values are shown in **Table 5**.

Table 3. Fuzzy positive ideal solution (FPIS, A^*) and fuzzy negative ideal solution (FNIS, A^-) of IPA

	Fuzzy positive ideal solution A^*	Fuzzy negative ideal solution A^-
Fuzzy importance	(3.867, 6.244, 6.661)	(2.439, 3.932,5.472)
Fuzzy satisfaction	(3.662, 5.922,6.574)	(2.691,4.337,5.550)

Table 4. Distance between each target reaching the positive ideal solution and the negative ideal solution

Items	Distance from positive ideal solution d_i^+	Distance from negative ideal solution d_i^-
Color expression	0.000	2.653
Landscape realism	0.826	1.962
Presentation of power and beauty	1.015	1.755
Presentation of lush plants	1.068	1.721
Presentation of a sense of emptiness	2.940	0.000
Presentation of a sense of tranquility	1.957	0.856
Presentation of changes in light and shadow	0.960	1.729
Presentation of a sense of slowness	2.580	0.407

Table 5. CC_i values of each solution

	1. Color expression	2. Landscape realism	3. Presentation of power and beauty	4. Presentation of lush plants	5. Presentation of a sense of emptiness	6. Presentation of a sense of tranquility	7. Presentation of changes in light and shadow	8. Presentation of a sense of slowness
Proximity coefficient	1	0.704	0.634	0.617	0	0.304	0.643	0.136
Sequence	1	2	4	5	8	6	3	7

Taking the average value of importance and satisfaction as the origin of the coordinates, importance as the x-axis, and satisfaction as the y-axis, the quadrants of the factors are obtained as shown in **Table 6**.

Table 6. Quadrants of the items

Items	High satisfaction–average satisfaction, High attention– average attention	Quadrants
1. Color expression	(0.392,0.660)	Quadrant I
2. Landscape realism	(0.373,0.071)	Quadrant I
3. Presentation of power and beauty	(0.278, 0.080)	Quadrant I
4. Presentation of lush plants	(0.299, -0.012)	Quadrant IV
5. Presentation of a sense of emptiness	(-0.605, -0.648)	Quadrant III
6. Presentation of a sense of tranquility	(-0.253, -0.114)	Quadrant III
7. Presentation of changes in light and shadow	(-0.171, 0.499)	Quadrant II
8. Presentation of a sense of slowness	(-0.314, -0.533)	Quadrant III

The IPA two-dimensional matrix diagram is shown **Figure 4**.

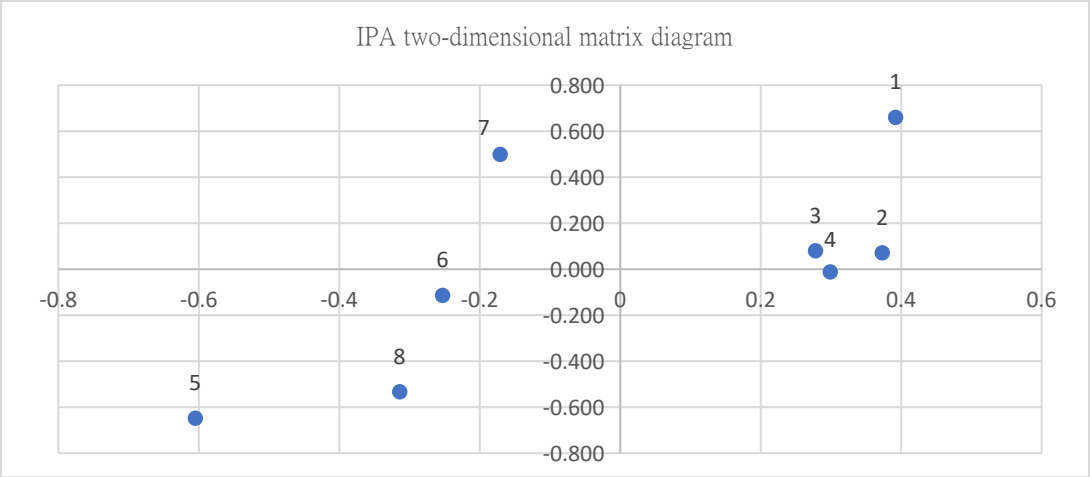

Figure 4. IPA two-dimensional matrix diagram

This study surveyed 311 Taiwan residents to investigate their cognitive preferences for the beauty of local landscape paintings and explore the two-dimensional charm factors using Importance-Performance Analysis (IPA). The survey included eight public experience items, each categorized into four quadrants, as outlined below.

There are three projects in the first quadrant, namely "Color expression," "Landscape realism," and "Presentation of power and beauty," of which the public holds high expectations and satisfaction levels. These aspects should be maintained and promoted vigorously to gain a competitive edge in artwork. There is only one item in the second quadrant, which is "Presentation of changes in light and shadow." Projects falling in this quadrant mean that the public has high expectations for the changes in light and shadow in the picture, but their satisfaction is low. Improving this aspect is crucial as neglecting it may pose a threat to overall satisfaction. There are three items in the third quadrant: "Presentation of a sense of emptiness," "Presentation of a sense of tranquility," and "Presentation of a sense of slowness." These items are of lesser importance to the Taiwan residents, with low satisfaction levels. While these projects do not warrant significant attention,

incremental improvements can enhance overall satisfaction and identity. The fourth quadrant contains only one project, "Presentation of lush plants," which is not a priority for the public but enjoys high satisfaction. Reallocating resources from this area to improve other qualities may be beneficial. Artists should maintain the quality of their works while considering viewer preferences to enhance overall satisfaction without overemphasizing less important aspects.

5. Conclusion

This study focuses on exploring the cognitive preferences of Taiwan residents for the beauty of local landscape paintings and identifying their attractive factors. Departing from traditional subjective creation modes, this study aims to encourage creators to prioritize factors that appeal to viewers, thereby fostering the transformation of cultural and creative products into art. This approach aims to advance the development and promotion of artistic culture and accelerate the popularization of art products. The research methodology involves expert interviews followed by the EGM to identify factors related to the creative attributes of landscape paintings from the Taiwan region. Transitioning to the equal-ratio aesthetic scale model, Fuzzy IPA, and Fuzzy TOPSIS methods were used to understand subjective feelings about landscape paintings from the Taiwan region. By ranking goals based on affordability and idealization, the study evaluates their relative merits and analyzes varying preferences and evaluation standards among the public. Additionally, it assesses the public's familiarity, knowledge level, and artistic appreciation ability regarding landscape paintings from the Taiwan region aiming to inform interactions between viewers and painting art creators.

The study introduces new research concepts in painting creation, elucidates research theories, and enhances understanding of viewers' perceptual evaluations. The research results facilitate the commercialization of painting art and convey new artistic concepts, evoking positive emotions and beautiful imaginations among viewers. This study aims to popularize the beauty and meaning of paintings and artworks, contributing to the enhancement of Taiwan residents' cognition and aesthetic literacy in painting art. It also promotes art education and serves as a reference for product popularization initiatives.

Disclosure statement

The authors declare no conflict of interest.

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