Strategy for Improving the Method of Displaying Damaidi Rock Art under User Experience

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Abstract

As a significant cultural heritage site, Damaidi Rock Art has primarily been studied for its value connotation, while research on its display and dissemination remains insufficient. In order to improve the public awareness of Damaidi Rock Art, the study builds a user-experience oriented display design model, collects user satisfaction and expectation experience needs. To summarize the user experience needs of Damaidi Rock Art, this paper also builds a research strategy for the display of rock paintings. The research uses the Kano model to eliminate the low impact demand factors and take Analy tic Hierarchy Process (AHP) to rank the visual symbols. The research tends to achieve the revitalization and utilization of the cultural heritage resources of Damaidi Rock Art. From side of museum setting, the paper shows the new method to display Damaidi Rock Art. In addition, this paper could provide ideas for similar cultural heritage communication research.

Keywords: Damaidi Rock Art, Cultural Heritage, User Experience, Display Design, Museum communication

1 Introduction

New media display technologies, which overcome spatiotemporal constraints, have become a prominent trend in contemporary museum exhibition design [1]. However, current practices in rock art display predominantly rely on static graphic presentations [2]. Even museums adopting new media technologies often fail to develop rock art-specific display methods, resulting in ineffective emotional engagement with audiences and limited communicative impact. Guided by user emotional experience theory, this study employs Damaidi Rock Art as a case study to construct a UX-driven exhibition design framework. It explores the elements of audience experience, establishes an emotional communication medium with the viewers, enhances user perception and Damaidi Rock Art cultural dissemination ability, and proposes a programme for conveying the rock painting information with high quality and effectively improving user experience.

2 Literature review

Rock Art is an important historical and cultural heritage, recording the production life and spiritual world of ancient people in the form of visual symbols. Rock Art is mostly located in high mountains, dense forests or the Gobi, and most cannot be visited by tourists due to the limitations of geography and research work [3]. Currently, the research on Rock Art in northern China mainly focuses on the standardisation of rock painting data recording, classification and staging of rock paintings, rock painting dating and rock painting functions, etc. The lagging of rock painting display design and the supporting use of emerging technologies in rock painting cultural dissemination are problems that need to be solved urgently at present.

The integration of digital technologies overcomes the spatiotemporal constraints inherent in traditional museum exhibitions, enabling visitors to intuitively grasp the profound cultural significance of Rock Art heritage and the urgency of its preservation, thereby fostering heightened awareness of heritage conservation and strengthened collective cultural identity [4].At the present stage, there are some problems in the construction of cultural heritage digitisation, such as the digital display content is consistent with traditional museums, resulting in the advantages of digital technology not being fully utilized [5]. The digital display of Rock Art clearly reflects this, digital display templating, display form and display content does not match, failing to effectively convey the deeper meaning of rock art, the tourists perceive poor experience, cultural communication function decline.

In today's information explosion media environment, emotion serves as a catalyst that amplifies engagement and interest in cultural connotation. The introduction of emotion into display design can not only promote the depth of people's knowledge of things, but also positively and effectively convey the information of exhibits to the viewers [6]. Many scholars at home and abroad enhance user perception by intervening in emotion research, such as Christopher Morse through the study of tourists' visiting experience to establish a lasting impression of the triggering factors, which can be used to enhance the satisfaction of tourists [7]. Korean scholar Joo Young-sook uses interactive media to carry out the emotional experience, exploring the possibility of activation of education [8].

3 Damaidi art

Damaidi Rock Art, located in Ningxia, China, is a large-scale rock art group, reflecting the general pattern of early human activities, and providing important archaeological evidence for the study of the social and cultural integration between nomadic and farming civilizations in northern China. It has a huge scale, covering an area of about 15 square kilometers, with more than 200 sets of images per square kilometer, exceeding the world-recognized standard of determining the "main distribution area" of Rock Art by 20 times, and giving people a sense of shock from the grandiose images and numerous group scenes. The unique bio-geographical environment, historical trajectory and cross-cultural exchanges of the region have shaped the uniqueness and thematic diversity of the Damaidi Rock Art. The uniqueness of their style, the diversity of their painting techniques and the vocabulary of their symbols can reflect the artistry of different eras.

