

Research on digital interaction design of youth Intangible Cultural Heritage Based on kano-ahp

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ABSTRACT Objective: Taking the digital experience design of Haining shadow play in Zhejiang Province as the object, this study clarifies the experience needs and priority order of youth groups in order to enhance the attractiveness and effectiveness of digital communication for intangible cultural heritage. Methods: User interviews, the KJ method, and the Kano model are used to identify demand attributes, and the analytic hierarchy process (AHP) is adopted to rank the weights of demand indicators. The design process considers touch interaction, optical projection, screen display, and other digital-media interfaces that rely on electromagnetic and visual information transmission. Results: The attribute classification and weight order of nine core requirements are clarified across three dimensions: interactive experience, visual style, and functional modules. Based on these results, a system design strategy is proposed with touch-screen interaction as the core, visual clarity as the basis, and educational integration as the extension. Conclusion: The study constructs an evidence-based design path of “demand attribute–weight–strategy,” providing a theoretically grounded and practically oriented reference framework for digital experience design of intangible cultural heritage such as Haining shadow play.

INDEX TERMS youth group, kano-ahp method, digital interaction, shadow play, optical projection

I. INTRODUCTION

AGAINST the backdrop of rapid advancements in digital technology, academic exploration in the field of digital humanities has opened up innovative pathways for the preservation, continuation, and promotion of intangible cultural heritage. In accordance with the relevant provisions of the “Opinions on Promoting the Implementation of the National Cultural Digitization Strategy” jointly issued by the General Office of the CPC Central Committee and the General Office of the State Council, it is necessary to leverage cutting-edge information technologies to comprehensively advance the digitization, preservation, and perpetuation of cultural heritage, and to focus on building a national cultural big data system [1]. Under this policy direction, integrating the theoretical models and technical approaches of digital humanities into the protection of intangible cultural heritage has become a necessary measure to enhance national cultural governance capabilities and promote the modernization of the governance system and

governance capacity. Based on this, this study focuses on youth groups, which are key service objects such as intangible cultural heritage experience center and university library, and selects the national intangible cultural heritage technology “Zhejiang Haining shadow play” as a

case. Integrating the application of user demand research methods, combining the KJ method (affinity map method) and Kano AHP integration model, this paper identifies and analyzes the demand tendency of youth groups in the dimensions of interactive experience, visual presentation and functional structure, and then summarizes the digital experience design strategies for this group, in order to provide reference for relevant academic exploration and practical application. Under the background of continuous promotion of macro policies and wide application of digital technology, the innovation of digital technology not only injects new era connotation into the inheritance and development of intangible cultural heritage, but also makes it face a series of new challenges [2]. Wang X, et al. [3] mentioned that there are several outstanding problems in the current practice of digital inheritance and dissemination of intangible cultural heritage in China: the lack of general theories and methods as support;The form of communication is relatively simple and the effect is limited;The audience differences were not fully considered, resulting in weak pertinence.These problems not only affect the integration and effective dissemination of intangible cultural heritage digital resources, but also increase the complexity and difficulty of the dissemination work. Gomes C C, et al. [4]

analyzed the types of digital services in the scene of cultural tourism integration in Beijing, Shanghai and Chongqing, and found that offline digital experience devices generally have problems of poor accessibility, complex operation and low practicability, which are difficult to truly meet the actual use needs of users. The study stresses that improving user experience is the key to promoting digital services in the context of cultural tourism integration. Terezie [5] focused on the digital services of the Intangible Cultural Heritage Museum. The research found that the current offline digital experience mainly focused on the reservation and display functions, while it was obviously insufficient in terms of activation and utilization and social services, and the mode of communication was relatively simple. Therefore, it is necessary to systematically build a facility system combining inheritance and experience around the actual needs of users. To sum up, providing accurate and sustainable digital services and creating high-quality interactive experience for the public, especially young people, has become the key to broaden the inheritance and communication channels of intangible cultural heritage.

