Research on Sustainable Design Strategy of Innovative Public Art Promoting Nature-relatedness Based on Kansei Engineering

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Abstract—In the post-pandemic period, "quarantine" reduces the nature-relatedness of the public, a social problem that urgently needs to be solved globally. Related researchers point out that the public is more connected to nature and healthier physically and mentally. However, few studies have investigated the mediators that enhance nature-relatedness. From the perspective of innovation and sustainable development of public art, this study explores the specific schemes of ceramic public art to enhance nature-relatedness. From the design dimension of ceramic public art, it is found that modelling, composition, decoration and spatial language are indispensable factors in enhancing nature-relatedness, and we are committed to finding specific design solutions. A mathematical model correlation library between design dimensions and perceptual intentions is constructed through Kansei Engineering and Quantization-I theory. The results show that public art with "close" and "functional" perceptual intentions greatly enhances nature-relatedness. The corresponding design categories are: "rotary and curved", "momentum and visual conflict", "painted decoration", "glaze decoration", "organize space". In terms of sustainable design strategies, this study proposes that public art should combine environmental, aesthetic, and social value for innovative design. The research results can help managers of urban ecological planning and planners of public art effectively identify the relevant elements of public art to enhance nature-relatedness. We should also increase the public's current needs analysis, combining sustainable design with the post-epidemic period to make a theoretical contribution to global propositions.

Keywords- public art; Kansei Engineering; Quantization-I theory; sustainable design; innovative design; nature-relatedness

1 INTRODUCTION

Negative sentiment has risen significantly in more than one-third of countries in the post-pandemic era. Confinement and social distancing significantly affect people's physical and mental health. In recent years, many psychologists have proved through research that enhancing nature-relatedness can improve the public's negative emotions and strengthen happiness[1-5]. Nature-relatedness is positively associated with sustainable thinking and behaviour and is a lever for sustainable design[6]. Ceramic public art has various high-quality features such as environmental protection, flexibility, and sustainability, which can enhance the public's nature-relatedness. It restores the emotional resources the public has depleted in daily life, enhances mental resilience, shapes positive environmental protection attitudes, promotes social interaction and integration, and cultivates a good sense of place, belonging, identity [7-9]. This study is based

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on the theory of Kansei Engineering and Quantization-I to explore the relationship between the dimensions of ceramic public art design and public demand. The innovative ceramic public art design method will promote the sustainable development of humans and the environment.

2 METHODS

2.1 Research Model

This research mainly studies the sustainable design strategy of ceramic public art to enhance nature-relatedness through the perspective of Kansei Engineering and Quantization-I theory, as shown in Figure 1.

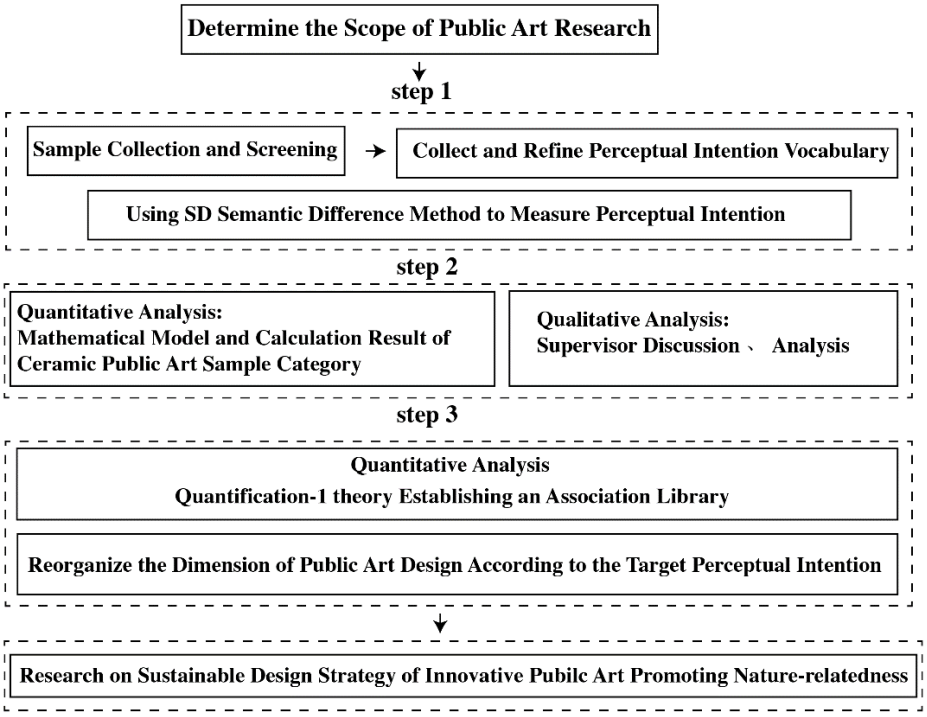

Figure 1. Research model.