Compared to other rock art studies, Damaidi offers richer interdisciplinary research material. However, its exhibition design lags in adopting UX-driven frameworks informed by cognitive psychology, necessitating a visitor-centric redesign. This study therefore selects Damaidi Rock Art as a case to systematically investigate exhibition design through a UX lens, aiming to bridge the gap between heritage interpretation and perceptual engagement.

4 User-experience oriented design modelling of rock art displays

This study takes Damaidi Rock Art as an object to explore exhibition design strategies that combine technology and cultural heritage [9]. Literature analysis, user interviews and expert interviews are integrated in the preliminary stage to extract the user's emotional experience needs of Rock Art [10]. The Kano model is introduced to identify the demand factors that can enhance visitor satisfaction [11]. The Kano-AHP composite model is used to rank the user experience needs and importance of Rock Art to improve the accuracy and scientificity of the analysis. This research methodology has been widely applied across diverse fields. For instance, Wang Jia employed the Kano-AHP model to develop interaction design strategies enhancing users' immersive shopping experiences and constructed a mind-flow experience framework [12]. Similarly, Zhan Qinchuan adapted the model to cultural tourism product design, strengthening visitors' cultural identification and immersive engagement with the Sumeru Grottoes [13]. Combined with the theory of emotional design, this study proposes a user-experience oriented rock art display design model with 'culture-experience-technology' co-design (Fig. 1), which clarifies the user needs of the Damaidi Rock Art display design, and adjusts and optimises the design direction in response to the actual differences in user needs.