II. RESEARCH DESIGN AND METHODOLOGICAL TOOLS

A. RESEARCH SUBJECT

Several scholars have already explored the topic of innovative preservation and transmission of Haining Shadow Puppetry, an intangible cultural heritage art form in Zhejiang Province. For example, Bai M et al. [6] examined the artistic characteristics and digitalization needs of Haining Shadow Puppetry, proposing a dissemination strategy for its digital development empowered by AIGC; Jimura T [7] explored innovations in the digital production of stage design for Haining Shadow Puppetry, highlighting the importance of digital technology for the dissemination of this art form; Muhsen N et al. [8] examined the current state of Haining shadow puppet theater's dissemination and the need for innovative models, emphasizing the importance of tailoring dissemination strategies to user needs and targeting younger audiences.

B. RESEARCH METHODS AND PROCESS

User needs serve as the fundamental guiding principle for research on interactive design for the digitization of intangible cultural heritage. Given that interactive experience design in this field is still in its early stages and user needs remain unclear, this study will first conduct semi-structured interviews to establish typical user personas and a digital user experience flowchart. It will then employ the KJ method (affinity diagramming) to organize and summarize user preferences across three primary dimensions: interactive experience, visual presentation, and functional composition. Building on this foundation, this study comprehensively applies the Kano model and the Analytic Hierarchy Process (AHP) to systematically construct a complete analytical process encompassing "needs assessment—attribute categorization—

weight evaluation—strategy generation." This provides a structured methodological framework to support functional planning and experience optimization in the interactive design of digital intangible cultural heritage. The detailed research framework is shown in Figure 1.

III. ANALYSIS OF YOUTH'S DEMAND FOR DIGITAL EXPERIENCE OF SHADOW PLAY IN HAINING, ZHEJIANG

A. CREATING USER JOURNEY MAPS TO IDENTIFY USER NEEDS

This study focuses primarily on young people aged 14 to 35, a demographic defined in accordance with China's Medium- and Long-Term Youth Development Plan (2016–2025). To address the cognitive and behavioral diversity within this wide span, the research specifically targets the 'digital native' commonalities shared across these cohorts while employing adaptive interface complexity that scales from the playful, simplified needs of younger adolescents to the depth-oriented requirements of young professionals. The study first collected 71 valid responses through an online questionnaire. Building on this foundation, in-depth research was conducted via online semi-structured interviews with eight young respondents (two males and six females). The interviews primarily covered basic user information, their level of familiarity with Zhejiang Haining Shadow Puppetry and their sources of information, their preferences regarding the digitalization of intangible cultural heritage, as well as their specific needs and challenges encountered during actual use. According to the comprehensive analysis, the young people's overall cognition of the cultural connotation of this intangible cultural heritage is relatively limited. Youth groups generally have insufficient understanding of the cultural connotation of Haining shadow play. Its understanding channels mostly rely on traditional media such as TV, film, social media and so on. Only a few people have been contacted through offline performances, but the experience is relatively simple, which failed to stimulate sustained interest [9-12]. Respondents generally expect a new model that is more interactive, cultural atmosphere and exploratory. Based on the differences in interest orientation and behavioral motivation of young users, they can be summarized into two main types: first, culture oriented users, who usually have high interest in culture and history and prefer to acquire relevant knowledge through interactive experience. The second is experience oriented users, whose direct interest in traditional cultural content is relatively limited, and their participation motivation mainly stems from the pursuit of novel interactive forms and immersive experience. To systematically analyze user behavior and experience characteristics, this study developed corresponding user experience journey maps based on typical user personas. This tool provides a systematic overview of the entire process of user interaction with digital service platforms [13,14]. Based on data obtained from interviews, the digital experience process of shadow puppet theater

