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Research on the Current Situation and Improvement Path of Digital Cultural Tourism Experience in the Zhejiang East Canal Museum

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Abstract: Under the background of integrated development of culture and tourism, dynamic inheritance of cultural heritage and Digital China construction, digital technology has become an important driving force for museum experience upgrading. Taking Zhejiang East Canal Museum as the case, this study adopted questionnaire survey (315 valid samples) to explore the current situation and bottlenecks of its digital cultural tourism experience. Results show that the museum has formed basic digital services and entertainment-education functions, which are recognized by tourists. However, there are still prominent problems: weak cultural narrative on digital platforms, serious homogeneity of cultural tourism content, and insufficient in-depth immersive experience. It is difficult to meet tourists' demands for high-quality and in-depth cultural experience. Accordingly, this paper puts forward optimization paths from three aspects: upgrading digital service platform, optimizing digital immersive experience, and building an integrated digital ecosystem, so as to realize the deep integration of digital technology and Grand Canal culture connotation.

Keywords: Integration of culture and tourism;Digital construction;Tourist experience;Living Heritage

Under the background of high-quality development of cultural and tourism integration, dynamic inheritance of cultural heritage and construction of Digital China, the traditional static protection mode of linear cultural heritage is transforming to digital, immersive and participatory dynamic inheritance. Digital technology effectively balances heritage protection and public tourism utilization, and becomes the core support for museum cultural communication and experience upgrading. At present, domestic and foreign studies have achieved results in canal culture, museum digital display and cultural tourism integration, but most studies focus on single dimension such as technology application or heritage protection. The research perspectives are fragmented, emphasizing technology over cultural integration and tourist experience, and lack of empirical research on canal museums.Zhejiang East Canal is an important part of the Grand Canal of China, with rich regional culture and living heritage values. As the first special museum themed on Zhejiang East Canal, it is a typical sample for studying digital experience upgrading of canal cultural venues. With tourists' demand shifting to high-quality immersive experience, it is urgent to solve the problems of static display, weak interaction and insufficient cultural narrative in digital construction.Therefore, this paper takes Zhejiang East Canal Museum as the research object, selects three dimensions of digital service platform, digital entertainment-education and digital immersive experience, uses questionnaire survey to conduct empirical analysis, and puts forward improvement paths. The research aims to provide reference for digital transformation and cultural tourism integration of similar cultural venues along the canal.

2.1 Digital Culture and Tourism

In the field of cultural and tourism integration and digital technology empowering the inheritance of cultural heritage, relevant scholars have reached a consensus. Cultural and tourism integration is not merely the simple superposition of the cultural and tourism industries, but a systematic and in-depth integration from multiple dimensions such as concepts, resources, and technologies (Fan, 2019). The rapid development of the digital economy has further driven the integration of culture and tourism to undergo a systematic transformation from single technology empowerment to the overall reshaping of the industry (Xu, 2026; Zeng, 2025).Xu (2026) broke through the traditional perspective of technical tools and constructed an integrated analysis framework from technological empowerment to content construction and then institutional innovation. Wang and Lu (2026) pointed out that digital communication can mobilize the flow of elements such as people, objects, information, and capital, reconstruct the production model of cultural and tourism spaces. Tian and Zhang (2026) proposed that the concept of " digital cultural tourism " can achieve a three-dimensional interconstruction of "integration, reconstruction, and identification". Wu, Wang, and Wu (2026) confirmed that immersive digital scenes can activate tourists' cognition and shape their value belonging through the creation of multiple layers of scenarios. Parsa (2019) also focused on the efficiency upgrade of cultural tourism scenarios and heritage management through digitalization, relying on the Internet of Things.

2.2 The dynamic inheritance of canal culture

As a large-scale linear cultural heritage, the Grand Canal is characterized by a wide range of resources, diverse heritage types, and prominent living attributes. Its protection and utilization should abandon the fragmented and point-like thinking

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and adhere to the overall and systematic activation approach (Li & Wang, 2016). Early research has verified the practical value of digital technology in the revitalization of canal heritage. Zhang (2019) relied on VR technology to achieve the digital reproduction of canal ancient sites and initially explored the visual and perceptible communication path of cultural heritage. With technological iteration, the research frontier is gradually moving towards new-generation technological scenarios such as the metaverse and digital twins. Li (2025) pointed out that metaverse technology can reconstruct the value system of canal culture through immersive interaction design, injecting new vitality into the digital inheritance and intergenerational transmission of canal culture.At the practical application level, foreign studies have verified the feasibility of digitalization and Internet of Things technologies in the intelligent management, operation and maintenance of linear canal heritage (Parsa, Weeks, Safa, & Zelbst, 2019). Domestic research on intangible cultural heritage and cultural heritage has further clarified that the living heritage is different from the traditional static exhibition and solid-state preservation mode. Adhering to the people-oriented approach and taking modern life as the scene is the core path for the sustainable development of cultural heritage (Xu, 2018; Hu, 2012).

3.1 Overview of the Zhejiang East Canal Museum

As the first museum in China dedicated to the theme of the Zhejiang East Canal, the Zhejiang East Canal Museum is located in the Zhejiang East Canal Cultural Park of Shaoxing City. With the core theme of "Connecting Rivers and Seas, Benefiting the World", it houses over 2,000 sets of cultural relics and officially joined the Global Water Museum Alliance in April 2026. The museum is equipped with a variety of digital exhibits. Relying on intelligent devices of sound, light, electricity and film, it creates a panoramic cultural experience scene. Through digital applications such as the 3D modeling system of historical waterways for ship roaming, the 270-degree circular screen motion capture "Hundred Songs of Yue", and the dynamic holographic cultural symbol "Spiritual Field", it deconstructs traditional culture with modern technology and realizes the integration and dialogue between cultural relics and technology(Zhang, Xu, & Wang, 2026).Promote the contemporary transformation of the cultural genes of the canal.