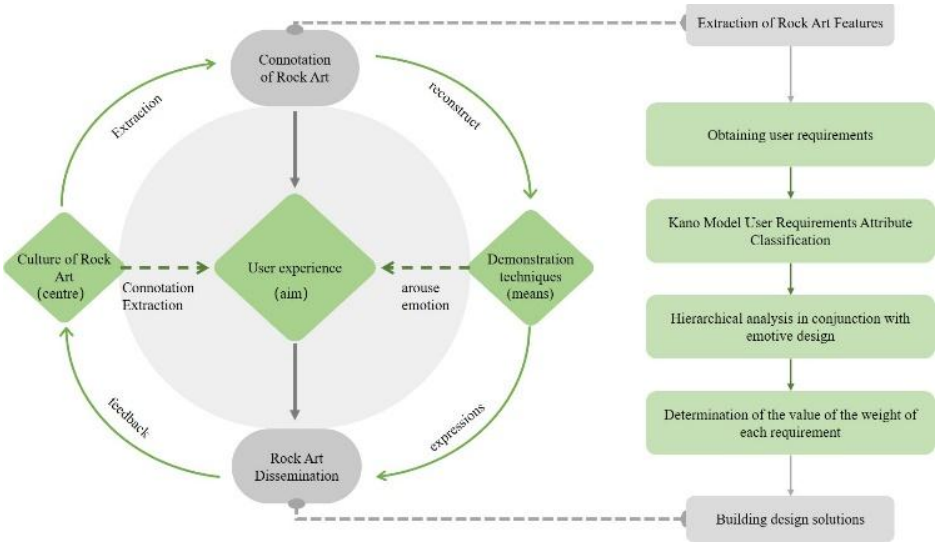

Fig. 1 User Experience Oriented Rock Art Display Design Model

5 Examples of Damaidi rock art display design

A. Obtaining user requirements

In order to accurately explore the user experience factors of the Damaidi Rock Art display design, 30 subjects were selected in this study to conduct a preliminary user experience survey. According to the "National Museum of China Data Report (2023) [14] ", the proportion of audience in each age group can be seen as follows: 19.12% of the audience aged 0-18 years old; 42.69% of the audience aged 19-35 years old; 31.34% of the audience aged 36-59 years old; and 6.85% of the audience aged 60 years old or older. Viewers aged 19-59 accounted for 74.03%, so users in this age group were selected as the research object. Two high school students, 15 college students from Liaoning, Guangxi and Xi'an, 9 postgraduates from Guangxi, Shanxi and Liaoning, and 4 cultural and exposition staff over 36 years of age were selected. 30 subjects were given semi-structured interviews for an average of 20 min after visiting the Rock Art exhibition area. The content of the interviews centered on the experience and expectation for improvement during the tour, and follow-up interviews were conducted. The results were summarized and organized and experts were invited to discuss them, and the specific content of the Kano questionnaire was finally sorted out, as shown in Table 1 and Table 2.

Table 1. Kano questionnaire content

Interview distillation	Questionnaire content
More interested in the historical stories of the artifacts.	A sense of history
Can't understand the meaning of Rock Art	Reduce the difficulty of comprehension
Wish there could be story interpretation	Storyline
Wish there could be more interesting forms of display, such as dynamic	Dynamic
With a little bit of special effects and artistic sense	Incorporation of Special effects
It should have its own characteristics	Uniqueness
First of all, it should guarantee the sense of entertainment	Entertainment
The picture should be good, so that you can take pictures and have an atmosphere	Immersive experience
More interested in effects with sound and light	Multi-technology integration
More interested in effects with sound and light "I want to see real scenes, not too sci-fi	Restore the real scene
Sensitive to sound, sound is more attractive	Audible

Table 2. Kano questionnaire design

Enterprise	Like	Must-be	Neutral	Live with	Dislike
With this feature	5	4	3	2	1
Without this feature	1	2	3	4	5

B. Sample selection and exclusion criteria

• Selection Criteria for Research Participants: 1) have visited Damaidi Rock Art or have had a rock art tour within one year; 2) know about rock art (or at least know what rock art is).

• Exclusion Criteria: 1) People under the age of 18. In China, according to the General Principles of Civil Law, people under the age of 18 have not yet formed a complete system of understanding things and do not have the ability to be economically independent; 2) Understanding of Rock Art (at least knowing what Rock Art is); 3) Tourists who are not interested in Rock Art [15].

• Criteria for selecting experts: 1) Engaged in related industries and understanding of rock art; 2) Engaged in museum service industry; 3) At least 5 years of design experience with concrete design results.

• Questionnaire exclusion criteria: 1) Filling in time less than 1 minute; 2) Highly consistent options or obvious contradictory answers ;3) Agreeing with the account to fill in the questionnaire several times to take only one.

C. Kano Model User Requirements Attribute Classification

In this study, a total of 139 questionnaires were distributed online and offline, and 121 valid questionnaires were successfully recovered by eliminating the obviously unreasonable questionnaires. Cronbach's alpha coefficient was calculated using SPSS (version 27.0) to assess internal consistency. The result (α=0.831) exceeded the 0.7 threshold recommended by Nunnally (1978), confirming robust data credibility. The questionnaire

feedback was classified after corresponding with the Kano evaluation table to obtain the Kano result analysis (Table 3).

Table 3. Analysis of kano results

Requirement Item	A	O	M	I	R	Q	Demand Attributes
Entertainment	31	14	20	30	22	6	Attractive（A）
Immersive experience	39	22	18	27	11	4	
Restore the real scene	52	12	12	26	14	5	
Dynamic	19	37	16	29	14	6	One-dimensional（O）
Incorporation of Special effects	17	38	14	29	18	7	
Multi-technology integration	29	35	13	24	13	2	
Audible	17	34	18	31	15	6	
Reduce the difficulty of comprehension	12	14	40	27	23	5	Must-be（M）
A sense of history	22	12	39	28	16	4	
Storyline	20	17	28	43	8	5	Indifferent（I）
Uniqueness	24	17	19	38	21	4	

As delineated in Table 3, the 11 users' requirements are categorized into four Kano attributes:

Attractive (A) include entertainment, immersive experience, and restore the real scene. In design practice this requirement should focus on. These requirements are potential expectations of users, which can increase satisfaction.