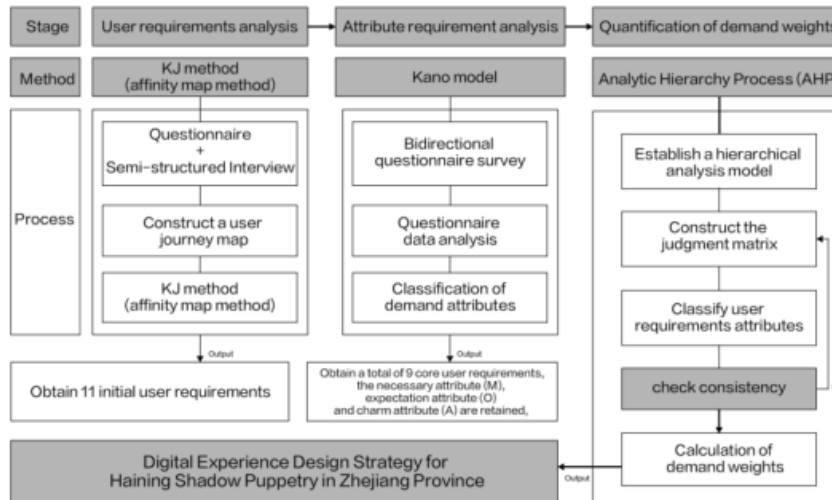


FIGURE 1. The digital experience design framework for Haining Shadow Puppetry in Zhejiang Province

has been categorized into three main stages: pre-experience, referring to the stage from when users develop interest and search for information to when they decide to try it; during-experience, referring to the core stage where users actually perform operations, interact, and form impressions; and post-experience, referring to the stage after users complete the experience, during which they share their experiences, reflect on them, and form future intentions. For these two typical user segments, we mapped out their behavioral paths, the media they use, their emotional fluctuations, and their inner thoughts in specific scenarios, ultimately creating a digital user experience map (Figure 2). By comparing and analyzing the emotional feedback of these two user segments throughout their journeys, we further clarified their expectations for the digital shadow puppet theater experience and identified potential design trends. The typical user personas and corresponding journey maps are shown in Figure 2.

Based on the analysis of user journey map and the systematic summary of interview materials, this study initially identified the functional requirements of Haining shadow play digital interactive experience. Further, the KJ method (affinity map method) was used to cluster and integrate these attributes, which were finally refined into 11 specific functional attributes and classified into three core categories (as shown in Table 1). To ensure the rigor of the subsequent Kano model analysis, a preliminary expert screening was conducted; three attributes (F3 Voice interaction, F6 Retro/authentic, and F11 Resource pool) were initially flagged as secondary. However, to maintain data integrity, all 11 indicators were ultimately retained for the broad-scale questionnaire to allow users to define their own priorities. The classification results laid a solid foundation for the subsequent design of Kano questionnaire.

B. ANALYSIS OF USER DEMAND FOR DIGITAL EXPERIENCE OF SHADOW PLAY IN HAINING, ZHEJIANG PROVINCE BASED ON KANO MODEL

1) Designing a Kano Model Questionnaire

Based on the classification of user needs according to KJ method, this study then introduces Kano model to systematically analyze the digital experience needs of youth groups by designing a special questionnaire and using SPSS statistical tools. When designing the questionnaire, the initial step is a two-way evaluation questionnaire to determine the Kano attribute category corresponding to each functional demand. The questionnaire uses a Likert five point scale to set up two scenarios for each functional demand: forward (with the function) and reverse (without the function) to measure the satisfaction level of users in different contexts. The scale has five levels: very like, not bad, general, reluctantly accept, and dislike. The specific questionnaire form is shown in Table 2.

This study collected data through a questionnaire survey, and used SPSS software for statistical analysis to explore the specific needs of youth groups in digital experience. Through various social platforms (such as wechat, xiaohongshu, microblog, etc.), the data of youth groups aged 14-35 were collected. During this expanded data collection phase (N=356), a preliminary segment validation was conducted to ensure the two personas identified in the pilot study (Culture-oriented and Experience-oriented) remained representative. The results confirmed that 82% of the larger sample still aligned with these core behavioral motivations, justifying the application of the original journey maps. Due to objective factors, the survey questionnaire was completed by scanning code on the spot and published online simultaneously. The questionnaires were distributed from October 20, 2025 to December 20, 2025. After review, 11 invalid questionnaires were eliminated, and 356 valid questionnaires were finally obtained, with an effective recovery rate of 97%. In order to ensure the accuracy and reliability of the