3.2 Questionnaire Design

The questionnaire is divided into three parts.

The first part is the basic information of tourists, including gender, age, education, occupation, income, residence, visit times and purpose. The second part is the evaluation of digital experience, including three dimensions:

(1) Digital service platform (7 items): online exhibition hall, ticket reservation, digital guide, barrier-free service, etc.

(2) Digital entertainment and education (7 items): cultural experience, popular science understanding, activity participation, etc.

(3) Digital immersive experience (6 items): visual, auditory, tactile experience, cultural cognition, etc.

All items adopt Likert 5-point scale (1=strongly disagree, 5=strongly agree). The third part investigates the travel intention of potential tourists.

This study distributed and collected questionnaires through a combination of online and offline methods from September 2025 to March 2026. To ensure the validity of the research sample, a screening question was designed at the very beginning of the questionnaire in this study: "Have you visited the Zhejiang East Canal Museum?" Only respondents who fill in "yes" are eligible to fill in the subsequent items. A total of 328 questionnaires were collected in this study. After screening and sorting, 315 valid samples were identified, with an effective rate of 96.03%.

4.1 Reliability and validity analysis

4.1.1 Reliability analysis

This study uses Cronbach's α coefficient to measure its internal consistency reliability. As shown in Table.1, the Cronbach's α coefficients of each variable scale in this survey questionnaire are all greater than 0.8, indicating that the reliability and quality of this survey questionnaire are high and can be used for further analysis.

Table.1 Cronbach reliability analysis

Name	Cronbach's α coefficient	Standardized Cronbach's α coefficient	Number of terms
Digital service platform	0.910	0.910	7
Digital entertainment and education solution	0.913	0.913	7
Digital immersive experience	0.899	0.899	6
As a whole	0.972	0.972	20

4.1.2 Analysis of validity

To assess the validity of the scale items included in the questionnaire, exploratory factor analysis (EFA) was employed to incorporate all variables into the factor analysis process, followed by the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. As presented in Table 2-2, the KMO statistic yields a value of 0.816, exceeding the threshold of 0.8. Concurrently, the Bartlett's test of sphericity yields a statistically significant result, which attests to the sound structural validity of the scale and confirms its suitability for factor analysis.

Table.2 The Inspection of KMO and Bartlett

KMO		0.816
Bartlett Sphericity inspection	Approximate chi-square	13942.589
	df	153
	p	0.000

It can be seen from the total variance explanation table 2-3 that the principal component analysis method was used to extract common factors with eigenvalues greater than 1 as the standard. A total of 3 factors were extracted by factor analysis, and the eigenvalues were all greater than 1. The variance explanation rates of these 3 factors after rotation were 30.057%,27.506%,22.357%, respectively. The cumulative variance explanation rate after rotation is 79.920%, close to 80%, indicating that the extracted common factors can well explain most of the information of the original variables, and the structure validity of the questionnaire is excellent, which can effectively measure the real perception of tourists on the digital experience of the East Zhejiang Canal Museum.

Table.3 Total Variance Explanation Rate Table

Item	Characteristic root			Rotation frontality interpretation rate			Post-rotation variance explanation rate		
	Eigen Value	% of Variance	Cumulative %	Eigen Value	% of Variance	Cumulative %	Eigen Value	% of Variance	Cumulative %
1	11.773	65.403	65.403	11.773	65.403	65.403	5.410	30.057	30.057
2	1.346	7.477	72.881	1.346	7.477	72.881	4.951	27.506	57.563
3	1.267	7.039	79.920	1.267	7.039	79.920	4.024	22.357	79.920
4	1.105	6.137	86.056	-	-	-	-	-	-
5	1.035	5.748	91.804	-	-	-	-	-	-
6	0.820	4.556	96.360	-	-	-	-	-	-
7	0.405	2.252	98.612	-	-	-	-	-	-
8	0.061	0.340	98.951	-	-	-	-	-	-
9	0.048	0.266	99.218	-	-	-	-	-	-
10	0.045	0.252	99.469	-	-	-	-	-	-
11	0.031	0.173	99.643	-	-	-	-	-	-
12	0.019	0.104	99.747	-	-	-	-	-	-
13	0.017	0.093	99.839	-	-	-	-	-	-
14	0.012	0.065	99.904	-	-	-	-	-	-
15	0.008	0.046	99.950	-	-	-	-	-	-
16	0.004	0.022	99.972	-	-	-	-	-	-
17	0.004	0.019	99.992	-	-	-	-	-	-
18	0.001	0.008	100.000	-	-	-	-	-	-

The data of this study was rotated using the maximum variance rotation method (varimax) to identify the correspondence between factors and research items. Table 2-4 shows the information extraction of factors for research items and the corresponding relationship between factors and research items. It can be seen that the commonality values corresponding to all research items are all higher than 0.5, indicating a strong correlation between the research items and the factors, and that the factors can effectively extract the information. A1 to A7 mainly load on factor 1, covering service processes such as online exhibition halls, ticket reservation, and guide equipment, reflecting the supporting role of digital technology in enhancing visit convenience; B1 to B6 mainly load on factor 2, focusing on AR/VR visual enhancement and interactive devices, demonstrating the sensory immersive atmosphere constructed by the museum through technological means; C1, C3, and C5 mainly load on factor 3, focusing on popular science content and cultural value cognition, representing the core functions of digital educational and entertainment solutions in knowledge dissemination and dynamic inheritance. In conclusion, the validity of the questionnaire has been met, the dimension division is reasonable, and it is suitable for subsequent path mechanism research.

