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A Study on the Association between Interface Usability and Visit Intention of the Digital Museum of the Forbidden City: Design Analysis Based on Heuristic Evaluation

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Abstract: This study, based on the Technology Acceptance Model (TAM) as the explanatory framework, focuses on how the interface usability of the Digital Palace Mini Program (mobile version) affects the intention to access through the user experience mechanism. A purely qualitative design analysis was conducted using heuristic evaluation and task walkthroughs. The study selected five key pages (such as navigation, routes, etc.) and six typical task paths to construct an evidence chain, systematically identifying and summarizing the types of interface issues. The research reveals that usability issues mainly fall into five categories: information architecture and labels, visibility of navigation and paths, search and discoverability, feedback and error tolerance, readability, consistency, and accessibility. These problems tend to be magnified in continuous task chains by increasing cognitive load and uncertainty, weakening control and trust, thereby reducing perceived ease of use (PEOU), and further affecting content acquisition efficiency and perceived usefulness (PU), thus suppressing the tendency for continuous visits and returns. Based on evidence-based discovery, this paper proposes executable optimization suggestions for the interface of digital museums, providing design references for enhancing the accessibility and continuous usage of digital cultural heritage platforms for the public.

Keywords: Digital Palace; Interface Usability; Heuristic Evaluation; Task Walkthrough; Technology Acceptance Model (TAM); Intention to Access

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1.Introduction

1.1 Background and Research Motivation

Digital museums are becoming an important gateway for the public to access cultural heritage. Their value extends beyond the mere digitization of collections; it lies in transforming knowledge, exploration paths, and cultural experiences into understandable and sustainable daily usage scenarios through interfaces and interactions [1][2]. Digital cultural platforms such as the Digital Museum of the Forbidden City typically feature high information density, diverse content types, and frequent cross-level navigation. Users' browsing, searching, understanding, and immersion often require the interface to provide clear structure, stable paths, and timely feedback. For most non-professional users, whether they will continue to engage is

determined not by the content value itself, but is rapidly shaped by the interface experience at several key nodes: being unable to find an entry point, not understanding the classification, receiving unclear feedback, and encountering inefficient search can all cause the exploration to be interrupted at an early stage.

In this context, the issue of usability is not merely an operational flaw; it can alter users' overall judgment of whether the platform is user friendly and worth their investment, and further influence the tendency for continued access and return visits. The Technology Acceptance Model (TAM) provides a straightforward explanation: perceived ease of use and perceived usefulness influence users' behavioral intentions [3]. Therefore, to understand the issue of continuous visits to the Digital Palace, merely focusing on macro level dissemination or technical presentation is insufficient. Instead, it is necessary to return to the interface level and present a traceable evidence chain that proceeds from specific problems to experience consequences, and then to intention tendencies [1][2].

Based on this, this study takes the interface of the Digital Museum of the Forbidden City as a case, conducts a systematic usability diagnosis based on actual task processes and, within the explanatory framework of TAM, provides a qualitative interpretation of how usability affects the intention to access, thereby offering a more operational design basis for the interface optimization of digital cultural heritage platforms. Therefore, the motivation of this study is as follows: taking the interface of the Digital Museum of the Forbidden City as a case, from a design perspective, a systematic usability inspection method is adopted to identify key issues. Under the explanatory framework of TAM, the correlations among usability, experience mechanism, and access intention are qualitatively explained, thereby providing an executable design basis for the interface optimization of digital cultural heritage platforms.

1.2 Research Objectives Questions and Contributions

This study aims to identify the key usability issues of the Digital Museum of the Forbidden City interface, explain the mechanism by which these issues affect users' intention to visit, and propose actionable suggestions for interface optimization. The research questions are as follows:

RQ1: What are the key usability issues present in the interface of the Digital Museum of the Forbidden City?

RQ2: How do these usability issues affect users' intention to visit (qualitative mechanism)?

RQ3: Based on the assessment results, what actionable interface optimization suggestions can be proposed?

In terms of methodology, this paper employs heuristic evaluation and task walkthrough to construct the evidence chain: heuristic evaluation is used to systematically identify interface and interaction issues [4][5] , while task walkthrough is used to identify key difficulty points and interruption points along typical task paths and to analyze how they lead to experience consequences such as uncertainty, frustration, or reduced trust [6]. At the theoretical level, this paper uses the Technology Acceptance Model (TAM) as the explanatory framework to conduct a qualitative interpretation of the relationships among interface issues, perceived ease of use, perceived usefulness, and intention to access [3][7].