2.2 Samples Collections

Three hundred seventy-eight ceramic public art samples were initially collected through the Internet, documents, books, etc. An online questionnaire survey was conducted on graduates of a university in Hebei Province, China. We initially screened and obtained 65 ceramic public art samples and numbered the samples respectively. According to the modelling dimension and influence weight of ceramic public art, the larger the sample difference value, the more typical the sample is. Sixteen samples with the most significant difference value of the above data analysis were selected as representative samples.

2.3 Design Categories Extraction

From the perspective of morphological tectonics, this study conducts an in-depth analysis of the design categories of 16 public art samples and finally obtains 16 design categories. For example, modelling language can be divided into four categories: "linear," "rotary and curved," "arch and dome," and "box." The design categories under each design item of public art are coded and set to form an encoding matrix, as shown in Figure 2.

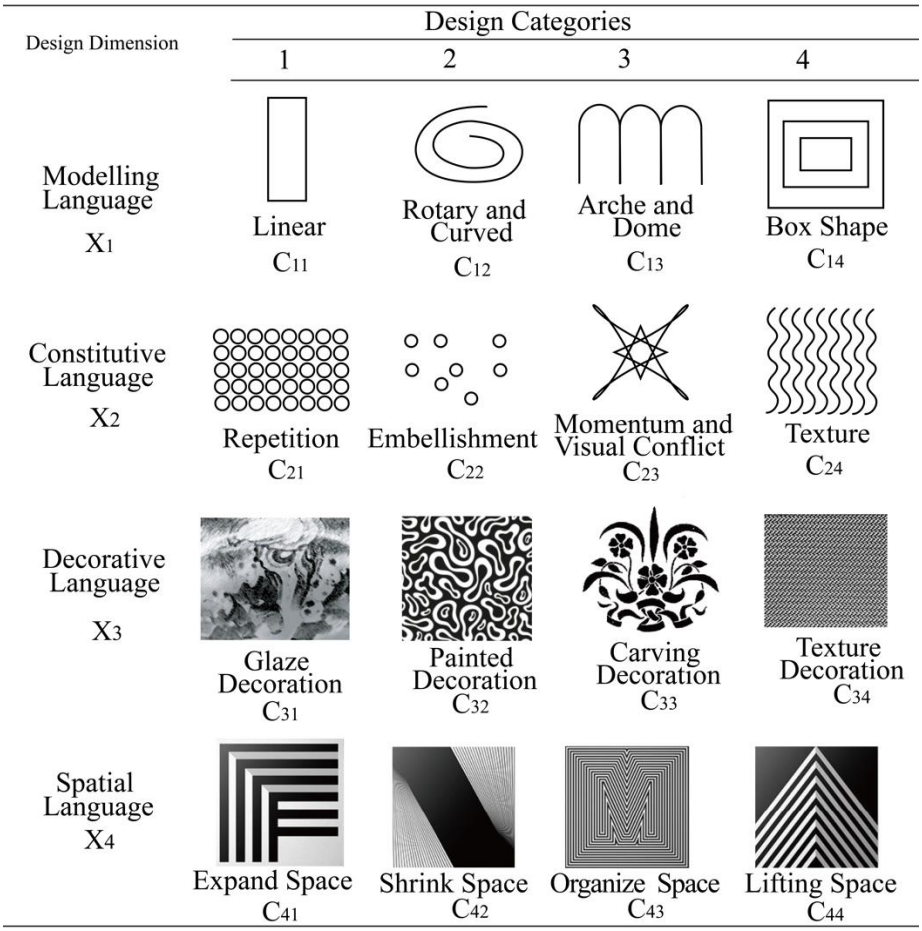

Figure 2. Coding matrix diagram

2.4 Sample Assessment Scale

One hundred graduates from a university in Hebei Province, China, evaluated 16 samples of their perceptual intentions through questionnaires, as shown in Figure 3.