Table.4 Rotated factor loading coefficient matrix

Item	Factor loading coefficient			Common variance (common factor variance)
	Factor 1	Factor 2	Factor 3	
A1	0.751			0.762
A2	0.821			0.835
A3	0.750			0.765
A4	0.817			0.832
A5	0.500			0.606
A6	0.742			0.757
A7	0.819			0.831
B1		0.769		0.807
B2		0.803		0.832
B3		0.767		0.818
B4		0.805		0.829
B5		0.773		0.816

B6	0.792		0.832
C1		0.871	0.916
C2		0.520	0.640
C3		0.872	0.930
C4		0.524	0.648
C5		0.879	0.930

Rotation method: Maximum Variance Method (Varimax).

4.2 Descriptive statistical analysis

4.2.1 Basic information of tourists

From the perspective of tourists' gender, he gender structure is relatively balancedthe proportion of females is slightly higher than that of males, accounting for 55.56%. The age structure is mainly composed of middle-aged and young people. Among them, tourists aged 18 to 30 account for the highest proportion, at 44.76%, while those aged 31 to 40 make up 28.89%. The combined proportion of the two exceeds 70%.

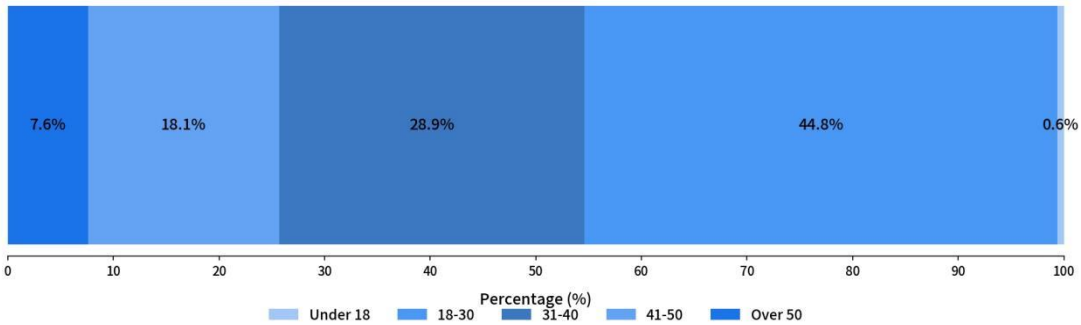

Fig.1Respondent Age Contribution

As shown in Fig.2, the overall educational level of the surveyed tourists is relatively high. Among them, the proportion of people with college or bachelor's degrees is 62.54%, and the proportion of those with high school or technical secondary school degrees is 26.66%. From this, it can be reasonably inferred that there is a certain relationship between the educational level of tourists and their experience of museum culture.

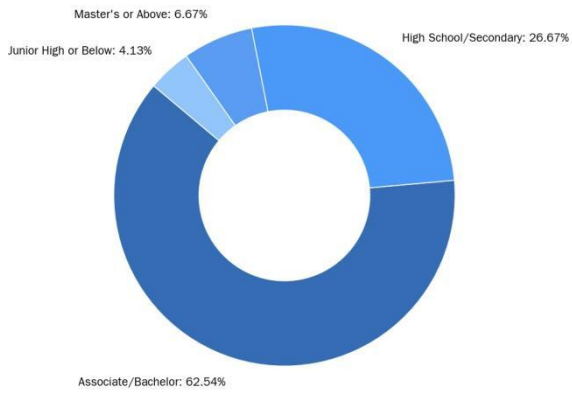

Fig.2 Education background

Among the occupations of the surveyed tourists, corporate employees accounted for as high as 72.70%, making them the main force among the tourists. This group of people has a stable daily work and life, with fixed leisure time and the right to choose their own consumption. Compared with people in other occupations, they pay more attention to cultural experience and mental relaxation.

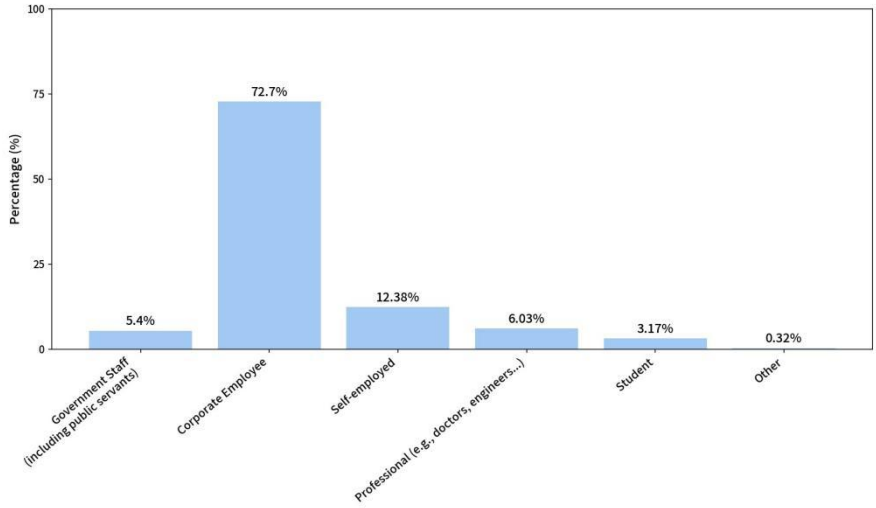

Fig.3 Profession

The monthly income is mainly concentrated in the range of 6,001 to 8,000 yuan, accounting for 48.89% of this group. Overall, due to the large proportion of the company's staff, the overall income level of tourists is good and they have a stable economic foundation.