The contribution of this paper lies in its use of a traceable interface evidence chain to reveal the structured types of interface usability problems in digital museums. Within the TAM framework, it further explains how usability problems affect the intention to access through experience consequences and, based on this, refines executable interface optimization suggestions for digital cultural heritage platforms.

2.Literature Review and Conceptual Framework

2.1 Digital Museums Interface Research: Focus and Trends

In response to the research concerns raised in the introduction regarding how the usability of digital museum interfaces affects users' intention to continue visiting and returning, this section outlines the common discussion dimensions and analytical perspectives of related research to provide context for this study and to explain the rationale for the subsequent conceptual framework and method selection. Regarding research on the interfaces of digital museums and digital heritage platforms, discussions have long moved beyond merely digitizing and publishing collections. Instead, they increasingly focus on how users achieve understanding, exploration, and sustained participation through the screen medium. Existing studies generally point out that digital museum interfaces face typical challenges such as high content density, diverse content types, and complex navigation paths: users may engage in browsing-style exploration with low goal specificity or perform searches and

learning with clear objectives. Therefore, interface design needs to balance information organization, interaction guidance, and experience presentation [1][8].

At the level of information organization, information architecture and label design have been repeatedly identified as key factors influencing users' comprehension and content orientation. For platforms that operate multiple modules in parallel, such as exhibitions, collections, knowledge interpretation, and educational tours, whether the classification logic aligns with users' mental models, whether terminology is used consistently, and whether the hierarchy is appropriate directly affect users' ability to locate and understand content. Closely related to information organization is research on interaction guidance, which examines whether the navigation structure is stable, whether the current location and return path are clear, whether key entry points are sufficiently visible, and whether system feedback supports users in advancing through task sequences (e.g., searching, filtering, accessing details, and extended reading). When guidance mechanisms are inadequate, users are more likely to experience disorientation and uncertainty, which can lead to premature discontinuation of exploration [9].

Meanwhile, immersive experiences and narrative presentations (such as 3D displays, AR/VR, and interactive narratives) have become an important development direction for digital museums in recent years. Most related studies suggest that these presentation methods can enhance the sense of presence and emotional engagement, thereby increasing cultural participation and learning motivation. However, some research also points out that immersive technologies may introduce learning costs, operational complexity, and equipment barriers. If there is a lack of sufficient guidance, feedback, and recovery mechanisms, the immersive experience may instead turn into frustration, weakening the tendency to continue using it [10].

In addition to usability, digital museums also need to establish credibility through their interfaces. Due to their functions of disseminating knowledge and providing authoritative explanations, the credibility cues in the interface, such as source and date annotations, curator explanations, image processing instructions, and copyright information, will influence users' judgment of the platform's reliability and further affect their tendencies toward continuous access, sharing, and recommendation. On the other hand, digital cultural services for a broader public are increasingly emphasizing accessibility and support for accessibility, including readability (font size, contrast), multimedia alternative information (subtitles or alternative text), touch-friendly design, and compatibility with low-end devices, etc. These factors jointly determine the coverage and accessibility of the platform in real-usage scenarios [11][12].

Although previous studies have provided a wealth of topics and experiential summaries for the interface design of digital museums, there remains a lack of systematic qualitative interpretation based on an interface evidence chain that explains how micro-level interface issues trigger changes in cognitive load, frustration, sense of control, and trust, and further shape visit intention [13]. Therefore, this paper starts from the interface layer, combines heuristic evaluation and task walkthrough to conduct structured diagnosis of key pages and task processes, and explains the mechanistic relationship between usability and access intention within the TAM framework, thereby proposing executable optimization suggestions for digital cultural heritage platforms [3][4][6][7].

2.2 Usability and Heuristic Evaluation in Design Research

In the context of digital museums, usability is not merely about whether the interface is smooth and easy to operate; rather, it concerns whether users can meaningfully engage with the cultural content. The classic discussion of usability typically centers on effectiveness, efficiency, and satisfaction: effectiveness refers to whether users can achieve key goals (e.g., finding an exhibition entrance, retrieving a target artifact and accessing its details, or obtaining interpretations and supplementary information); efficiency is reflected in the steps, time, and cognitive effort required to achieve the same goal; and satisfaction is often associated with the sense of smoothness, control, and trust experienced during exploration, which in turn influences whether users are willing to continue browsing and revisit [8][14].