Sample	Perceptual Intentions	Score
	Close-Distannt	5 4 3 2 1
	Cultural-Superfical	5 4 3 2 1
	Critical-Descriptive	5 4 3 2 1
	Interesting-Boring	5 4 3 2 1
	Functional-Decorative	5 4 3 2 1

Figure3. Sample assessment scale.

2.5 Quantificcation- I Theory

This study divides the ceramic public art samples into four design items and 16 design categories. Suppose there are m samples, X number of items, and r number of categories. Then, the number of design categories of the first item (X_1) is r_1, and each category is recorded as C_{11}, C_{12}, C_{13}, ..., C_{1r}. The number of design categories of the 4 item (X_4) is r_4, and each category is counted as C_{41}, C_{42}, C_{43}, ..., C_{4r}. The number of design categories of the i item is r_i, and each category is counted as C_{i1}, C_{i2}, C_{i3}, ..., C_{ir}. The formula of the j category in the i item of the m ceramic public art sample is:

$$\delta_m(i,j)=\begin{cases}1(\text{The } m \text{ sample, the i design item, is the j design category})\\ 0(\text{otherwise})\end{cases} \tag{1}$$

If there is a corresponding design category in the sample, the value is 1. Otherwise, the value is 0. For example, the "modelling language" of the sample numbered m is "box," the corresponding category is C_{14}, this category is assigned a value of 1, and the other categories are both given a value of 0. In the Quantification-I theory, the evaluation value of perceptual intention is the dependent variable, and the design dimension and the design category are the independent variables. If there is a linear correlation between the evaluation value of ceramic public art samples and design items and design categories, the equation is:

$$y_m=\sum_{i=1}^{n}\sum_{j=1}^{r_i}\delta_m(i,j)b_{ij}+\varepsilon_m \tag{2}$$

y_m is the perceptual evaluation value of the m sample. b_{ij} is the score of the j category in the i item. δ_m is the error of the m sampling. In this study, the number of samples m=1, 2, ..., 16. The number of design items n=4, and the four design items are expressed as X_1, X_2, X_3, X_4. The design category of each design item is defined as r_1=4, r_2=4, r_3=4, r_4=4. According to the above formula, the perceptual evaluation values, design dimensions, and design categories of the 16 samples are coded accordingly. The perceptual evaluation matrix diagram is obtained in Table 1.

Table 1. Perceptual intention assessment matrix.

Sample Numbel	Perceptual Intention Evaluation Value					Design Category	
	C—D	C—S	C—D	I—B	F—D	X_1	X_2

	(Close — Distant)	(Cultural — Superficial)	(Critical— Descriptive)	(Interesting— Boring)	(Functional— Decorative)	C_{11}	C_{12}	C_{13}	C_{14}	C_{21}	C_{22}	C_{23}	C_{24}
2	2.18	3.93	3.79	2.25	2.32	0	1	0	0	0	0	0	1
5	2.22	3.78	3.93	2.24	2.17	0	0	1	0	1	0	0	0
8	3.91	2.19	2.26	3.77	2.3	1	0	0	0	1	0	0	0
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64	2.26	3.92	3.75	2.18	2.27	1	0	0	0	1	0	0	0

3 RESULTS

3.1 Experimental Results

We used SPSS to conduct multiple linear regression analyses between the perceptual intentions and design categories. "Close-distant " as an example, calculate the value of its design categories. The calculation results are shown in Table 2.

Table 2. " Close (C) - Distant (D)" analysis results.

Design Dimension	Modelling Language	Category Score	Salience	Partial Correlation Coefficient
Modelling Language X_1	Linear C_{11}	-1.622	0.026	0.809
	Rotary and Curved C_{12}	0.040	0.941	
	Arch and Dome C_{13}	-0.499	0.427	
	Box C_{14}	-1.662	0.004	
Constitutive Language X_2	Repetition C_{21}	1.530	0.061	0.777
	Embellishment C_{22}	-0.043	0.937	
	Momentum and Visual Conflict C_{23}	1.740	0.044	
	Texture C_{24}	0.070	0.918	
Decorative Language X_3	Glaze Decoration C_{31}	1.522	0.058	0.784
	Painted Decoration C_{32}	1.777	0.037	
	Carving Decoration C_{33}	-0.040	0.941	
	Texture Decoration C_{34}	-0.70	0.916	
Spatial Language X_4	Expand Space C_{41}	1.518	0.060	0.781
	Shrink Space C_{42}	-0.043	0.937	
	Organize SpaceC_{43}	1.733	0039	
	Lifte SpaceC_{44}	0.070	0.917	
Constant term		2.131		
Multiple Correlation Coefficient R		0.998		
Coefficient of Determination R^2		0.996		