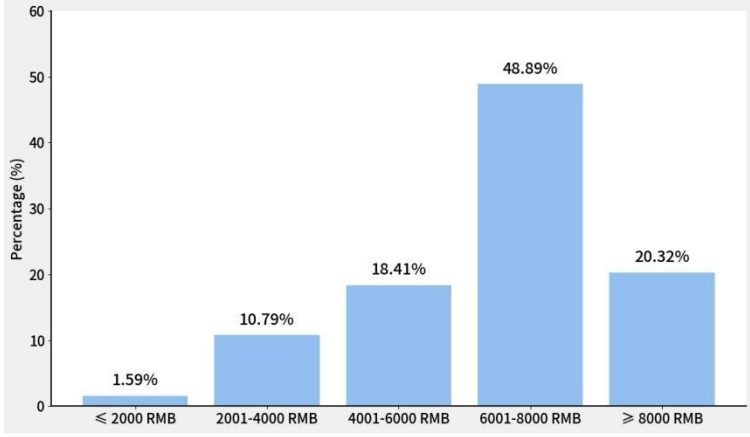

Fig.4 Monthly income

The distribution of permanent residences is relatively balanced. Among them, 38.41% are tourists from outside Zhejiang Province, 35.24% are from within Shaoxing City, and 26.35% are from other cities within Zhejiang Province. This reflects that the museum has a certain appeal to tourists from all over the country.

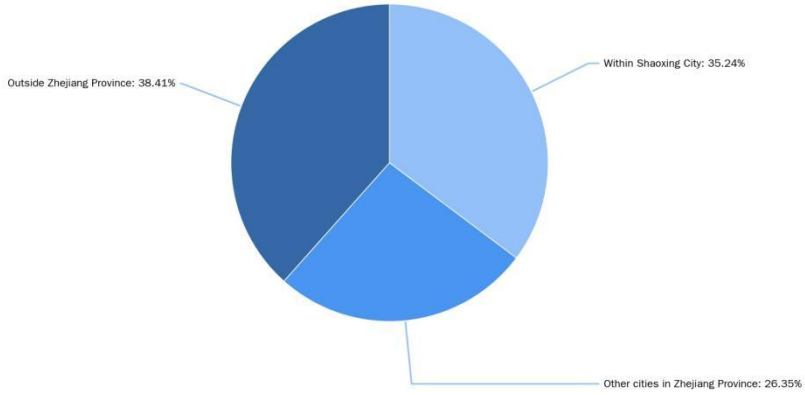

Fig.5 Permanent residence

4.2.2 Characteristics of tourists' travel

4.2.2.1 Number of visits

To further understand the actual visiting behavior of tourists towards the Zhejiang East Canal Museum, this study conducted a statistical analysis of the visiting frequency. As shown in Fig.6, among the on-site visitors, those who have been here once account for as high as 80.00%, forming the absolute majority of the sample, while those who have been here twice account for 20.00%.

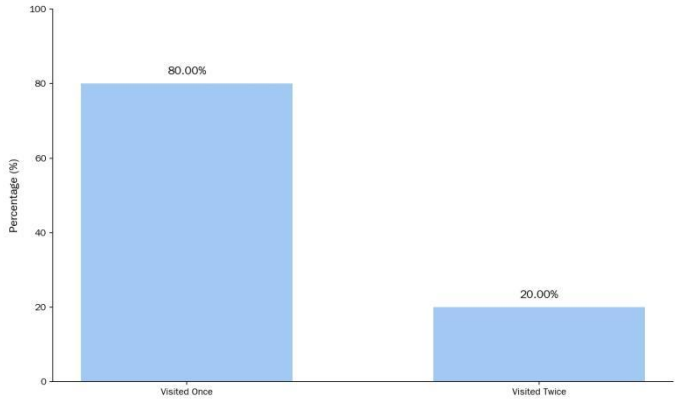

Fig.6 Number of visits

4.2.2.2 Learn about the ways

To explore the main information channels through which tourists learn about the Zhejiang East Canal Museum, a statistical analysis was conducted. As shown in Fig.7, the online platform is the absolute dominant channel, with a selection ratio as high as 69%. New media platforms have become the primary information entry point and decision-making basis for attracting tourists, especially young people, to visit museums. Secondly, there are recommendations from relatives and friends, which reflects the lasting influence of interpersonal word-of-mouth in cultural tourism decisions. Television advertisements account for 43% and still maintain a certain coverage, while the effectiveness of other traditional or offline channels is relatively limited.

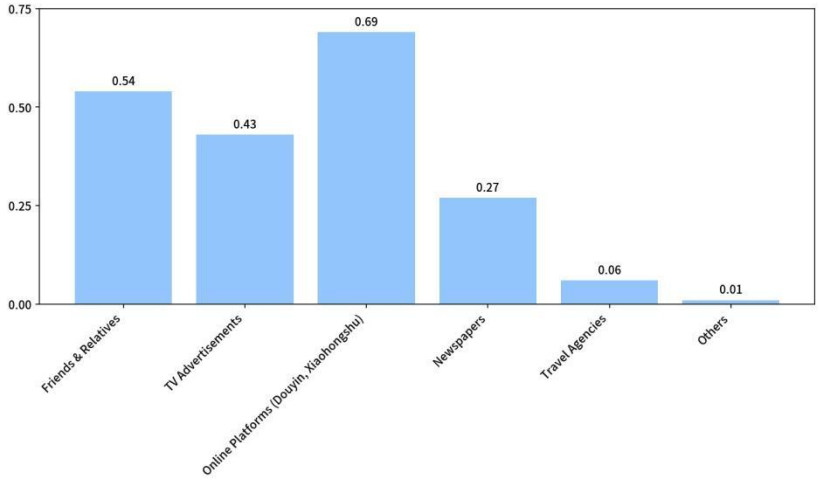

Fig.7 Learn about the ways

4.2.2.3 Purpose of the visit

The purposes of tourists' visits shown in Fig.8 are mainly for leisure and entertainment, with diversified purposes including educational learning and cultural experience. Among all the respondents, the proportion of those choosing leisure and entertainment as their purpose was the highest, with more than half of the tourists regarding museums as an important cultural and leisure venue. Secondly, there is the aspect of learning knowledge/education and cultural experience, which indicates that tourists hope to "learn through entertainment". Research investigations and parent-child activities, on the other hand, are relatively niche, reflecting the existence of professional audiences and specific family groups.