Among the various usability research methods, heuristic evaluation is a typical inspection method: researchers systematically review the interface against a set of general usability principles, thereby covering multiple pages and modules at lower cost, quickly identifying structural issues, and generating a traceable list of problems [4][5]. The strength of this approach lies in its efficiency and structured process, making it particularly suitable for research scenarios in which resources are limited but clear design-diagnosis outcomes are needed. However, its limitations are also evident: the evaluation inevitably reflects the

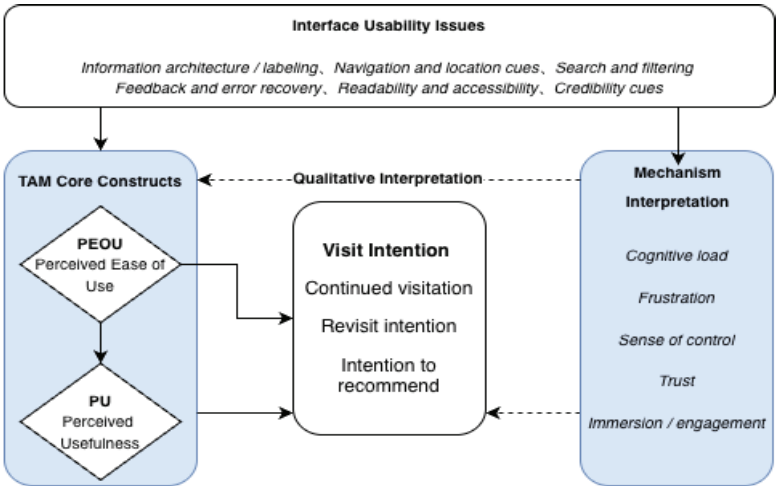
evaluator's perspective, and it cannot directly capture the behavioral choices and interruption reasons of real users in actual task contexts [5]. Therefore, alongside heuristic evaluation, this paper incorporates task walkthroughs. Using typical tasks as guides, it traces difficulty points and interruption points along critical paths, thereby strengthening the contextual grounding and evidential support of problem descriptions [6].

2.3 Conceptual Lens: From Usability to Visit Intention

It should be noted that the correlation discussed in this article is not a statistical correlation or regression test. Instead, it constitutes a qualitative mechanistic interpretation based on interface evidence and usability criteria, explaining why these interface issues affect the willingness to continue access. The explanatory pathway begins with interface issues, proceeds through experiential consequences, and further examines their impact on the intention to access [15][16].

In terms of the explanatory framework, this paper introduces the Technology Acceptance Model (TAM) as a conceptual guideline. User acceptance of a system is typically related to perceived ease of use (PEOU) and perceived usefulness (PU), which further influence behavioral intention [3][7]. In the context of digital museums, usability issues such as information architecture, navigation paths, search and filtering, system feedback, and readability first alter users' judgments of whether the operation is effortless and easy to understand, thereby influencing PEOU. Simultaneously, these issues further change users' judgments of whether the platform is useful and worth investing time in, thereby influencing PU. These judgments are typically perceived and articulated through more specific experiential dimensions, such as fatigue and abandonment due to increased cognitive load, frustration stemming from disorientation and uncertainty, a diminished sense of control owing to insufficient feedback, weakened trust caused by inadequate credibility cues, and immersion and engagement fostered by clear narrative guidance. The resulting experiential consequences further shape users' tendencies toward continued visits, return visits, and recommendations [13]. Based on this logical relationship, this paper constructs the qualitative conceptual framework shown in Figure 1 to organize the subsequent findings and discussion.

Figure1: TAM-informed conceptual framework with qualitative mechanism interpretation