One-dimensional (O) include dynamic, incorporation of special effects, multi-technology integration, and audible. This kind of demand is positively correlated with user satisfaction, and the more thoughtful the desired demand is considered in design, the higher the user satisfaction is, so efforts need to be made to satisfy the attribute demand.

Must-be (M) include reduce the difficulty of comprehension and a sense of history, which are essential factors in design and without which satisfaction will drop dramatically.

Indifferent (I) include storyline and uniqueness. Whether this need is met or not has a small impact on the visitor experience, so this attribute is not being considered in the design.

D. Hierarchical analysis in conjunction with emotive design

Guided by the above results and Norman's three-tiered emotional design framework (visceral level, behavioral level, reflective level), we established a AHP model [16]. Among them, the best solution for the optimal solution for Damaidi Rock Art exhibition design serves as the target layer (X), Visceral Level (V), Behavioral Level (B), and Reflective Level (R) form the criterion layer, and the sub-criterion layers are the specific user requirement elements Fig. 2.

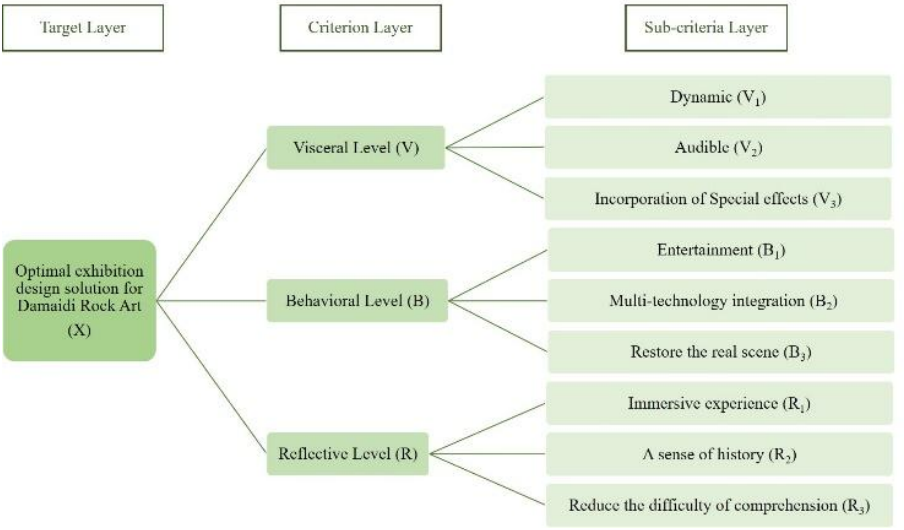

Fig. 2 Damaidi Rock Art Display Design Hierarchy Analysis Model

In this paper, 10 experts in related fields are invited to carry out the assessment, comparing and scoring the elements of each level two by two in accordance with the principle of scoring on a scale of 1-9 [17]. In the two-by-two comparison, in order to ensure the consistency of the participants' thinking and to determine whether there is a logical error in the matrix, a consistency test is required. Through the four steps of the geometric mean algorithm, the weight values are calculated (Table 4-7).

Table 4. Indicator weights at the normative level

	V	B	R	Weighted (W)
V	1	3	1/2	0.353
B	1/3	1	1	0.213
R	2	1	1	0.434

Table 5. Visceral-Level indicator weights

	V1	V2	V3	Weighted (W)
V1	1	7	5	0.742
V2	1/7	1	1/3	0.082
V3	1/5	3	1	0.191

Table 6. Behavioural-level indicator weights

	B1	B2	B3	Weighted (W)
B1	1	5	1/5	0.668
B2	1/5	1	1/7	0.069
B3	5	7	1	0.254

Table 7. Reflective-Level indicator weights

	R1	R2	R3	Weighted (W)
R1	1	5	5	0.229
R2	1/5	1	1	0.070
R3	1/5	1	1	0.701

A consistency test of the results of the judgement matrix calculations is required (Table 8). The consistency test of all the judgement matrices in this study was passed by（C_R≤0.1）