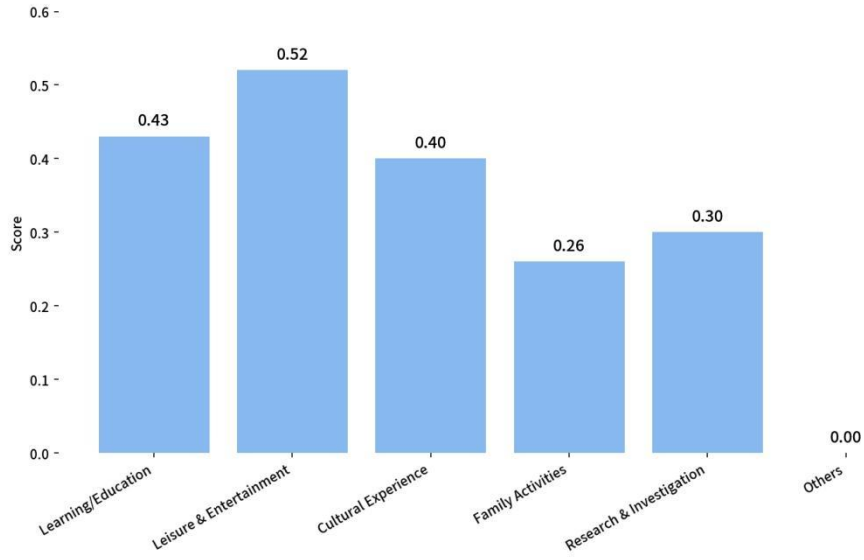

Fig.8 Purpose of the visit

4.3 Visitors' experience of the venue facilities

As shown in Table.5, visitors generally hold an approving attitude towards the experience of the museum's digital service platform. Overall, the proportion of positive evaluations for each project is close to or exceeds 50%. Among them, the online exhibition hall is rich in content and can meet the browsing needs, receiving a positive evaluation of 50.16%. This indicates that the online digital exhibition has initially realized the remote access and basic display of cultural resources, breaking through the time and space limitations of physical visits. The convenience and efficiency of ticket reservation and information inquiry, as well as the clear and useful explanations of digital tour guides, have received positive evaluations, indicating that digital services have been widely recognized for enhancing the operational convenience and cognitive assistance of visits. However, the data also reflects that some methods need to be strengthened. 20% to 30% of tourists choose average in each project, believing that the current service platform can meet the basic functional needs, but it has not yet met the expectations of tourists in terms of deeper content services and the innovation of online participation forms, and there is still a gap.

Table.5 Digital service platform

Name	Option	Frequency	Percentage(%)
The online exhibition halls (such as 3D exhibition halls, high-definition pictures, etc.) are rich and diverse in content, which can meet the browsing needs	1	8	2.54
	2	67	21.27
	3	82	26.03
	4	90	28.57
	5	68	21.59
The online ticketing reservation system has a smooth process and is easy to operate	1	9	2.86
	2	70	22.22
	3	86	27.30
	4	91	28.89
	5	59	18.73
It provides practical self-service tour guide equipment and services	1	9	2.86
	2	80	25.40
	3	62	19.68
	4	97	30.79
	5	67	21.27
offers considerate digital barrier-free services for special needs	1	6	1.91
	2	84	26.67
	3	59	18.73
	4	95	30.16
	5	71	22.53
visitors through digital explanations, electronic explanations and other methods	1	8	2.54
	2	75	23.81
	3	64	20.32
	4	92	29.21
	5	76	24.12
Digital services have a fast response speed, with no lag or delay	1	7	2.22
	2	83	26.35
	3	64	20.32
	4	89	28.25

Name	Option	Frequency	Percentage(%)
Overall, the digital service platform has enhanced the convenience of my visit	5	72	22.86
	1	7	2.22
	2	76	24.13
	3	81	25.71
	4	90	28.57
	5	61	19.37

As shown in Table.6, the respondents' overall feedback on the digital entertainment and education plan is generally positive. The proportion of high scores in each indicator exceeds 40%, while the proportion of low scores is generally less than 3%, presenting a clear right-skewed distribution. Specifically, the fact that "one can obtain a digital entertainment experience that is cost-effective" and "the cultural value contained can be recognized and experienced through technological scenarios" have received extremely high recognition indicates that digital displays not only enhance entertainment but also effectively promote cultural perception. At the same time, in the two indicators of "being able to easily participate in various digital entertainment activities provided by the museum" and "visitors being able to learn about the relevant knowledge of canal culture", the proportion of those who chose to agree (4 points) was also close to or exceeded 30%. In contrast, the proportion of those who chose "strongly disagree" (1 point) did not exceed 3% among all indicators, further confirming the effectiveness of this model in enhancing tourist satisfaction and cultural identity.