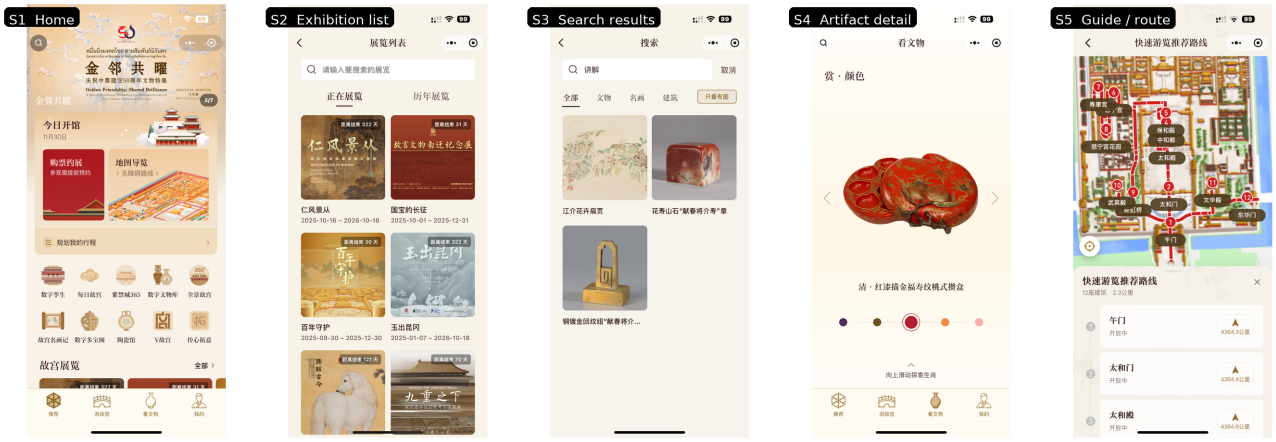
3.Methodology

3.1 Research Design and Scope

This study employed qualitative interface analysis, focusing on the mobile interface of the Digital Palace Museum. To cover users' most common access paths, as shown in Figure 2, which presents the page-type coding scheme with representative screenshots were selected as the analysis scope: the home page (S1), the exhibition list page (S2), the search results page (S3), the artifact detail page (S4), and the integrated tour and route page (S5). All pages were archived as screenshots under a unified evidence coding rule: S1–S5 denote the page type, and the two-digit sequence after the hyphen indicates the screenshot number for that page (for example, S3-02 represents the second evidence screenshot of the search results page). The screenshot collection date was 2025-11-30. During the analysis and recording process, each finding was linked to an evidence screenshot number (S-code), a task step number (T-code), and a page-location description, ensuring that subsequent findings, mechanism discussions, and design suggestions could be traced back to specific interface evidence. Specifically, the

S-code follows the format S page type hyphen screenshot number (for example, S3-02), and the T-code follows the format T task number hyphen step number (for example, T3-2).

Figure2: Page type coding scheme with representative screenshots (S1–S5)



3.2 Task Walkthrough（Cognitive Walkthrough）

To establish a traceable evidence chain, this paper combines two inspection methods, heuristic evaluation and task walkthrough, for interface diagnosis. Heuristic evaluation is employed to systematically identify problem types and their violation patterns across multiple pages. Task walkthrough, in turn, examines how these problems cause comprehension deviations, operational bottlenecks, and potential interruptions along typical task paths, thereby supplementing the contextual factors that a purely heuristic evaluation might overlook [4][5][6].

In the heuristic evaluation, each of the five key page types was examined individually against Nielsen's ten usability principles. For each identified issue, we documented a description of the problem and its triggering conditions, the corresponding heuristic principle, the page location and screenshot number (S-code, e.g., S3-02), and preliminary improvement suggestions. Subsequently, duplicate entries were removed and similar problems were consolidated to generate a structured list of usability issues. To reflect the potential impact of each issue on task completion, a severity rating scale from 0 to 4 was applied, defined as follows: 0 indicates no problem; 1 indicates a cosmetic or minor issue; 2 indicates a secondary usability problem, which impairs fluency but allows continuation; 3 indicates a major problem, one that significantly increases effort or is likely to induce errors; 4 indicates a critical problem that may lead to task failure or user abandonment.

In terms of task walkthrough (also referred to as cognitive walkthrough), this study establishes six typical tasks (T1–T6), gradually checking whether users can find the entry, understand the meaning, receive clear feedback after an operation, and recover and continue in abnormal situations. For each task step, it records the specific page and control position, system feedback performance, as well as possible breakpoints or decision points (such as an unclear return path, unexplainable filtering results, or a lack of next-step guidance in an empty state, etc.), and links the evidence to a numbered screenshot (S-code). The task step number is represented by a T-code, following the format T-task number-step number (for example, T3-2 represents the second operational step of task T3).

The task settings are as follows:

T1: From the homepage, enter any content module and return smoothly.

T2: Enter the exhibition list and open a specific exhibition entry.

T3: Use the search function to retrieve keywords and access the target entry from the results.

T4: On the artifact details page, obtain key information and interpretive content, and either continue exploring or return.

T5: Enter the tour route page, complete the process of entering, viewing nodes, and finally select the option to continue exploring or return.

T6: Simulate a scenario with no results, a return, or a switch; observe the blank state, error prompts, and the subsequent guidance.

The output of this study includes a list of issues (with severity grading), key breakpoints from the task review, screenshot numbers (S-code) and task step numbers (T-code), as well as preliminary optimization suggestions that can be implemented. The evaluation process is illustrated in Figure 3, and the evidence log table template is shown in Table 1.

