PROCEEDINGS OF ASIA DESIGN AND INNOVATION CONFERENCE
5–6 DECEMBER, 2024, SHANGHAI, CHINA

RESEARCH ON THE DESIGN OF THANGKA CULTURAL CREATIVE PRODUCTS IN THE CONTEXT OF SUSTAINABLE DESIGN: BASED ON KANO-AHP-QFD HYBRID MODEL

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ABSTRACT
With the widespread adoption of cultural sustainability concepts, the demand for cultural creative products is increasingly trending toward diversification and personalization. Tibetan Thangka, as an important intangible cultural heritage of China, poses an urgent challenge: scientifically transforming its traditional aesthetic characteristics into design elements that meet the needs of modern users has become a pressing issue. This study aims to explore a user data-driven design research model for Thangka cultural creative products, with the goal of enhancing user satisfaction and promoting the sustainable inheritance of Thangka culture. Firstly, user needs were collected through surveys, and the KANO model was employed to categorize these needs into four dimensions: visual appeal, emotional connection, symbolic meaning, and functionality. Then, the Analytic Hierarchy Process (AHP) was used to construct a hierarchical model of user requirements and calculate the weight of each need. Subsequently, Quality Function Deployment (QFD) theory was applied to map user need information into specific design elements, which were then ranked according to their importance. Based on these design elements, we completed the design practice of Thangka cultural creative products that meet user requirements. Finally, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was utilized to evaluate the effectiveness of the design solutions. By employing the KANO-AHP-QFD hybrid research method, user needs can be objectively obtained, making the product design process more scientific and rational. This provides new insights for the inheritance and innovation of Thangka culture and offers valuable reference for the innovative design research of other intangible cultural heritage products.

Keywords: Sustainable Design, Intangible cultural heritage preservation, Tibetan Thangka, Cultural and Creative Product Design, Kano-AHP-QFD Hybrid Model

1 INTRODUCTION

Thangka, also known as Thangka, is a scroll painting art created on a special cloth or paper, whose main purpose is to describe the history, culture and customs of Buddhism. Because it is influenced by history and religion factor, Thangka is listed as the first batch of state-level non-material cultural heritage in 2006 [1]. As one of China's important intangible cultural heritages, Thangka captivates global attention with its intricate details, rich religious symbolism, and vivid colors.

However, with the development of modern society, the inheritance and innovation of Thangka craftsmanship face numerous challenges [2]. In terms of design creativity, the outcome of Thangka is greatly influenced by individual techniques. The creator's skill level and emotional expression significantly impact the artistic effect of the work [3]. In terms of heritage conservation, due to the influence of humidity, water stains, mildew and dirt, the number of images of well-maintained Thangka paintings is decreasing [2]. However, in the sustainable transmission of traditional intangible cultural heritage, there has been limited in-depth exploration of how to effectively balance modern design with traditional craftsmanship to enhance the user experience of cultural creative products. Specifically, a significant research gap remains in the scientific and systematic integration of user needs. This study aims to explore the innovative design methods of Thangka cultural and creative products in the context of sustainable design, with the aim of realizing the modern inheritance and creative practical application

of Thangka culture. This article takes Thangka cultural and creative products as an entry point and profoundly explores the following two core issues:

- Q1. Thangka aesthetic features reappear: What are the core aesthetic features of Tibetan Thangka? How can we reproduce the aesthetic features of Thangka through cultural and creative products?
- Q2. Scientific research path: Can the hybrid research model help designers optimize the design of thangka cultural and creative products more scientifically?