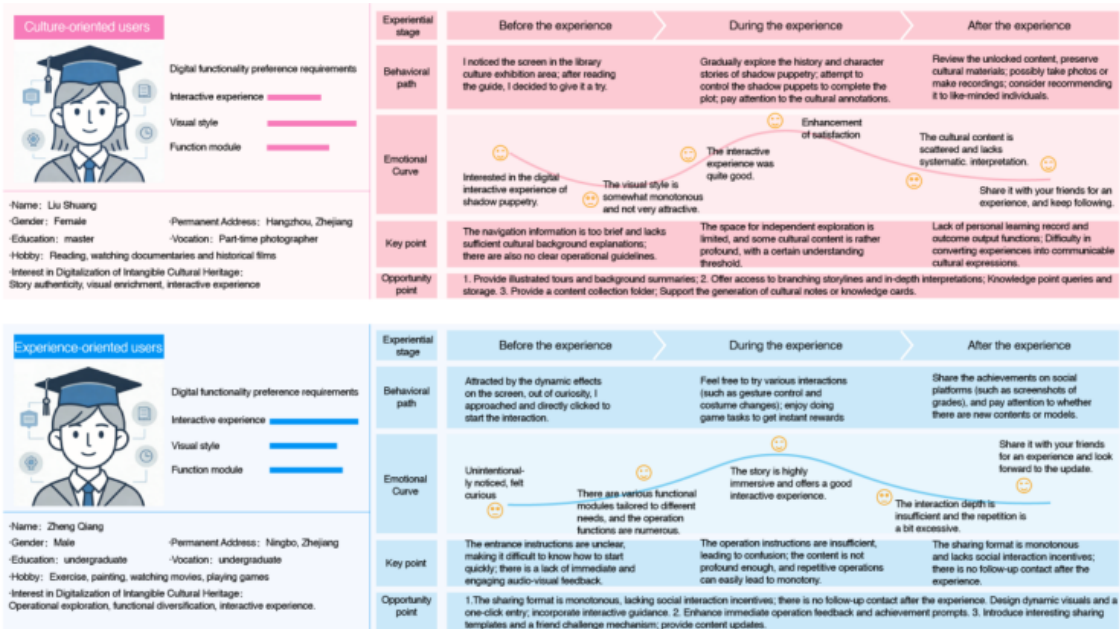


FIGURE 2. Typical User Profiles and User Journey Maps

TABLE 1. The digital experience function requirements project of Zhejiang Haining shadow puppetry and its classification table

Demand category	Number	Functional requirements project	Explain
Interactive experience	F_1	Body Movement Control	Gesture, shadow sensing, joystick, etc., support non touch screen simulation of traditional manipulation
Interactive experience	F_2	Touch screen / drag	Manual control, instant touch feedback, suitable for DIY Story Creation
Interactive experience	F_3	Voice interaction	AI dialogue and voice commands enhance the naturalness of man-machine communication
Interactive experience	F_4	Games / simulations	Performance simulation, scoring system, and professional skill tutorials to master traditional puppet manipulation, improving the cultural depth
Interactive experience	F_5	DIY/Creation	Character assembly, animation generation, video export, encourage personalized expression
Visual style	F_6	Retro / authentic	Classic character image and history unfold, simulating the texture of real shadow play
Visual style	F_7	Special effects / Animation	Holographic /vr animation, visual effects, creating an immersive atmosphere
Visual style	F_8	Clear / concise	High-sensitivity operation and simple logic to prevent information overload
Functional module	F_9	Education / Science Popularization	Introduction to historical technology, learning of operating principles, and support for interactive tutorials
Functional module	F_{10}	Social / multi person	Message Sharing, multi person operation, real person interaction, for E-type users
Functional module	F_{11}	Resource pool	Classic repertoire library, online viewing, Aria matching for quick access

TABLE 2. Kano Model Bidirectional Problem Questionnaire

When this function is available, your attitude is (positive)					Haining shadow play digital interactive user needs	When there is no such function, your attitude is (reverse)				
I like it very much	Not bad	Commonly	Reluctantly accept	Dislike		I like it very much	Not bad	Commonly	Reluctantly accept	Dislike
					F_1 Body Movement Control					
					F_2 Touch screen / drag					
					F_3 voice interaction					
					...					
					F_{11} Resource library					

follow-up analysis results, this study used SPSS software to test the reliability and validity of the questionnaire data. The test results show that the average cronbachs' α coefficients of the forward and reverse items are above 0.8, and the kmo values are above 0.7, indicating that the questionnaire data has a good level of reliability and is suitable for factor

analysis. This study was approved by the Ethics Committee of Zhejiang University of Media and Communications, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form. See Table 3 for specific inspection results.