Figure3: Evaluation process illustration

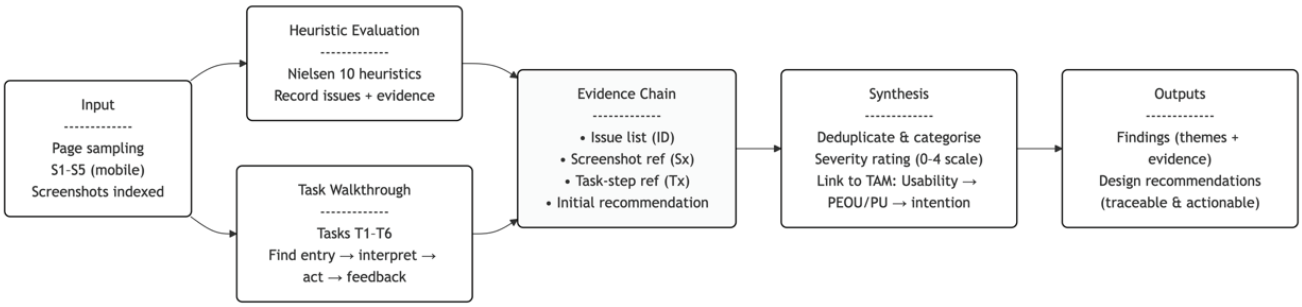


Table1:Extract of evidence log (template)

Issue ID	Page / Position (Sx)	Task step (T1–T6)	Heuristic (Nielsen)	Severity (0–4)	Problem description	Recommendation
H01	S3 / filter bar	T3-2	Match	2	Filter label unclear; scope may be misread	Rename label; show applied-filters summary
H02	S2 / list cards	T2-2	Consistency	1	Date format inconsistent across cards	Unify date format; align with locale
H03	S5 / route list	T5-3	Status visibility	3	Weak progress cue between nodes	Add progress indicator & current-node highlight

Note: Task steps are referenced using T-code (e.g., T3-2 indicates Step 2 of Task 3).

3.3 Qualitative Analysis and Trustworthiness

This study conducts a thematic analysis of the assessment records and evidence screenshots (S-code) in two steps. First, duplicate entries are removed and problem items recorded in both heuristic evaluations and task walkthroughs are merged. These are then classified into problem themes based on their primary manifestations and triggering scenarios: information architecture and labels, navigation and paths, search and discoverability, feedback and error tolerance, readability, consistency, and accessibility, as well as credibility cues. Second, potential experiential mechanism themes triggered by these problem types are refined (e.g., increased cognitive load, heightened frustration, diminished sense of control, shifts in trust, and variations in immersion/engagement). These mechanisms are then correlated with the explanatory pathways of the Technology Acceptance Model (TAM) to elucidate how usability issues affect perceived ease of use (PEOU), perceived usefulness (PU), and access intention [3][7].

To enhance the research credibility and conclusion traceability, all evidence materials including screenshot codes, issue records, and task-step documentation are retained as an audit trail and subjected to a secondary review. Furthermore, by cross-referencing heuristic evaluation items with key breakpoints identified in the task walkthrough, consistency is verified across two analytical dimensions: violations of usability principles and their observed impact on actual task performance. This triangulation reduces potential bias arising from a single methodological perspective [17]. Where feasible, inviting peers to conduct random checks and reviews of selected pages and entries is recommended to further strengthen the consistency and reliability of the interpretations.

4.Findings and Discussion

4.1 Usability Issues Overview: Scope and Typology

This study focused on five key pages of the Digital Palace Museum mobile app (S1 homepage, S2 exhibition list, S3 search results, S4 artifact details, and S5 navigation and route integration page), combining them with six typical tasks (T1 to

T6) to form an evidence chain for a structured summary of interface usability issues. Based on the heuristic evaluation and task walkthrough records, usability problems were primarily aggregated into six themes: information architecture and labels, navigation and path visibility, search and discoverability, feedback and error tolerance, readability, consistency, and accessibility, as well as credibility cues. From a distribution perspective, different types of problems manifest differently across pages and task sections: problems related to navigation and paths are more likely to be triggered during cross-page navigation, return hierarchy changes, and state switching; search and discoverability problems are concentrated in the stages of inputting search terms, switching categories, and interpreting results; and feedback and error tolerance-related problems often impact users' ability to continue the task in situations such as empty states or node switching.

To ensure the traceability of the analysis process, during the evaluation stage, each finding was recorded in a sequential and structured format that included the issue, evidence screenshot (S-code), task step number (T-code), corresponding heuristic principle, severity rating (0 to 4), problem description, and preliminary suggestions. Due to space constraints, only an overview summary—listing issue types, covered task steps, corresponding heuristic principles, severity levels, and key evidence screenshot numbers (S-code) is presented in Table 2 in the main text. In the subsequent analysis, evidence screenshot codes (S-code) or task step codes (T-code) are referenced to support the arguments and mechanism explanations.