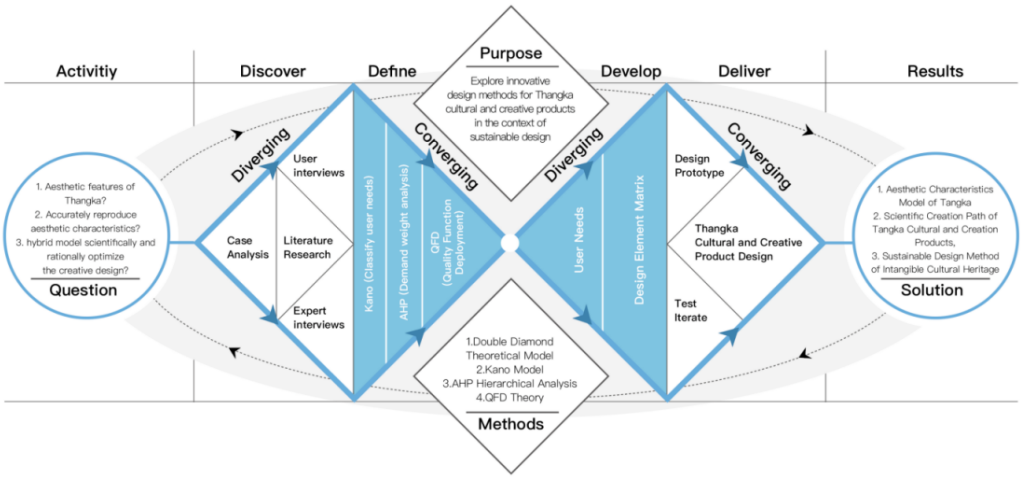

Figure 1. Research path based on the double diamond model

Therefore, this study systematically studies the design of Thangka cultural and creative products from the perspective of user needs. As shown in Figure 1. The study uses the double diamond model as a theoretical guide, and through the Kano model [4], AHP hierarchical analysis method [5], and QFD quality function [6], it systematically explores the user satisfaction and design element importance of Thangka cultural and creative products. Based on scientific data calculation, the design plan of Thangka cultural and creative products is finally obtained.

2 LITERATURE REVIEW

2.1 Thangka

Tibetan Thangka refers to a religious scroll painting mounted with colorful brocade and displayed for worship. It is a unique form of painting [7] in Tibetan culture and is also one of the most important intangible cultural heritages of China. However, the traditional process of Thangka painting is highly demanding and extremely complex, often requiring a long time to complete [2]. In recent years, with the global trend of advocating carbon neutrality and sustainable development, the research field has gradually paid attention to the inheritance and protection of intangible cultural heritage skills. Intangible Cultural Heritage (ICH), which is also the cornerstone of sustainable development, has received increasing attention from scholars and governments in recent years.

2.2 Sustainable Design Theory

The concept of sustainable development was proposed by the World Commission on Environment and Development (WCED) [8] in 1987, and ecology, economy and society were identified as the three pillars of sustainable development. Protecting intangible cultural heritage is an important way to ensure the inheritance of intangible cultural heritage from generation to generation [9]. The importance of protecting intangible cultural heritage for sustainable development has been widely recognized by the international community. Therefore, by combining sustainable design theory with Thangka cultural and creative products, we can not only better preserve and inherit the traditional art form of Thangka, but also ensure its competitiveness in the modern market and meet the dual needs of contemporary consumers for the functionality and sustainability of cultural products.

2.3 KANO-AHP-QFD Hybrid Study Model

- The Kano model, proposed by Professor Noriaki Kano of the Tokyo Institute of Technology in 1984 [10], primarily aims to explore user needs in depth, classify and prioritize them, and evaluate user satisfaction levels with specific product attributes.

- The Analytic Hierarchy Process (AHP), developed by American management scientist Thomas L. Saaty in the 1970s [11], is a widely used decision-making method. AHP is a decision support tool used to address decision-making problems with multiple levels and criteria. Its core involves using expert subjective judgment or experiential evaluation to determine the relative importance of these criteria.
- Quality Function Deployment (QFD) was introduced by Japanese scholars Yoji Akao and Shigeru Mizuno in the 1960s [12]. QFD transforms customer requirements into specific technical characteristics, aligning them with product design, engineering, and manufacturing processes. This approach ultimately enhances customer satisfaction, increases product competitiveness in the market, shortens development cycles, and reduces development costs.