Table 8. Consistency test results

Metric	X	V	B	R
λmax	3.0950	3.0440	3.0540	3.0280
CI	0.0475	0.0220	0.0270	0.0140
RI	0.5800	0.5800	0.5800	0.5800
CR	0.0820	0.0380	0.0470	0.0240
Consistency Test	Pass	Pass	Pass	Pass

The results show the dominance of Reflective-Level with a weight value of 43.4%, Visceral-Level with 35.3% and Behavioral-Level with 21.3%. In the design practice, Reduce difficulty of comprehension, Dynamic and Entertainment, which accounted for 30.4%, 26.1% and 14.2% of the total, were taken as the core factors; Immersive experience (9.9%), Incorporation of special effects (6.7%), and Restore real scene (5.4%) were taken as the secondary factors in the research of displaying Rock Art; A sense of history (3%), Audible (2.8%), and Multi-technology integration (1.4%) accounted for a relatively small percentage, but were also important factors in the design of Rock Art display methods (Table 9).

Table 9. Combined weights

Primary Criteria	W	Secondary Criteria	W	Comprehensive Weight	Ranking
		V1	0.742	0.261926	2
V	0.353	V2	0.082	0.028946	8
		V3	0.191	0.067423	5
		B1	0.668	0.142284	3
B	0.213	B2	0.069	0.014697	9
		B3	0.254	0.054102	6
		R1	0.229	0.099386	4
R	0.434	R2	0.070	0.030380	7
		R3	0.701	0.304234	1

6 Programme design and evaluation

A. programme design

Aiming at the existing problems in rock art display design, such as the mismatch between the display method and the content of the rock art, the failure to convey the deeper meaning of the rock art, the poor audience experience, and the decline in the function of cultural dissemination, a programme is designed by combining the results of the above research and analysis with the actual situation of the rock art in Damaidi [18].

• In the selection of materials, we choose rock art images with high recognizability and in line with the normal logic of human cognition (such as independent hunting scenes and clear animal forms), so that viewers can understand the connotation of rock art more intuitively. Damaidi Rock Art is

highly artistic, and most of its subjects are realistic, showing the living conditions of the ancient ancestors. We select content according to the classification of Damaidi Rock Art. Different types of rock art content, such as hunting and animal husbandry, war and dance, patterns and symbols, temples and pagodas for worship, and hand and foot hoof prints, etc., are chosen. And these selected contents are classified and displayed according to themes. Moreover, we strengthen the modern relevance through symbols and metaphors, which reduces the cognitive load and increases the interest. We adopt the materials from the four books of Damaidi Rock Art compiled by the Northwest Second College of Ethnic Studies. Since the rock art with a large painting width is difficult to be divided because of objects sticking together, we select separate and clear rock art materials for picture collocation, which makes it easy for viewers to understand.

• In the design of the content, we adopt a dynamic form, combined with the annotations of the references to restore the living state of the ancient ancestors, so that the viewer can better understand the connotation of the rock art, and the cultural interpretation of the past human production and life in the form of a dynamic exhibition, which can help the viewer to establish the intellectual system of the Damaidi Rock Art more quickly. Unity software is used to set the dynamic mode of each element according to the composition of the screen for bone binding, and then create 2D animation; corresponding animation is created for each element individually, with a time period ranging from 3-15s, and cyclic playback, so as to achieve the effect that the content of the screen varies in different time periods.