TABLE 3. Reliability and validity test results

Problem	Cronbachs α coefficient	Kmo value
Forward problem	0.851	0.851
Reverse problem	0.921	0.909

2) Data Sorting and Analysis of Kano Questionnaire

After summarizing the Kano questionnaire survey results, this study extracts the satisfaction coefficient of each demand element and substitutes it into formula (1) to obtain the user satisfaction coefficient (better, b) when each function is available, and substitutes it into formula (2) to obtain the dissatisfaction coefficient (worse, w) when each function is missing. On this basis, Kano attributes are classified for the functional requirements of the digital interactive experience of shadow play in Haining, Zhejiang. The specific results are shown in Table 5.

$$B = \frac{A + O}{A + O + M + I} \quad (1)$$

$$W = -\frac{O + M}{A + O + M + I} \quad (2)$$

According to Kano model classification criteria, indifference attribute (I) has a weak effect on improving user satisfaction, so it is excluded in subsequent analysis. However, it is noted that while F11 (Resource Pool) was categorized as an 'Indifference' attribute regarding direct emotional satisfaction, it serves as the essential back-end infrastructure supporting the F9 (Education / Science Popularization) module. Therefore, while excluded from the priority weight calculations, it is retained in the system architecture as a functional necessity. Finally, the necessary attribute (M), expectation attribute (O) and charm attribute (A) are retained, so as to determine the nine core functional requirements covered by the digital interactive experience design of shadow play in Haining, Zhejiang Province.

IV. DESIGN STRATEGY AND PRACTICE OF DIGITAL EXPERIENCE OF SHADOW PLAY IN HAINING, ZHEJIANG

A. DESIGN STRATEGY

Firstly, according to the attribute classification standard of Kano model, the indifference attribute (I) has limited effect on improving user satisfaction, so it is excluded in the subsequent analysis. Through screening, three categories of essential attribute (m), expected attribute (o) and charismatic attribute (a) were finally retained, and based on this, nine core functional requirements for the digital interactive experience design of shadow play in Haining, Zhejiang Province were determined. Secondly, based on the index weight analysis results obtained by AHP, the optimization order of the first level criteria layer and the weight priority of the second level criteria layer are integrated. Guided by the priority of the three first-level dimensions of interactive experience, visual style and functional modules, and

combined with the comprehensive weight ranking of the indicators in the second level criteria layer, a specific design strategy orientation is formed.

1) Interactive Experience Layer

According to the weight analysis results of AHP, the five attributes covered by the interactive experience layer are sorted according to the comprehensive weight as follows: C2 touch screen / drag (M) > C5 diy/ creation (O) > C1 limb action control (A) > C3 voice interaction (A) > C4 game / simulation (A). This ranking reveals the relative importance and priority of each interaction mode for achieving the overall user experience goal in the digital experience design of shadow play in Haining, Zhejiang Province. As the essential attribute with the highest weight, touch screen / drag should become the core of interaction design. It is necessary to intuitively map the manipulation logic of Haining shadow play into touch screen gestures, such as dragging and moving characters, opening and closing zoom, etc. By physically simulating the traditional 'behind-the-curtain' puppet control through these touch-and-drag mechanics, the design bridges the gap between modern digital habits and traditional craftsmanship. This tactile engagement serves as a cognitive gateway, transforming passive viewing into active 'performance,' thereby deepening the user's understanding of the physical complexity and artistic nuances inherent in Haining shadow play. Diy/ creation as a key expected attribute, the design should provide a modular component library based on shadow play cultural elements, such as characters, costumes, props, etc., to support users to freely combine and preview the effect in real time, and finally generate personalized works that can be saved and shared to meet the user's sense of participation and creative experience. As a crucial attribute of charm, body movement control needs to ensure stable and reliable recognition. The strategy is to design a simplified and easy to execute standard action library for triggering specific storylines or actions as an immersive supplement to touchscreen interaction, enhancing the realism of the experience. The weight of voice interaction and game / simulation is relatively low. The former can be used as an aid to design specific lines or concise voice commands to promote the plot; The latter should be designed as a lightweight plot game, focusing on the classic fragments of shadow play, so that users can experience the cultural core in a simple operation. Both of them serve as supplementary links for the overall experience.