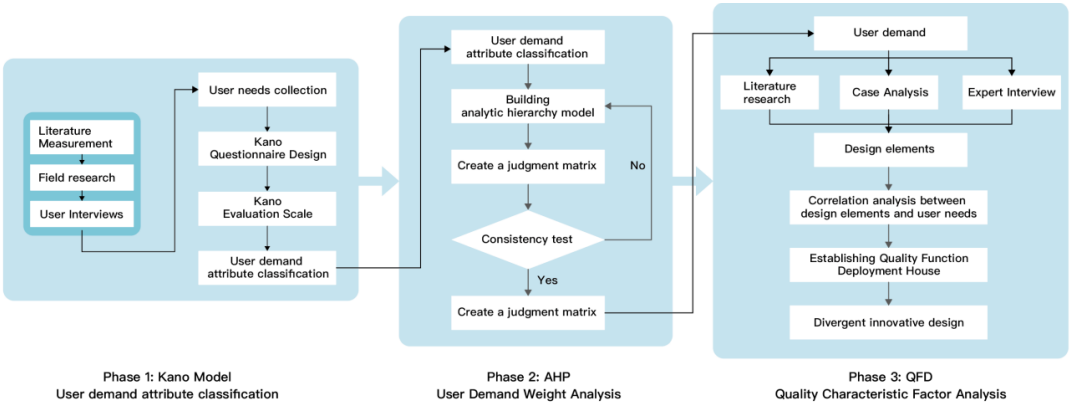

Figure 2. Kano-AHP-QFD hybrid model Research framework

As shown in Figure 2, the hybrid model combines the strengths of these three methodologies, providing a systematic framework for understanding, prioritizing, and translating user needs into sustainable product designs. It scientifically enhances the accuracy and effectiveness of addressing user needs in the design process of Thangka cultural creative products, contributing to the modernization and transmission of Thangka craftsmanship and the promotion of design practices.

3 RESEARCH METHODS

3.1 KANO-User demand acquisition and classification

First, we conducted a field investigation and research in the Tibet Autonomous Region, the main production area of Thangka, to truly understand the development status and innovative inheritance of Thangka. Secondly, during the survey process, the research team randomly selected 20 tourists and thangka collectors who had purchased thangkas for semi-structured interviews. Through coding analysis of the interview texts, they initially obtained 39 consumer demand factors. Third, due to the limited number of interview samples, we supplemented the analysis by using bibliometric methods to review relevant data on Thangka cultural creative products from Web of Science and CNKI databases. Finally, to ensure the scientific validity and rationality of the user needs, we consulted six designers specializing in intangible cultural heritage products, three professors focused on brand design, and one Thangka intangible cultural heritage creator. They reviewed, consolidated, and categorized 39 user needs. As shown in Table 1, 18 core user requirement elements were identified across four dimensions: symbolism, visual aesthetics, emotional value, and functionality.

Table 1. Initial user needs of Thangka cultural and creative products

Level 1 user needs	Level 2 user needs
A. Meaning	A1.Religious Symbols, A2.Cultural Heritage A3.Inspiration, A4.Blessing Attributes
B. Visual Perception	B1.Vivid Colors, B2.Simplicity B3.Regional Characteristics, B4.Creativity B5.Abstraction, B6.Detailing Precision B7.Visual Hierarchy
C. Emotional Experience	C1.Cultural Affiliation, C2.Cultural Depth C3.Spiritual Healing, C4.Resonance

D. Functionality	D1.Decoration, D2.Collectibility, D3.Sustainability

According to the questionnaire design principles of the KANO model, a KANO two-factor five-point Likert questionnaire scale was created. The score range is 1 to 5, with 1 representing the lowest level of importance and 5 representing the highest. Respondents were asked to rate the importance of each requirement element from both positive and negative dimensions. To obtain more accurate user needs and effective information, a combination of online and offline methods was used for the survey. A total of 97 questionnaires were distributed, with 83 returned and 76 valid responses, resulting in an effective response rate of 91.56%. Among them, 50 questionnaires were distributed online SoJump, and 47 were distributed offline in the Barkhor Street commercial district in Lhasa, Tibet. The survey primarily targeted younger and middle-aged groups, with 29.7% aged 18-30, 43.6% aged 30-40, and 17.2% aged 40-50. Respondents included university students, cultural artifact enthusiasts, art professionals, and business people, accounting for 73% of the sample. Based on the results of the dual-factor user needs survey, the K_A, K_O, K_M, K_I, K_R and K_Q values for each requirement indicator were calculated. The results are shown in Table 2.