Table2: Summary of usability issue typology and evidence

Category	Task step (T-code)	Heuristic (Nielsen)	Severity (0–4)	Evidence (S-code)	Key symptom (1 line)
Information architecture and labels	T4-1 T5-1	Match between system and the real world ; Consistency and standards	2	S4-02 S5-02	Labels/CTAs are ambiguous; users may hesitate or misinterpret where to go next.
Navigation and path visibility	T4-2 T5-2 T5-3	Visibility of system statu ; User control and freedom	3	S4-02 S5-02 S5-03	Hidden paths and map occlusion reduce wayfinding; users can feel lost or stuck.
Search and discoverability	T3-1 T3-2 T3-3	Match between system and the real world ; Recognition rather than recall	2	S3-02 S4-03 S3-03	Search scope and result cues are unclear; users struggle to scan and pick the right item.
Feedback and error recovery	T6-1 T3-3	Help users recognize, diagnose, and recover from errors ; Visibility of system status	3	S3-01 S3-03	Empty state and active filters provide weak next-step guidance; abandonment risk increases.
Readability consistency accessibility	T1-1 T4-2	Aesthetic and minimalist design ; Visibility of system status	2	S1-01 S4-03	Small and low-contrast text and dense overlays increase reading effort, especially on mobile.

Note. Evidence codes (S-code, e.g., S3-01) refer to the author's screenshot archive. Task steps are referenced using T-code (e.g., T3-2 indicates Step 2 of Task 3). Screenshot archive (device, app version and capture date) is available from the authors upon request.

4.2 Key Usability Findings: Evidence Based Analysis

Based on heuristic evaluation and task walkthrough, this study categorizes key issues into four dimensions for evidence-based summarization: the observed phenomenon, supporting evidence (S-code), the violated heuristic principle(s), and the resulting experience impact. Overall, usability barriers tend to be magnified in consecutive task chains, for instance, when retrieving details and then returning, or when entering a navigation flow and selecting a node to continue browsing. Specifically, when entry semantics, system status prompts, and the return hierarchy lack clarity, users often resort to trial and error to understand the system. This increases cognitive load and uncertainty, which may reduce perceived ease of use (PEOU) and, through diminished information acquisition efficiency and exploration coherence, further lower perceived usefulness (PU) and the intention to continue visiting.

First, on detail and navigation-related pages, entry or prompt labels are often difficult for users to interpret in terms of expected outcomes (e.g., S4-02, S5-02). Users struggle to predict whether a click will trigger a jump, an expansion, or a content overlay, leading to hesitation and repeated attempts. These issues primarily relate to the heuristics of Match between system and the real world and Consistency and standards. Their experiential consequences include reduced operational efficiency and a weakened sense of control. To improve, clear action-oriented labels, for example using View details, Expand

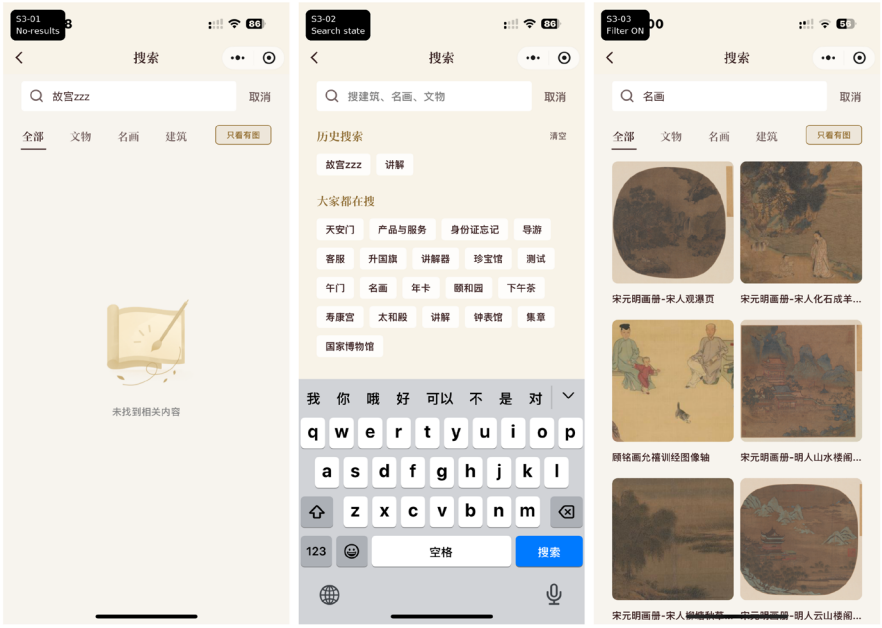
description, or Open pop-up, should be adopted, and brief outcome previews could be provided for key operations.