2) Visual Style Layer

According to the weight analysis results of AHP, the two attributes covered by the visual style layer are sorted in order of comprehensive weight: C7 clear / concise (m) > C6 special effects / animation (A). Clarity and simplicity, as the top-ranked core elements in the comprehensive weighting and prioritization of design principles, should form the cornerstone of interface design. The interface

TABLE 4. Kano Model Attribute Classification Table

Your attitude is (positive)	When there is no such function, your attitude is (reverse)				
	I like it very much	Not bad	Commonly	Accept reluctantly	Dislike
I like it very much	<i>Q</i>	<i>A</i>	<i>A</i>	<i>A</i>	<i>O</i>
Not bad	<i>R</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>M</i>
Commonly	<i>R</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>M</i>
Accept reluctantly	<i>R</i>	<i>I</i>	<i>I</i>	<i>I</i>	<i>M</i>
Dislike	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>Q</i>

Mandatory properties	Satisfaction will not necessarily be improved when being satisfied, and the lack will be greatly reduced
Expected properties	Having it can significantly improve satisfaction, while lacking it can lead to a decrease in satisfaction
Charismatic attributes	When it is available, it will improve satisfaction, but its lack will not lead to a decrease in satisfaction
No difference attribute	Being satisfied or not will not affect satisfaction
Reverse attribute	Satisfaction decreases when satisfied
Suspicious attribute	The interviewee answered incorrectly or did not understand a certain question

TABLE 5. Kano user questionnaire classification and calculation results

Category	Demand	Proportion of demand attribute data (%)						Kano property	Better (<i>B</i>)	Worse (<i>W</i>)
		<i>A</i>	<i>O</i>	<i>M</i>	<i>I</i>	<i>R</i>	<i>Q</i>			
Interactive experience	<i>F</i> ₁	50.56	13.48	11.24	22.47	0.56	1.69	<i>A</i>	0.66	-0.25
Interactive experience	<i>F</i> ₂	24.16	14.89	31.46	26.97	0.28	2.25	<i>M</i>	0.40	-0.48
Interactive experience	<i>F</i> ₃	43.82	17.42	9.27	26.69	1.40	1.40	<i>A</i>	0.63	-0.27
Interactive experience	<i>F</i> ₄	46.63	12.64	6.46	32.02	0.84	1.40	<i>A</i>	0.61	-0.20
Interactive experience	<i>F</i> ₅	28.37	36.24	10.39	22.75	0.84	1.40	<i>O</i>	0.66	-0.48
Visual style	<i>F</i> ₆	25.84	29.21	10.11	33.71	0	1.12	<i>I</i>	0.56	-0.40
Visual style	<i>F</i> ₇	46.63	14.89	5.90	30.62	0.56	1.40	<i>A</i>	0.63	-0.21
Visual style	<i>F</i> ₈	24.16	19.38	32.30	21.91	0.28	1.97	<i>M</i>	0.45	-0.53
Functional module	<i>F</i> ₉	22.75	35.39	15.17	24.72	0.84	1.12	<i>O</i>	0.59	-0.52
Functional module	<i>F</i> ₁₀	39.33	21.07	9.83	27.81	0.84	1.12	<i>A</i>	0.62	-0.32
Functional module	<i>F</i> ₁₁	25.56	30.62	10.11	32.58	0.28	0.84	<i>I</i>	0.57	-0.41