The results show that the category scores of " modelling language X_1" are arranged in descending order are: rotary and curved(C_{12}) (0.040) > arch and dome (C_{13}) (-0.499) > linear (C_{11}) (-1.622) > box (C_{14}) (-1.662). The data show that: among the perceptual intentions of " close (C) - distant (D)," design category of "rotation and bending" is the most significant influencing factor; The least impact on "close" is "box". Combined with Quantification-I theory, the final regression model is obtained as:

$$Y=a+b_{11}C_{11}+b_{12}C_{12}+b_{13}C_{13}+b_{14}C_{14}+b_{21}C_{21}+b_{22}C_{22}+b_{23}C_{23}+b_{24}C_{24}+b_{31}C_{31}+b_{32}C_{32}+b_{33}C_{33}+b_{34}C_{34}+b_{41}C_{41}+b_{42}C_{42}+b_{43}C_{43}+b_{44}C_{44} \quad (3)$$

Bringing each value into the above formula can get the prediction equation of " close-distant" as:

$$Y_{close\text{-}distant}=2.131-1.622C_{11}+0.040C_{12}-0.499C_{13}-1.662C_{14+}1.530C_{21}-0.043C_{22}+1.740C_{23}+0.070C_{24}+1.522C_{31}+1.777C_{32}-0.040C_{33}-0.70C_{34}+1.518C_{41}-0.043C_{42}+1.733C_{43}+0.070C_{44} \quad (4)$$

It can be seen that the greatest contribution to "close - distant" is " modelling language" X_1 = 0.809, followed by "decorative language" X_3 = 0.784, "spatial language" X_4 = 0.781, "constitutive language" X_2 = 0.777. The smallest contribution to "close-distance" is "constitutive language." For the "close" intention of ceramic public art, the reference order of the design dimension is modelling language> decorative language> spatial language> constitutive language. According to the same method, the partial correlation coefficients between the perceptual intentions of "cultural-superficial," "critical-declarative," "interesting-boring," and "functional-decorative" can be obtained.

3.2 "Close" and "Functional."

The primary purpose of this ceramic public art practice is to enhance the public's nature-relatedness. After field visits and group discussions, a questionnaire survey was conducted combined with the nature-relatedness scale. The respondents were students who graduated from a university in Hebei Province, China, aged 28-37, and the minimum educational background is a bachelor's degree. Fifty questionnaires were distributed in this survey, and 46 valid questionnaires were received. By analyzing the collected 46 questionnaire data, it is found that the ceramic public art that can produce the most " nature-relatedness " has the two perceptual intentions of "close" and "functional." as shown in Table 3.

Table 3. Design category association library that enhances nature-relatedness.

Design Item	**Modelling category**	
	Close	Functional
X_1	C_{12}	C_{12}
X_2	C_{23}	C_{23}

X_3	C_{32}	C_{31}
X_4	C_{43}	C_{43}

3.3 Sustainable Design Strategies for Public Art

Based on the above analysis, the sustainable design strategy of public art should consider the works' environmental, aesthetic, and social value. The three are intertwined with each other due to the perceptual intention of the public and the design dimension of public art. The frame diagram is shown in Figure 4.

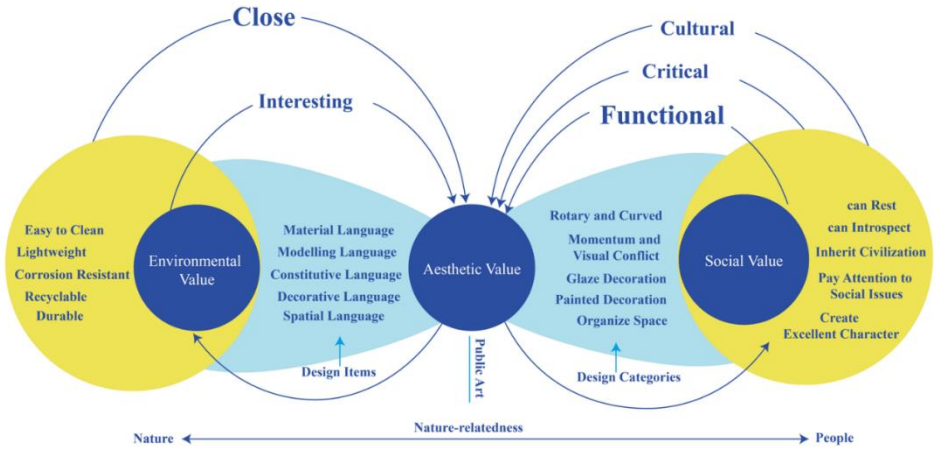

Figure 4. Sustainable design Strategies for public art.