• In terms of space creation, the overall design chooses the combination of projection and physical display to create an immersive space, breaking through the traditional screen limitations. Based on the real effect of the rocks in Damaidi Rock Art, the simulated rock scenery is produced to build a real display space for Rock Art to integrate the animation projection display method, and the multi-sensory immersion is enhanced by the Unity particle system (such as sand, dust, flame) and low-frequency sound effects [19].The Rock Art is presented in a dynamic and modernised form, so that it has a sense of history and a sense of immersion while realising a modern presentation [20].

Due to the influence of various factors, the specific environment is still under construction, so we use the screen effect diagram to display (Fig. 3).

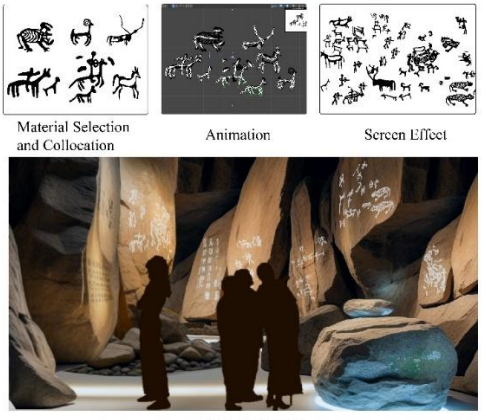

Fig. 3 Design Evaluation

B. programme assessment

In order to verify the user satisfaction level of the programme, 15 subjects and 5 design teachers from the previous study were invited to rate each indicator on a scale of 1-10 through the programme debriefing Fig. 4.

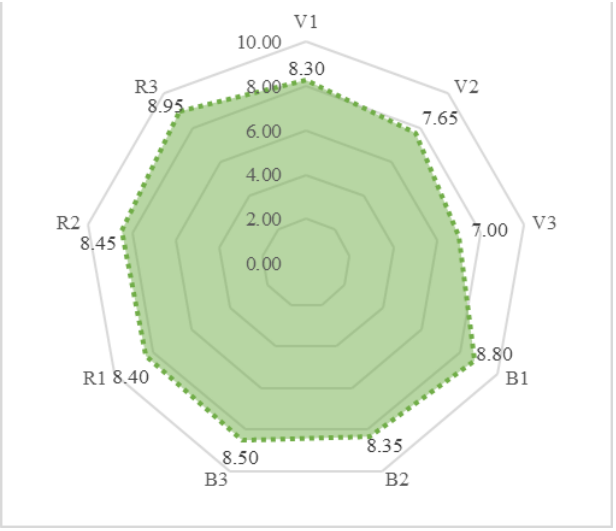

Fig. 4 Design Evaluation

In summary, according to the evaluation results, it can be seen that this programme has a high level of satisfaction in terms of Reduce the difficulty of comprehension, Entertainment and Restore the real scene, but the design of the Audible and the Incorporation of Special effects needs to be improved. The overall user satisfaction of this programme is above 7 points, and it has a certain degree of feasibility.

7 Conclusion

The connotation of cultural heritage is rooted in its original spatial and temporal context and the multilayered structure of cultural space, requiring the stratification of cultural resources to guide tailored design based on the distinct attributes of each layer. As a complex and diverse cultural heritage resource, the effective digital communication of Rock Art demands deep exploration of its cultural essence through creative reinterpretation, rather than superficial replication of its forms.

This study adopts a user experience-oriented approach, developing a Rock Art display design model that quantifies the weightings of factors influencing user perception and proposes a dynamic exhibition framework. However, the proposed dynamic presentation of Damaidi Rock Art primarily relies on existing literature focusing on symbolic interpretations of petroglyphs, necessitating further interdisciplinary validation through empirical studies. This scheme is expected to be practically applied in the project in Zhongwei, Ningxia, and this thesis is only a preliminary design scheme, and the specific scheme validation is still to be studied in depth.

Current challenges in enhancing cultural heritage interpretation，such as optimizing museums' communicative and educational efficacy and rendering cultural narratives more engaging — underscore the urgency of innovative

design research and experimental implementation.

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Abbreviations

AHP Analytic Hierarchy Process

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