must employ a minimalist layout, a clear visual experience, and a symbolic system that minimizes information clutter, ensuring, above all, unimpeded functional recognition and operation. Building on this foundation, by extracting and systematically applying the classic, rustic colors of Zhejiang Haining shadow puppetry—such as the pale yellow of the curtain, the warm ochre of the puppets, the ink-gray of the lines, and the vermilion accents—we create a visual tone that is unified, serene, focused, and imbued with an elegant, classical charm. As a key charm attribute, special effects / animation must strictly serve the content narrative and interactive feedback, and deeply draw lessons from shadow play's light, shadow and engraving aesthetics. The animation rhythm should be as slow as a play, the special effects should be appropriately restrained, the immersion and emotional resonance should be enhanced at the critical moment, and the visual experience should be injected with flexibility and surprise without disturbing the clarity of the main body.

B. DESIGN PROPOSAL

Guided by the aforementioned design strategies, this study designed and developed a digital immersive interactive experience system for Haining shadow puppetry, intended for public cultural venues such as intangible cultural heritage experience centers and university libraries (as shown in Figure 4). The system uses a medium-sized touchscreen as its core interactive interface, integrated with sensor modules and an audio system, with the aim of translating strategic-

level analysis into concrete experiential practices. The following sections will elaborate on the key design aspects from three perspectives: interactive experience, visual style, and functional modules. First, visual style. The design strictly follows C7 clarity / conciseness as the essential attribute of the highest weight. The interface adopts the minimalist layout and blank space, the main visual area simulates the ancient shadow play scene, the background uses the warm and ancient tone of rice paper texture, and the core operation elements are systematically designed using the classic colors extracted from Haining shadow play, so as to build a quiet, focused and cultural visual tone. C6 special effects / animations, as charm attributes, should be used cautiously. They can only produce delicate light and shadow flow effects when the shadow puppet is manipulated, or adopt transition like ink halo during scene switching, so as to endow the experience with flexible drama charm on the premise of ensuring the absolute clarity of the interface. Second, interactive experience. The design takes the C2 touch screen / drag with the highest weight as the core interaction mode. Users can drag the shadow characters on the screen directly by their fingers, and zoom the scene props by kneading gestures to intuitively restore the experience of behind the scenes manipulation. C1 limb with lower weight, C4 game / simulation and C3 voice interaction are used as supplements. Simple arm waving actions are designed to trigger a specific plot, or the narrative is promoted by reading classic lines, forming an interactive



FIGURE 4. Digital Experience Design Scheme and Application Scenarios of Zhejiang Haining Shadow Puppetry

closed loop with touch screen as the core and multi-level mild participation. In addition, this study and its practical framework have certain limitations, as they currently focus primarily on the experience design of single-point interactive interfaces. Future research could be expanded to encompass the planning of narrative experiences across the entire exhibition space, integrating digital installations with physical displays and live performances to create multidimensional, immersive cultural environments. This design strategy and practical framework are also expected to provide a systematic reference for the digital interactive presentation of other intangible cultural heritage.

V. CONCLUSION

This study addresses prominent issues in the current digital dissemination of intangible cultural heritage, such as homogenized experiences, insufficient interactivity, and imprecise targeting of young people's needs. Taking Zhejiang Haining shadow puppetry as a case study, the research combines the Kano model with the Analytic Hierarchy Process (AHP) to systematically identify and quantify the core preferences of young users in terms of interactivity, visual appeal, and functionality. By developing a design strategy based on the evaluation of demand attributes and comprehensive weightings, this study provides empirical evidence and a roadmap for creating immersive, participatory digital ICH experiences that align with the needs and aesthetic preferences of young people. It offers practical guidance for promoting the revitalization, transmission, and sustainable development of ICH in the digital age.

AUTHOR CONTRIBUTIONS

Conceptualization – Lirong Lin, Shihao Liu and Yizhen Liu; methodology – Lirong Lin, Shihao Liu and Yizhen Liu; investigation – Lirong Lin, Shihao Liu and Yizhen Liu; writing-original draft preparation – Lirong Lin, Shihao Liu and Yizhen Liu. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

HUMAN RESEARCH SUBJECTS

This study was approved by the Ethics Committee of Zhejiang University of Media and Communications, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

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