Table 2. KANO questionnaire analysis table

User needs	K_A	K_O	K_M	K_I	K_R	K_Q	Requirement Type
A1.Religious Symbols	40.9%	5.6%	9.3%	39.5%	3.9%	0.8%	A
A2.Cultural Heritage	14.6%	12.6%	58.9%	10.2%	3.5%	0.2%	M
A3.Inspiration	20.4%	38.9%	9.7%	20.9%	8.4%	1.7%	O
A4.Blessing Attributes	18.9%	9.3%	44.7%	17.3%	9.8%	0%	M
B1.Vivid Colors	5.3%	10.7%	66.3%	11.3%	6.4%	0%	M
B2.Simplicity	16.1%	7.9%	57.7%	6.4%	11.9%	0%	M
B3.Regional Characteristics	7.6%	5.7%	53.3%	13%	19.2%	1.2%	M
B4.Creativity	57.9%	13.1%	10.5%	10.7%	7.8%	0%	A
B5.Abstraction	23.2%	39.7%	5.4%	18.4%	9.8%	3.5%	O
B6.Detailing Precision	14.7%	6.8%	58.3%	12.4%	7.8%	0%	M
B7.Visual Hierarchy	6.7%	17.1%	59.9%	11.6%	4.7%	0%	M
C1.Cultural Affiliation	39.4%	12.8%	19.1%	13.4%	13.9%	1.4%	A
C2.Cultural Depth	17.2%	37.5%	4.8%	29.9%	7.6%	3%	O
C3.Spiritual Healing	23.1%	39.2%	4.7%	20.4%	9.9%	2.7%	O
C4.Resonance	3.9%	16.9%	9.1%	58.7%	11.4%	0%	I
D1.Decoration	21.6%	45.4%	4.2%	18.2%	10.6%	0%	O
D2.Collectibility	16.1%	15.4%	51.7%	11.3%	5.5%	0%	M
D3.Sustainability	8.9%	10.2%	10.4%	59.2%	9.6%	1.7%	I

As shown in Figure 2, A2. Cultural heritage, A4. Blessing function, B1. Vibrant colors, B2. Simplicity, B3. Regional characteristics, B6. Fine details, B7. Visual layering, and D2. Collectibility as a must-have attribute (M) are the eight needs that should be prioritized in the design process. A3. Inspiration, B5. Abstraction, C3. Spiritual healing, C4. Sense of resonance, and D1. Decoration are classified as one-dimensional requirements (O). Meeting these five needs in the design will enhance user satisfaction, while failing to meet them will result in decreased satisfaction. A1. Religious symbolism, B4. Creativity, and C1. Cultural belonging are classified as attractive requirements (A). Meeting these three needs in the design of Thangka cultural creative products can significantly enhance consumer satisfaction, while failing to meet them will not decrease satisfaction.

3.2 AHP-User Demand Weight Analysis

After categorizing user needs using the Kano model, this study applies the AHP (Analytic Hierarchy Process), known for its strong logical decision-making capabilities, to scientifically analyze complex elements and calculate the weight of each user need [13]. This approach clarifies the importance of each need and highlights the key focus areas in the subsequent design process of Thangka cultural creative products. First, a hierarchical model for Thangka cultural creative products is constructed. Second, the demand elements within the criteria and sub-criteria layers are compared pairwise and scored to establish the corresponding judgment matrix. Third, the weights of the elements in the sub-criteria layer are

calculated and ranked. Finally, a consistency check and analysis are performed on the target weight results.

As shown in Figure 3. Based on the preliminary classification of user need types, an AHP-based hierarchical model of user needs for Thangka cultural creative products is established. The goal layer represents the design of Thangka cultural creative products. The criteria layer consists of four dimensions of needs: symbolism A, visual aesthetics B, emotional value C, and functionality D. The sub-criteria layer is composed of 16 sub-elements, categorized as must-be requirements, one-dimensional requirements, and attractive requirements, identified through the Kano model analysis.