4 DISCUSSION

The " modelling language" of ceramic public art is the most critical factor affecting public perception and the most significant factor that enhances nature-relatedness. At the same time, "constructive language," "decorative language," and "spatial language" also have a substantial impact on improving nature-relatedness.

"Close" and "functional" are the main perceptual intentions of ceramic public art that can enhance nature-relatedness, while "interest," "culture," and "criticism" are auxiliary perceptual intentions.

In the Post-epidemic period, ceramic public art undertakes various social functions such as narrowing public emotions, weakening social distance, and enhancing psychological resilience. "close" is the most critical design proposition in the current era. At the same time, ceramic public art should combine various "functional" such as "resting," "thinking," and "moving," and infiltrate local culture and shared memory into these functions.

5 CONCLUSIONS

With the development and progress of science and technology, emerging environmental protection materials appear in an endless stream. In addition to ceramics, it can also be wood, bamboo, cotton, and hemp. These materials have the advantages of being low cost, renewable and recyclable. Because of their low density, high strength and corrosion resistance, they expand the dimension of the public art design. Sustainable design strategies for public art enhance the development and application of environmentally friendly materials.

The sustainable design strategy of public art is more conducive to enhancing nature-relatedness. Higher nature-relatedness will benefit physical and mental health and improve cognitive function. We should also increase the public's current needs analysis, combine sustainable design with the Post-epidemic period, and make theoretical contributions to global propositions.

The findings can help managers of urban environmental planning and planners of public art to effectively identify the relevant elements of public art to enhance nature-relatedness, for example, material, shape, and regional culture. The monotonous water features and plants tend to homogenize more public settings and cannot effectively enhance the public's nature-relatedness and sustainable domain cognition[10, 11]. Therefore, guide the appropriate managers and public art planners to focus on developing specific elements, not just improving the natural environment.

REFERENCES

[1] Nisbet, E.K., J.M. Zelenski, and S.A. Murphy, Happiness is in our Nature: Exploring Nature Relatedness as a Contributor to Subjective Well-Being. Journal of Happiness Studies, 2011. 12(2): p. 303-322.

[2] Nisbet, E.K. and J.M. Zelenski, The NR-6: a new brief measure of nature relatedness. Frontiers in Psychology, 2013. 4.

[3] Martyn, P. and E. Brymer, The relationship between nature relatedness and anxiety. Journal of health psychology, 2016. 21(7): p. 1436-1445.

[4] Gamage, K.A., N. Munguia, and L. Velazquez, Happy Sustainability: A Future Quest for More Sustainable Universities. Social Sciences, 2022. 11(1): p. 24.

[5] Robles-Moral, F.J., Learning about sustainability and SDG with future primary education teachers in initial training. Social Sciences, 2021. 10(11): p. 409.

[6] Barragan-Jason, G., et al., Human–nature connectedness as a pathway to sustainability: A global meta-analysis. Conservation Letters, 2021.

[7] Fang, M. and H. Chen. Advantages and Disadvantages of Ceramic Materials in Environmental Art. in IOP Conference Series: Materials Science and Engineering. 2020. IOP Publishing.

[8] Carlini, M., et al. Application of a circular & green economy model to a ceramic industrial district: An Italian case study. in AIP Conference Proceedings. 2019. AIP Publishing LLC.

[9] Koyuncu, H., et al. Utilization of ceramic wastes in the construction sector. in Key Engineering Materials. 2004. Trans Tech Publ.

[10] Sawyer, L., 3 Natures Remade and Imagined: “World-City” Beautification and Real Estate Reclamation in Lagos. Grounding Urban Natures: Histories and Futures of Urban Ecologies, 2019: p. 83.
[11] Freestone, R., From city improvement to the city beautiful, in The Australian Metropolis. 2020, Routledge. p. 27-45.