Table.6 Digital entertainment and education solution

Name	Option	Frequency	Percentage(%)
The cultural value contained can be recognized and experienced through technical scenarios	1	8	2.54
	2	67	21.27
	3	83	26.35
	4	91	28.89
	5	66	20.95
Popular science content (such as interactive games and VR dynamic displays) is easy to understand	1	9	2.86
	2	70	22.23
	3	85	26.98
	4	89	28.25
	5	62	19.68
The museum offers a digital entertainment experience that is easy to understand and provides good value for money	1	9	2.86
	2	79	25.08
	3	64	20.32
	4	96	30.48
	5	67	21.26
Visitors can easily participate in various digital entertainment activities provided by the museum	1	6	1.91
	2	83	26.35
	3	56	17.78
	4	95	30.15
	5	75	23.81
Presenting a diverse range of digital entertainment options	1	8	2.54
	2	75	23.81
	3	65	20.64
	4	91	28.89
	5	76	24.12
They can also learn about the relevant knowledge of canal culture	1	7	2.22
	2	83	26.35
	3	63	20.00
	4	91	28.89
	5	71	22.54
The digital cultural and entertainment activities in the museum are worth tourists' time to experience	1	7	2.22
	2	76	24.13
	3	80	25.40
	4	88	27.94
	5	64	20.31

As shown in Table.7 tourists generally have a high evaluation of the digital immersive experience of the Zhejiang East Canal Museum, presenting an overall positive feedback trend. At the multi-sensory experience level, the data performance is particularly prominent in that "digital interactive devices (such as touch screens and sensor devices) have enhanced the tactile experience", with the proportion of those who chose to agree (4 points) reaching as high as 30.79%, and the proportion of those who agreed in "digital displays (such as AR/VR) have greatly enhanced the visual experience" also reached 27.62%. It indicates that interactive technology significantly enhances the sensory stimulation on site. Meanwhile, the feedback in the emotional and cognitive dimensions was equally optimistic. Nearly half of the tourists chose to agree or strongly agree on the item that "the application of digital technology has enabled me to have a deeper understanding of

the culture of the Zhejiang East Canal." In addition, as many as 50.79% of the respondents said they were "amazed by the advancement of technology" in the museum, reflecting the shock brought by digital technology. Overall, the proportion of those who chose "strongly disagree" (1 point) among all the indicators did not exceed 3%, indicating that the immersive scenes constructed by the museum through digital technology have effectively enhanced the appeal of visitors and have been widely recognized by tourists.

Table.7 Digital immersive experience

Name	Option	Frequency	Percentage (%)
Digital displays (such as AR/VR) have greatly enhanced the visual experience	1	8	2.54
	2	67	21.27
	3	83	26.35
	4	87	27.62
	5	70	22.22
Through the application of digital technology, the sound effects of the museum (such as background music) made me feel extremely immersed	1	9	2.86
	2	70	22.22
	3	87	27.62
	4	92	29.21
	5	57	18.09
Digital interactive devices (such as touch screens and sensing devices) enhance the tactile experience	1	9	2.86
	2	80	25.40
	3	62	19.68
	4	97	30.79
	5	67	21.27
The application of digital technology has enabled me to have a deeper understanding of the canal culture in eastern Zhejiang	1	6	1.90
	2	85	26.98
	3	56	17.78
	4	94	29.84
	5	74	23.50
I was amazed by the advanced technology in the museum	1	8	2.54
	2	75	23.81
	3	66	20.95
	4	87	27.62
	5	79	25.08
Overall, the digital immersive experience enhances the appeal of the visit	1	7	2.22
	2	83	26.35
	3	62	19.68
	4	89	28.26
	5	74	23.49

4.4 Perception analysis

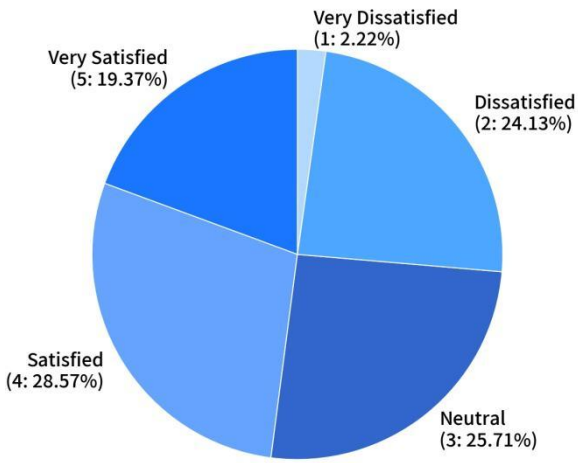

Fig.9 Satisfaction Degree

According to the visitor perception data from the digital service platform of the Zhejiang East Canal Museum, the overall evaluation is mainly positive, but the negative feedback is concentrated in the medium and low segments. The combined proportion of those who are very satisfied or satisfied with the experience is nearly half, indicating that the basic services of the platform have been recognized by the majority of tourists. However, the combined proportion of those who are

dissatisfied or average is close to 50%, coupled with only 2.22% of the extremely low negative reviews, suggesting that tourists' negative perception does not stem from the complete failure of the platform's functions, but is concentrated in the shortcomings of the detailed experience. Considering the scene characteristics of the Zhejiang East Canal Museum, these negative evaluations are likely to point to the platform's deficiencies in presenting the cultural features of the Grand Canal and the adaptability of digital services For instance, the online exhibition hall fails to accurately reproduce core themes such as the canal water conservancy project and the canal transportation culture. The self-guided tour explanations are not vivid and in-depth enough. The system response is lagging, and the coverage of barrier-free services is incomplete. Or the reservation process is cumbersome, and the functional design does not fully consider the usage habits of tourists of different ages. As a result, tourists cannot obtain a smooth and valuable visiting experience through digital services. This kind of concentrated "moderate to mild negative feedback" indicates that the platform does not need to undergo a disruptive reconstruction. Instead, it can effectively reduce negative perceptions by specifically optimizing the digital presentation of canal culture, refining service details, enhancing system stability and user-friendliness, and further magnifying the enabling role of digital services in the dissemination of Canal culture in eastern Zhejiang.