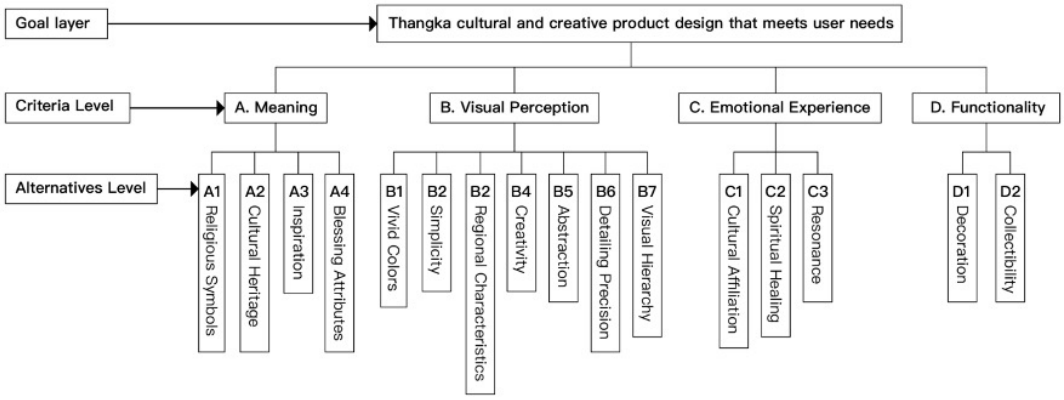

Figure 3. A Hierarchical Analysis Model for Thangka Cultural and Creative Product Design

To ensure the scientific rigor and objectivity of the user need weighting results, this study invited 15 experts in Thangka culture and related fields to participate in the survey. Experts performed pairwise comparisons and assigned scores to different levels of user needs for Thangka cultural creative products using the 1-9 scale method. The arithmetic mean of their evaluations served as the basis for calculating weights, creating the judgment matrix for each level. The geometric mean method [13] was then applied to calculate user need weights, followed by consistency checks on the judgment matrix scores. Detailed results are shown in Table 3, Table 4, etc.

Table 3. Criterion level weight

Index	A	B	C	D	Weight value	I_{CR}
A	1	0.75	1.25	1.5	0.2654	0.0008
B	1.3333	1	1.5	1.75	0.3334	
C	0.8	0.6667	1	1.25	0.2201	
D	0.6667	0.5714	0.8	1	0.1811	

Table 4. Sub-Criterion level weight

First-level indicators	Second-level indicators	Judgment Matrix							Weight value	I_{CR}
A	A1	1	1.25	2	1.75	/			0.3477	0.0011
	A2	0.8	1	1.75	1.25				0.2763	
	A3	0.5	0.571	1	0.75				0.1635	
	A4	0.571	0.8	1.333	1				0.2124	
B	B1	1	1.75	0.75	0.5	1.25	1.5	2	0.1424	0.0471
	B2	0.571	1	0.125	0.1	0.5	0.75	0.2	0.0469	
	B3	1.333	8	1	0.75	1.25	1.75	2	0.2077	
	B4	2	10	1.333	1	1.5	1.75	2	0.2558	
	B5	0.8	2	0.8	0.667	1	1.25	1.5	0.1318	
	B6	0.667	1.333	0.571	0.571	0.8	1	1.25	0.1044	
	B7	0.5	5	0.5	0.5	0.667	0.8	1	0.111	
C	C1	1	0.25	0.5	/				0.1463	0.0088
	C2	4	1	1.5					0.5317	
	C3	2	0.667	1					0.322	
D	D1	1	1.25	/					0.5556	0.0023
	D2	0.8	1						0.4444	

Finally, a consistency test is needed to determine the validity of the matrix. When $I_{CR} \leqq 0.1$, the consistency test passes, otherwise it fails. The calculation formulas are shown in formula (1) and formula (2). The results of the consistency check (I_{CI}) are as follows:

$$I_{CI} = \left(\lambda_{\max} - n\right) / \left(n - 1\right) \tag{1}$$

$$I_{CI} = I_{CR} / I_{RI} \tag{2}$$

The criterion layer I_{CR}=0.0008≦0.1, and the sub-criterion layer I_{CR} are 0.0011, 0.0471, 0.0088, and 0.0023, respectively, all less than 0.1, and the consistency test passes.

