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# Designing a Digital Technology-Based Interactive Museum Prototype as an Effort to Enhance Education and Cultural Preservation in Indonesia

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***Abstract***

*Museums play an important role in the preservation of cultural heritage and public education. However, the changing behavior of the younger generation, who are more interested in digital media, is leading to a further decline in visits to conventional museums. This research aims to design a digital technology-based interactive museum prototype as an effort to enhance education and cultural preservation in Indonesia. The research method uses a Research and Development (R&D) approach with the stages of needs analysis, system design, prototype development, and user testing. The research instruments include the System Usability Scale (SUS) and semi-structured interviews with 30 respondents. The research results show that the interactive museum prototype has an average SUS score of 75.6, which falls into the very good category, and received positive feedback regarding increased visitor engagement in understanding cultural collections. This research contributes to the development of a digital museum model that meets the needs of Indonesian society.*

***Keywords***: *Interactive Museum; Digital Prototype; Cultural Education; HCI; User Experience.*

## 1. INTRODUCTION

As institutions for cultural preservation and educational centers, museums face challenges in attracting modern visitors, especially young people who are accustomed to digital and interactive media. Museums serve as institutions for preserving cultural heritage, public education centers, and media for shaping collective identity. However, in the last decade, visitor expectations for museum experiences have shifted significantly with the increasing penetration of digital technology and the consumption habits of interactive content. Visitors today are generally looking for more than just static collections; they want interaction, multimedia narratives, and multimodal experiences. The Museum 4.0 concept responds to this shift by integrating Human-Computer Interaction (HCI) principles, user experience (UX), and interactive technologies (e.g., augmented reality (AR), virtual reality (VR), mixed reality, motion sensors, location-based services, and data analytics) into the design of the visitor experience. This integration is not merely adding "gadgets" to the exhibition space; what is more essential is how technology is designed based on user needs (user-centered) to foster engagement, deepen understanding of artifacts, and expand access to cultural narratives that are often hidden.

In the Indonesian context, many museums have begun the process of digitizing their collections (scanning photos or 3D artifacts) and providing electronic information boards. There are several local studies that highlight the importance of implementing interactive technology in museums to make them more attractive. For example, a study on the use of interactive multimedia in museum exhibitions in the Journal of Fine Arts & Color states that integrating interactive media enriches the collection's narrative and helps visitors understand cultural content more deeply [1]. Another study illustrates how the application of interactive technology in museum interiors can enhance the visitor experience [2]. Another study also confirms that museums are often considered boring when their exhibition media are still conventional, so interactive elements such as touchscreens and digital media need to be introduced to make them more engaging [3]. On the AR technology side, there is also local research that developed an augmented reality application for museum collection recognition based on Android and tested its usability [4]. This shows that AR is already being used as a medium for cultural education, but evaluation is often limited to technical aspects, not a holistic user experience.

However, digitalization without mature interactivity design often results in a "rebrand" of the appearance, rather than a transformation of the experience. The main gaps lie in (1) the absence of a systematic user requirements elicitation process, (2) minimal design referencing appropriate HCI frameworks and learning theories, and (3) limited empirical evaluation of prototypes using standard metrics such as the System Usability Scale (SUS), task success rate, time-on-task, or engagement indices.

This research aims to bridge that gap by designing an interactive museum prototype that not only showcases technology (AR, interactive QR codes, audio guides) but also centers the needs of visitors as the design anchor. The R&D (Research & Development) approach was chosen to ensure a systematic workflow: needs analysis, design, development, evaluation. On the pedagogical side, this research adopts the principles of constructivism, where visitors build their

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knowledge thru active interaction—thus, design decisions (flow, affordance, multimodal feedback) are aimed at triggering exploration, curiosity, and critical dialog with the artifact's text-context.

The objectives of this research are to identify the needs and requirements of interactive museum users in Indonesia, design and develop an interactive museum prototype with digital map features, AR artifacts, interactive QR codes, and audio guides based on design principles, evaluate the prototype thru SUS questionnaires and user interviews, and develop specific design guidelines for museums in Indonesia.

**Literature Review**

Human-Computer Interaction (HCI) is a field of study that focuses on designing interactive systems to meet user needs, be easy to learn, and provide a positive experience. Norman explained the concept of user-centered design, where technology design must be centered on the user, not just on technical functions [5]. In the context of museums, the HCI approach becomes important because visitors have diverse backgrounds—age, education, and digital literacy—so the interaction design must be inclusive.