5.1 Research conclusions

5.1.1 Digital empowerment has shown initial success but still needs improvement

Research has found that the digitalization of the Zhejiang East Canal Museum has been successful as a whole and has been widely recognized by the audience. The digital service platform has established a relatively complete basic service system, effectively supporting tourists' physical visits and cultural contacts in all aspects. Tourists generally have a high level of satisfaction with digital entertainment and education solutions and immersive experiences, recognizing that digital entertainment experiences are cost-effective and easy to participate in. This is attributed to intuitive and easy-to-operate forms such as VR displays and interactive games, which effectively lower the threshold for understanding cultural knowledge. Meanwhile, most tourists believe that digital technology has significantly enhanced the visual experience and deepened their understanding of the canal culture, indicating that digital means have achieved initial success in realizing "education through entertainment" and promoting in-depth cultural cognition. The respondents were mainly middle-aged and young people aged 18 to 40 and enterprise employees with college degrees or above. This group generally has a high acceptance of digital technology, possesses stable consumption capacity and the willingness to explore in-depth cultural content, providing a high-quality audience base for museums to deepen digital applications and promote the integration of culture and tourism.

However, in the context of the integration of culture and tourism, tourists' growing demands for in-depth experiences and personalized interactions still need to be further empowered and upgraded by digital technology in terms of immersive experiences, extended content, innovative interactions, and the deep integration of online and offline services, so as to build a more powerful, smarter, and more sticky online cultural inheritance and dissemination ecosystem.

5.1.2 The service platform has shortcomings in terms of user experience

Although the basic functions have been affirmed, the digital service platform has become a relatively concentrated area of negative perception among tourists. Data analysis shows that although core items such as the online exhibition hall content have received over 50% positive reviews, the proportion of visitors with average experiences is significant in all items, and dissatisfied reviews also account for a considerable proportion. This indicates that the current service platform has met the basic functional requirements such as reservation, navigation, and information inquiry, but there are obvious deficiencies in the depth, personalization, and smoothness of the experience. The problem may be specifically manifested in the fact that the presentation of core cultural connotations such as canal water conservancy and the history of canal transportation in the online exhibition hall still appears flat and simplistic, lacking narrative depth. The content of the self-guided tour may not be vivid enough and fails to form in-depth interactive interpretation with the cultural relics and scenes. The service process may have response delays, lag, or insufficient consideration of adaptability for special groups and tourists of different age groups. This "usable but not user-friendly" experience has led to the service platform failing to fully leverage its potential as an extension of online cultural experiences and a hub for smart services. Online and offline services have yet to form an integrated experience loop that is highly coordinated and seamlessly connected.

5.1.3 The feature of "one-time visit" is prominent

The data distribution of the number of visits clearly indicates that the vast majority of the interviewed tourists exhibit a significant single-visit behavior towards the museum. The high single-visit rate of up to 80% indicates that the canal culture has achieved certain results in attracting first-time visitors, but it faces challenges in stimulating tourists' willingness to revisit and building sustainable cultural interaction relationships. To a certain extent, a single visit by tourists restricts the deepening process of their understanding, recognition and dissemination of the culture of the Zhejiang East Canal from sightseeing perception. This current situation reveals a key issue: the low repeat visit rate, the limited sustainability and depth of cultural dissemination, and the inability of the currently operating digital experiences to effectively transform into a lasting driving force for tourists to revisit or develop an exploratory desire. This reflects two issues. On the one hand, the experience content is static, lacking a dynamic update mechanism based on storylines, character interactions, or user data feedback. On the other hand, the social and dissemination attributes of digital experiences have not been fully activated, lacking memorable or dissemination points for sharing on social platforms and triggering online community discussions. It has weakened the secondary dissemination ability of digital experiences to continuously ferment, form word-of-mouth and attract new visitors after the visit.

5.2 Suggestion on optimization

5.2.1 Construction of an integrated digital ecosystem

This approach can address the issues of fragmented and modular coordination in the digital construction of the Zhejiang East Canal Museum. However, when implementing this approach, it is necessary to adopt a systematic approach to coordinate resources, technologies, services, content and experiences, promoting the digital construction to move from single-point breakthroughs to overall coordination, and building an integrated digital ecosystem featuring interconnection, data sharing, business collaboration and continuous experience.

First of all, it is necessary to "break down barriers", remove the barriers of the three major modules, and build a closed-loop experience throughout the entire process. Integrate the three major systems of digital service platform, digital cultural tourism content and digital immersive experience, achieve data intercommunication and unified interface, and connect the links of online reservation, intelligent navigation, interactive entertainment and education, immersive experience and departure review into a complete chain, forming an integrated service system of "online traffic diversion - in-museum experience - post-class extension - dissemination and sharing". Enhance the smoothness of the full-cycle experience for tourists.

Furthermore, to achieve a closed loop of "online-offline", internal cooperation is necessary, cross-departmental coordination mechanisms should be strengthened, and the rights and responsibilities for construction and operation should be rationalized. Establish a cross-departmental collaboration mechanism for digital construction, coordinate multiple forces, clarify responsibilities and divisions of labor, break down departmental barriers and information silos, form a unified working pattern, and ensure the efficient operation of the digital ecosystem. There should also be external cooperation, deepen the interaction of internal and external resources, and broaden the support system for ecological construction. Strengthen long-term cooperation with multiple parties, integrate various resources, and build a co-construction and sharing model to provide content, technology and innovative vitality guarantees for the continuous optimization of the digital ecosystem.