Table 5. Relative weight calculation ranking table

Relative weight ranking	A1	A2	A3	A4	B1	B2	B3	B4
	3	6	12	9	10	16	8	4
	0.0923	0.733	0.0434	0.0564	0.0475	0.0156	0.0693	0.0853
	B5	B6	B7	C1	C2	C3	D1	D2
	11	14	13	15	1	7	2	5
	0.0439	0.0348	0.037	0.0322	0.117	0.0709	0.1006	0.0805

The results are shown in Table 5. Among the four criteria layer indicators, visual needs (B) have the highest weight. In the sub-criteria layer, the relative weight of demand elements from highest to lowest is as follows: C2 Cultural connotation, D1 Decoration, A1 Religious symbolism, B4 Creativity, D2 Collectibility, A2 Cultural heritage, C3 Spiritual healing, B3 Regional characteristics, A4 Blessing function, B1 Vibrant colors, B5 Abstraction, A3 Inspiration, B7 Visual layering, B6 Detail refinement, C1 Cultural belonging, and B2 Simplicity.

3.3 QFD-User Requirements Design Factor Mapping

QFD (Quality Function Deployment) is an effective method for translating user needs into design elements. By quantitatively analyzing the relationship between user needs and design elements, QFD outputs the weight of design elements. In this study, following the AHP (Analytic Hierarchy Process), QFD is applied to construct a relationship matrix between user needs and design elements using the House of Quality [14]. This process clarifies the weight of each design element, leading to the identification of the final design elements. It provides evaluative factors for optimizing the design scheme and offers more precise technical support and constraint guidance for the design process [15].

Table 6. Mapping results of user requirements and design elements.

User needs A	Design elements D
C2. Cultural Depth	D1. Swastikas, auspicious clouds, and eight auspicious symbols
D1. Decoration	D2. Floral patterns, spiral cloud patterns, and golden thread depictions
A1. Religious Symbols	D3. Buddhist symbols such as the Dharma wheel, lotus, Buddha hand gestures, and protective deities
B4. Creativity	D4. Traditional artistic techniques combined with modern methods
D2. Collectibility	D5. High-quality textiles and mineral materials
A2. Cultural Heritage	D6. Hand-painting techniques with intricate details and layered textures
C3. Spiritual Healing	D7. Symmetrical compositions and tranquil scenes
B3. Regional Characteristics	D8. Natural landscapes and ethnic clothing
A4. Blessing Attributes	D9. Design of auspicious symbols
B1. Vivid Colors	D10. Red and gold, blue and green color combinations
B5.Abstraction	D11. Abstract geometric patterns
A3. Inspiration	D12. Buddhist scenes and stories
B7. Visual Hierarchy	D13. Visual layering effect
B6. Detailing Precision	D14. Delicate brushwork and complex patterns
C1. Cultural Affiliation	D15. Traditional Tibetan symbols

B2. Simplicity	D16. Simple and concise patterns

As shown in Table 6. First, by studying the cultural background of Thangka and related literature on cultural creative products, and analyzing successful cases of Thangka cultural creative products, the initial user needs were translated into functional requirements. Nine experts were then invited to provide feedback on the preliminary design parameters, including six cultural creative product designers and three professors specializing in product design and visual communication. Through three rounds of summarizing, revising, and re-evaluating, the mapping from user needs to design elements D was finalized.

User		Design Elements															
Needs	Weight	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16
C2	0.117	★	○	★	■	●	○	○	○	○	○	○	■	○	○	★	○
D1	0.1006	★	●	○	○	○	○	○	○	■	○	○	○	○	○	■	●
A1	0.0923	●	●	○	○	○	○	○	○	●	○	○	★	○	○	★	○
B4	0.0853	○	○	○	○	○	★	★	○	○	○	★	○	■	○	○	■
D2	0.0805	○	○	○	○	★	○	○	○	■	○	○	○	○	○	○	○
A2	0.0733	○	★	★	○	○	○	○	■	★	○	○	○	○	○	★	○
C3	0.0709	○	○	○	○	○	○	★	○	○	○	○	★	○	○	○	○
B3	0.0693	●	●	●	★	○	○	○	●	★	○	○	○	○	●	○	○
A4	0.0564	○	■	●	■	○	○	○	○	★	○	○	○	○	○	○	○
B1	0.0475	○	○	○	○	○	○	○	○	○	■	○	○	★	○	○	○
B5	0.0439	○	○	○	○	○	○	○	●	○	○	★	○	○	○	○	★
A3	0.0434	■	●	■	○	○	○	○	○	★	○	○	●	○	○	○	○
B7	0.037	○	○	○	○	○	■	○	○	○	○	★	○	★	■	○	○
B6	0.0348	○	○	○	●	○	★	○	○	○	○	○	○	■	★	○	○
C1	0.0322	★	■	★	○	○	○	○	○	○	○	○	●	○	○	★	○
B2	0.0156	○	○	○	○	○	■	○	○	○	○	○	○	●	○	○	★
SUM		0.5884	0.5219	0.5115	0.3468	0.2377	0.2432	0.2343	0.2011	0.6732	0.057	0.2498	0.4604	0.2871	0.1659	0.5929	0.2923
Ranking		3	4	5	7	12	11	13	14	1	16	10	6	9	15	2	8