Second, during search and filtering, scope or conditions are often implicit, and result explanations lack sufficient cues (S3-02, S3-03). When filters are applied without clear indication of active settings or explanations of their effects, users may misinterpret results or overlook items excluded by the filter. This aligns with the heuristics of Visibility of system status and Recognition rather than recall and can reduce scanning and selection efficiency while increasing backtracking. We recommend persistently displaying a filter summary, for example listing scope, keywords, and active filters, in the results area along with a one-click clear option, allowing users to comprehend how the current results were generated without relying on memory.

Third, the state indicating no results tends to signal failure without offering a clear recovery path (S3-01). The page fails to provide actionable next steps, such as clearing the query, modifying keywords, switching search scopes, or suggesting alternative entry points, which readily creates a point of task interruption. This issue aligns with the heuristic Help users recognize, diagnose, and recover from errors and may heighten frustration while diminishing the motivation to continue exploration. It is recommended to position recovery actions as primary button options (e.g., Clear keywords, Switch range or category) and to offer a limited set of operable alternatives (e.g., suggested keywords or popular entry points).

Finally, when map points are densely clustered, labels overlap, and feedback during node transitions is subtle (S5-02, S5-03), the navigation route page elevates the effort required for orientation and route comprehension, thereby impeding continuous progression through the navigation task. This issue relates to the heuristics Visibility of system status and Aesthetic and minimalist design. Mitigation strategies include implementing label aggregation or hierarchical display, emphasizing the current node with highlighting and progress indicators, and providing collapsible panels. These measures collectively aim to lower cognitive load and improve user controllability.

Figure4: Interface Evidence of the Search and Filter Function: Empty State、Input Suggestions and Results Page



4.3 Mechanism Interpretation under TAM

Within the TAM framework, this study conceptualizes the relationship among interface usability issues, experiential consequences, and access intention as a mechanistic correlation. Interface barriers first influence users' judgments of whether the system is effortless and understandable, that is, perceived ease of use (PEOU). When users must repeatedly attempt and fail, frequently backtrack, or struggle to advance steadily through a task sequence, their judgments of whether the platform is worth investing time in and whether it can effectively deliver cultural information, perceived usefulness (PU), are also undermined, thereby reducing intentions for continued access, revisits, and recommendations. Synthesizing the evidence chain presented in Section 4.2, the following mechanisms are observed: unclear entry semantics and ambiguous

return hierarchies primarily impair PEOU by diminishing the user's sense of control and elevating cognitive load; non-explicit search conditions and insufficient explanatory cues in results lower information acquisition efficiency and increase misinterpretation, further eroding PU; the lack of recovery paths in navigation flows more readily creates interruption points, intensifying frustration and sapping the motivation to continue exploring; label overlap and subtle node transition feedback raise the cognitive cost of path comprehension and diminish the potential for immersion and sustained progression. Overall, these mechanisms are not derived from statistically significant causal tests but represent qualitative explanations of user experience outcomes grounded in interface evidence and usability criteria. They serve to illustrate how usability shapes variations in access intention within the mobile digital museum context.

5.Design Implications and Recommendations

Based on the findings and mechanistic explanations above, this paper proposes optimization recommendations for the Digital Palace mobile interface, with the objectives of reducing trial and error costs, enhancing state visibility and path controllability, and thereby improving users' continuous progression during search, comprehension, and navigation.

First, concerning entry semantics and consistency issues, it is advisable to adopt predictable naming for key operations by combining verbs with expected outcomes and to standardize the wording and presentation of similar entry points to minimize on screen semantic overlap. For operations that alter page layout, brief outcome cues such as expand, jump to, or open pop up should be provided to help users establish stable operational expectations.

Second, to improve the discoverability of search and filtering functions, a persistent summary of applied conditions, for example scope, keywords, active filters, should be displayed within the results area, accompanied by a one click option to clear all filters. For restrictive filtering strategies such as only show images, the system should explicitly indicate their impact, for instance, noting the reduction in result count or the hiding of non image entries, to reduce misunderstanding and the need for backtracking.

Third, to address insufficient feedback and error tolerance, the empty result state should be redesigned from a passive failure notification into an active recovery pathway. Primary level recovery actions, such as clear keywords or switch range or category, should be presented as prominent buttons, supplemented by a limited set of actionable alternatives such as suggested keywords, popular entry points, or a link back to recommended content, thereby lowering the likelihood of task abandonment.