Finally, it is about "sustainability", improving the long-term guarantee mechanism and consolidating the foundation for ecological sustainability. Incorporate the construction of an integrated digital ecosystem into the medium and long-term development plan of the museum, establish a long-term support system that integrates financial guarantee, dedicated personnel, assessment and incentives, and safe operation and maintenance, clearly define the investment of funds, team configuration, operation and maintenance standards, and update frequency, and ensure the stable operation, continuous iteration, and long-term empowerment of the digital ecosystem.

5.2.2 Upgrade of the digital service platform

The current platform needs to be upgraded from a tool that only provides basic services to a personalized experience portal that deeply integrates canal culture and has a smart core. First, deepen the cultural narrative of online content. Expand the content and reconstruct the narrative of the existing online exhibition hall. Not only should high-definition pictures of cultural relics be displayed, but also technologies such as 3D modeling, panoramic roaming, and dynamic infographics should be applied to systematically build digital narrative chains for topics such as "Smart Canal Engineering" and "Urban Life along the Banks". For instance, developing an interactive module called "Ancient Ship Decryption" enables users to virtually disassemble the ship's structure and understand its technological principles, or constructing a "Canal Rings" timeline to dynamically present the rise and fall of towns along the coast and their connections with historical events.

The next step is to promote the evolution of tour guide services towards intelligence and personalization, and upgrade the existing electronic tour guides. After the tourists' voluntary completion, interest tags and sections are marked through pre-trip questionnaires. During the visit, explanations, AR overlay information (such as restoring the busy AR scene on the ancient pier) or interactive tasks that match their levels are automatically pushed. Provide differentiated tour guide voice and content depth for different groups, multi-language support, and complete accessible audio-visual versions.

The final upgrade of the digital service platform aims to enhance its interactive and pre-experience functions, integrate tools for planning visiting routes into the reservation system, and customize personalized routes based on tourists' needs. Develop user-generated content (UGC) modules such as "Cloud Curation" or "My Canal Story", allowing visitors to combine their favorite exhibits or add written insights online to generate their own exclusive digital travelogues. This will integrate the service chain throughout the journey and enhance emotional connections.

5.2.3 Optimization of digital immersive experience

The core of the approach lies in breaking down silos and enhancing narrative depth and interactive significance. Connect the existing independent exhibits such as the ship's cruise and the circular screen theater with a clear narrative thread (such as "A Grain of Rice's Canal transportation journey from the Field"), making each digital experience a chapter in the entire story. In the "Yue Ge Bai Qu" circular screen theater, gestures or body-sensing interactions can be added, allowing visitors to choose plot branches through actions and influence the fates of the characters in the black-awning boat play, transforming from "viewers" to "participants".

Then, next to the "Spiritual Field" holographic device, a multi-touch table that interacts with it is added. Visitors can "dig" out archaeological discoveries and document fragments related to "Lei si" and the "Gou jian" sword on the table. By piecing together and interpreting these digital clues, they can add interactive content, unlock deeper cultural interpretation videos or expert interviews, and transform one-way viewing into active knowledge exploration. By using augmented reality (AR) technology, in front of specific physical cultural relics or scenes, the dynamic restoration process of historical

figures "appearing" to tell or demonstrate the production techniques of the objects is triggered through device scanning, achieving the narrative integration of virtual and real Spaces.

Then introduce a moderate gamification and co-creation mechanism, and design exploration tasks based on the entire museum. For instance, the "Search for the Canal Code" activity requires visitors to collect clue fragments by observing physical exhibits and completing interactive challenges on different digital exhibits. Eventually, they can synthesize a complete canal cultural symbol at the terminal and receive digital certification or souvenirs. This design encourages visitors to systematically explore the space and content, and naturally absorb knowledge in the process, enhancing the stickiness and interest of the experience.

5.3 Deficiency and Prospect

Although this study conducted a preliminary analysis of the digital experience at the Zhejiang East Canal Museum based on field research, there are still certain limitations, which also point out the direction for future research. First, the research samples were mainly concentrated on visitors to the museum, failing to fully cover potential visitors from other places, study groups and industry experts. The limitations of the sample structure may affect the universality of the research conclusions. The research methods are mainly descriptive statistics, focusing on the current situation description. They have not yet deeply applied more complex econometric models to reveal the intrinsic influence paths and mechanisms among variables such as digital services, immersive experiences, and tourists' cultural identity. Finally, the study was a single-case exploration and lacked horizontal comparisons with similar museums along the canal, which led to the conclusion being insufficient in reflecting the commonalities and characteristics of the digital development of linear cultural heritage. In addition, the discussions on countermeasures mostly focus on the aspect of experience optimization, and have limited contact with specific practical issues such as investment, operation and maintenance, and long-term management mechanisms of digital projects.

Under the background of the integration of culture and tourism and the construction of Digital China, digital technology has become the key to resolving the contradiction between the protection and utilization of cultural heritage and empowering its dynamic inheritance. Although there is a considerable accumulation of existing research both at home and abroad, the closed-loop empirical research on canal museums in China is still insufficient. As a carrier of the Zhejiang East Canal culture, the Zhejiang East Canal Museum still has significant room for improvement in terms of platform functions, content depth and interactive experience in its existing digital practices. The conclusion of this study can provide a reference for similar institutions. Subsequent research can continuously explore effective paths and mechanisms for digital technology to empower the dynamic inheritance of cultural heritage by expanding the sample scope, applying more rigorous empirical models, and conducting multi-case comparisons, contributing more systematic theoretical and practical solutions for high-quality development. In the future, the Zhejiang East Canal Museum should focus on deepening the construction of its digital service platform and promoting its transformation into a smart and personalized cultural portal. Optimize immersive experiences, go beyond technical presentation, and build a deeply interactive narrative field. And ultimately build an integrated digital ecosystem that combines online and offline to promote continuous cultural participation.

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