Figure 4. Quality house of QFD

As shown in Figure 4, constructing the House of Quality is central to the Quality Function Deployment (QFD) process. Using the Kano model and Analytic Hierarchy Process (AHP), user need elements and design parameters are established to form the House of Quality. User need weights are placed in the left wall, while design elements form the ceiling. Relationships between user needs and design elements are indicated by symbols ★, ■, and ●, representing weights of 1.5, 1.2, and 1, respectively. Final design element weights are calculated by summing the total weighted needs under each design element, adjusted by the relationship weight. These weights are normalized and ranked by importance. Based on Figure 4, the ranking order of design elements is: D8 > D15 > D1 > D2 > D3 > D12 > D4 > D16 > D13 > D11 > D6 > D5 > D7 > D14 > D10. Key design elements—such as auspicious symbols, traditional Tibetan motifs, cloud patterns, floral designs, Buddhist narratives, and modern interpretations—were selected for further development in sustainable Thangka cultural product design.

4 THANGKA CULTURAL CREATIVE PRODUCT DESIGN PRACTICE

4.1 Thangka cultural and creative product design practice

This chapter provides a detailed overview of the innovative design practices of Shu embroidery based on the Kano-AHP-QFD hybrid model. The Thangka cultural products are ultimately created as "Puzzle Magic Cube Designs" and "Collectible Stamp Designs." Firstly, the Thangka Magic Cube is designed in a 3x3 specification, where each face's patterns and graphic elements are thoroughly contemplated. The design incorporates 20 classic "Tibetan traditional symbols, auspicious clouds, spiral cloud patterns, and floral motifs [16]" By simplifying graphics, enhancing visual hierarchy, and abstracting patterns into geometric forms, the design aims to stimulate youth interest in the preservation of intangible cultural heritage through playfulness and interactivity. By rotating the magic cube, young individuals can

appreciate the aesthetic allure of Thangka art while inadvertently deepening their understanding of Thangka culture. As shown in Figure 5. Additionally, the design of Thangka postcards has been selected based on the preferences and highest acceptance rates among non-local tourists. The front of the postcards features classic Thangka patterns, including Buddhist figures, mandalas, and natural landscapes.

Figure 5. Thangka cultural creative product design

4.2 Design Evaluation

To evaluate whether the conceptual design of the Thangka cultural creative products effectively meets user needs, this study invited intangible cultural heritage inheritors and Thangka enthusiasts who had previously participated in user surveys. Using the TOPSIS method (Technique for Order Preference by Similarity to Ideal Solution), a comprehensive analysis and evaluation were conducted on Thangka-themed cultural products available on the market, including a Thangka pillow (Sample 1), Thangka tote bag (Sample 2), Thangka postcards (Sample 3), and the proposed conceptual design of the Thangka product. As shown in Table 7.

Table 7. Thangka cultural and creative concept design plan and sample analysis.

Thangka Conceptual Design	Thangka Sample 1	Thangka Sample 2	Thangka Sample 3
			

The evaluation criteria consist of 16 user requirements that were filtered using the KANO model and AHP (Analytic Hierarchy Process). A total of 11 participants from the previous user survey were invited

to rate each design based on the Thangka cultural creative product user requirement index system. The ratings were conducted using a 7-point Likert scale, and the raw scoring data for the evaluation criteria are shown in Table 8.