Finally, regarding path comprehension and visual clutter challenges in the navigation route, map congestion can be alleviated through tag aggregation or hierarchical labeling. The current node should be distinctly highlighted with a progress indicator, and collapsible side panels along with recovery functions, such as return to current node or center on current view, should be provided to strengthen controllability and browsing continuity.

Conclusion

This study takes the Digital Palace Museum mobile application as its research object. By integrating heuristic evaluation and task walkthrough, it performs evidence-based analysis of key pages and typical task chains, and identifies key issue types including inconsistent entry semantics, ambiguous search conditions and result explanations, missing recovery paths in empty states, and poor readability and feedback in navigation routes. Furthermore, from a TAM perspective, it systematically explains how usability issues influence perceived ease of use (PEOU), perceived usefulness (PU), and visit intention through experiential consequences such as increased cognitive load, reduced sense of control, and heightened frustration. The findings offer actionable optimization directions for improving the interfaces of digital cultural heritage platforms, highlighting the importance of foundational interaction qualities, specifically visible system states, controllable navigation paths, and recoverable error states, in mobile contexts for sustaining user engagement. Given the methodological and scope limitations, this paper presents qualitative interpretations grounded in interface evidence and usability criteria. Future research could incorporate actual user testing and longer-term usage scenarios to further validate and extend the findings regarding task performance and sustained usage behaviors across different user groups.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

[1] Parry, R. (2007). Recoding the museum: Digital heritage and the technologies of change. Routledge. https://doi.org/10.4324/9780203347485

[2] Marty, P. F. (2008). Museum websites and museum visitors: Digital museum resources and their use. Museum Management and Curatorship, 23(1), 81–99. https://doi.org/10.1080/09647770701865410

[3] Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–340. https://doi.org/10.2307/249008

[4] Nielsen, J., & Molich, R. (1990). Heuristic evaluation of user interfaces. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '90) (pp. 249–256). Association for Computing Machinery. https://doi.org/10.1145/97243.97281

[5] Nielsen, J. (1994). Heuristic evaluation. In J. Nielsen & R. L. Mack (Eds.), Usability inspection methods (pp. 25–62). John Wiley & Sons. https://doi.org/10.5555/189200.189209

[6] Wharton, C., Rieman, J., Lewis, C., & Polson, P. (1994). The cognitive walkthrough method: A practitioner's guide. In J. Nielsen & R. L. Mack (Eds.), Usability inspection methods (pp. 105–140). John Wiley & Sons. https://doi.org/10.5555/189200.189214

[7] Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science, 46(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

[8] Kabassi, K. (2017). Evaluating websites of museums: State of the art. Journal of Cultural Heritage, 24, 184–196. https://doi.org/10.1016/j.culher.2016.10.016

[9] Cunliffe, D., Kritou, E., & Tudhope, D. (2001). Usability evaluation for museum web sites. Museum Management and Curatorship, 19(3), 229–252. https://doi.org/10.1080/09647770100201903

[10] Sylaiou, S., Killintzis, V., Paliokas, I., Mania, K., & Patias, P. (2014). Usability evaluation of virtual museums' interfaces visualization technologies. In R. Shumaker & S. Lackey (Eds.), Virtual, augmented and mixed reality: Applications of virtual and augmented reality (pp. 124–133). Springer. https://doi.org/10.1007/978-3-319-07464-1_12

[11] Cordón Benito, D., & Maestro Espínola, L. (2017). Museums' corporate websites as tools for transparency. Revista Latina de Comunicación Social, 72, 941–956. https://doi.org/10.4185/RLCS-2017-1200-51en

[12] World Wide Web Consortium. (2023, October 5). WCAG 2.2 is a Web Standard "W3C Recommendation" . Web Accessibility Initiative. https://www.w3.org/WAI/news/2023-10-05/wcag22rec/

[13] Zheng, F., Wu, S., Liu, R., & Bai, Y. (2024). What influences user continuous intention of digital museum: Integrating task-technology fit (TTF) and unified theory of acceptance and usage of technology (UTAUT) models. Heritage Science, 12, Article 253. https://doi.org/10.1186/s40494-024-01365-4

[14] International Organization for Standardization. (2018). ISO 9241-11:2018 Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts. ISO. https://www.iso.org/standard/63500.html

[15] Maxwell, J. A. (2013). Qualitative research design: An interactive approach (3rd ed.). SAGE Publications.

[16] Hassenzahl, M. (2008). User experience (UX): Towards an experiential perspective on product quality. In Proceedings of the 20th Conference on l'Interaction Homme-Machine (pp. 11–15). ACM. https://doi.org/10.1145/1512714.1512717

[17] Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. International Journal of Qualitative Methods, 16(1), 1–13. https://doi.org/10.1177/1609406917733847