Table 8. Initial evaluation matrix.

Design plan	User demand evaluation indicators															
	A1	A2	A3	A4	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	D1	D2
Concept plan	5.2	4.4	4.9	5.1	5.3	4.7	5	5	5.3	5.5	4.6	4.9	5.8	4.7	5.5	5
Sample 1	2.9	3	2.9	3.5	3.3	4.1	3	2.5	3	3.1	3.4	3.3	2.5	3.4	3.1	2.8
Sample 2	3.7	3.9	4.1	3.2	3.7	4.1	3	3.4	3.7	3.3	3.9	4	2.9	2.6	3.8	2.7
Sample 3	2.5	3.7	2.1	3	2.9	2.7	2.4	2.8	2.9	3.3	2.8	2.6	2.7	3.4	3	2.5

As all evaluation criteria are maximization indicators, no positive transformation is needed. After performing dimensionless normalization on the criteria, the initial evaluation data were obtained. These data were then weighted using the relative weights from Table 6, resulting in the calculation of weighted standardized data, as shown in Table 9.

Table 9. Weighted standardized evaluation matrix.

Design plan	Evaluation indicators							
	A1	A2	A3	A4	B1	B2	B3	B4
	B5	B6	B7	C1	C2	C3	D1	D2
Concept plan	0.064	0.043	0.029	0.038	0.032	0.009	0.05	0.06
	0.03	0.024	0.023	0.02	0.091	0.046	0.07	0.059
Sample 1	0.036	0.029	0.017	0.026	0.02	0.008	0.03	0.03
	0.017	0.014	0.017	0.014	0.039	0.033	0.039	0.033
Sample 2	0.045	0.038	0.024	0.029	0.022	0.008	0.03	0.04
	0.021	0.015	0.019	0.017	0.045	0.025	0.048	0.031
Sample 3	0.031	0.036	0.012	0.022	0.018	0.005	0.029	0.036
	0.017	0.015	0.014	0.011	0.042	0.033	0.038	0.03

Table 10. Euclidean distance and relative post progress.

Design plan	S_i^+	S_i^-	C_i	Ranking
Concept design	0	0.095	1	1
Sample 1	0.087	0.014	0.141	3
Sample 2	0.073	0.029	0.286	2
Sample 3	0.09	0.011	0.113	4

As shown in Table 10. Based on the closeness coefficients of the solutions, the ranking is as follows: conceptual design > Sample 2(0.286) > Sample 1(0.141) > Sample 3(0.113). This indicates that the conceptual design of the Thangka cultural creative products, guided by the KANO, AHP, and QFD hybrid model, demonstrates higher satisfaction and overall acceptance, suggesting that it meets user needs to a considerable extent.

5 CONCLUSION

In terms of research conclusions, this study has innovatively applied the KANO-AHP-QFD hybrid model to the design of Thangka cultural and creative products, offering a scientific approach to capture user needs and translate them into design elements. This model significantly enhances precision in designing Thangka cultural products and provides a novel pathway for the development of cultural and creative products. Additionally, the research enriches approaches to modernizing intangible cultural heritage. Through design practices such as the Thangka cube and postcards, this study demonstrates how modern design techniques can be employed to make traditional art forms more appealing, providing direction for innovation in other intangible cultural heritage products. Lastly, an adaptable model framework is proposed: while focused on Thangka product development, the KANO-AHP-QFD hybrid model exhibits broad applicability, providing a valuable reference framework for other intangible

cultural heritage products and demonstrating the model's flexibility in addressing user needs across diverse cultural contexts.

Future research could further expand and optimize this model's application across several areas. Firstly, the model's applicability across other forms of intangible cultural heritage could be explored to verify its generalizability and adaptability. Secondly, integrating additional methodological tools, such as text mining, deep learning, and real-time feedback systems, could enhance the model's scientific rigor, accuracy, and dynamism. Additionally, design practices could be extended to include digital products and household items, thus attracting a broader audience. Finally, user feedback and satisfaction data from the actual market could validate the model's effectiveness, establishing a feedback-driven, iterative design process to continuously optimize cultural and creative product design and user experience.

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