Local studies on interactive interfaces show that applying HCI principles can improve the effectiveness of digital learning media in Indonesian higher education settings [6]. This supports the relevance of using the HCI framework in the design of an interactive museum prototype.

Interactive museums are a development of the new museology concept, which views visitors as active participants. Technologies like augmented reality (AR), virtual reality (VR), and interactive kiosks serve as a bridge to create deeper engagement. Sylaiou et al.'s research shows that AR can enhance the sense of presence and enjoyment in a museum context [7].

Nationally, research at the Gubug Wayang Museum in Mojokerto found that integrating interactive elements into the museum's interior significantly impacts the visitor experience [8]. Other studies also emphasize that interactive exhibitions are capable of attracting the interest of young people who previously considered museums to be rigid and boring spaces [9]. This confirms that interactivity is a key element in transforming the image of museums in Indonesia.

Constructivism views learning as an active process where individuals construct knowledge thru experience and social interaction. According to Piaget, effective learning occurs when individuals interact directly with real objects and situations, while Vygotsky emphasizes the importance of social interaction and scaffolding in learning [10].

In the context of interactive museums, constructivism is reflected thru visitor experiences that not only involve reading artifact descriptions but also direct interaction via digital media. Local research on interactive multimedia for history learning in high schools indicates that a constructivist approach thru interactive media can improve student understanding [11]. Thus, this theory can be adapted as a philosophical basis in the design of interactive museums.

AR/VR technology is becoming a major trend in museum transformation. AR allows visitors to see 3D representations of artifacts that are damaged or cannot be displayed directly. VR can create immersive experiences, such as reconstructions of historical spaces. Research by Amali and Andriani in the Scientific Journal of Computer Science shows that an Android-based AR application is able to increase user interest in recognizing local artifacts [12]. Despite the potential, the challenges of using AR/VR in Indonesian museums are the limited availability of visitor devices and network infrastructure. Therefore, the interactive museum prototype must consider device compatibility and usability testing on mid-range devices.

## 2. RESEARCH METHODE

This research uses the Research and Development (R&D) method, modified from the Borg & Gall model [13]. This model was chosen because it is suitable for producing a system prototype and simultaneously testing its usability. The R&D approach allows for systematic stages from needs analysis, design, development, to prototype evaluation. In the context of educational technology in Indonesia, the R&D method is widely used to design interactive media and has proven effective in producing innovative products that can be empirically tested. [14].

### 2.1 Tahapan Penelitian

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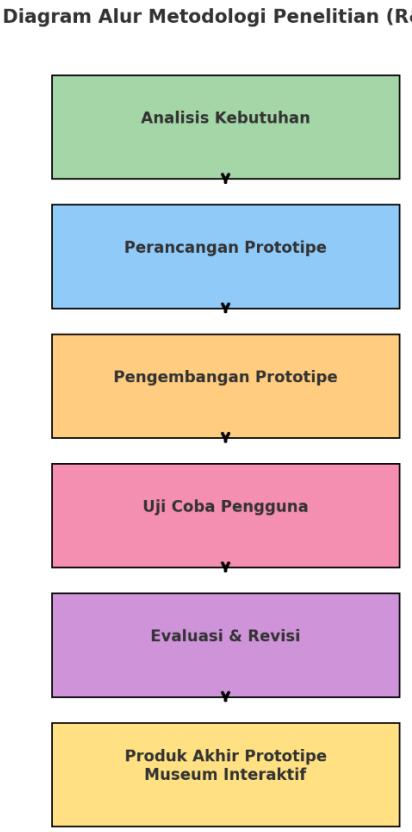


**Figure 1.** The Research Stages

The research stages can be explained as follows:

1. Needs Analysis • Direct observation of the exhibition space conditions.
   • Interviews with visitors and museum staff.
   • Study of digitalized collection documents that have already been completed.
   • The analysis results in a list of user requirements (space navigation, collection information, interactive needs).
2. Prototype Design
   • Designing the interface using Figma.
   • Structuring the system with key features: digital map, AR artifacts, interactive QR codes, and audio guide.
   • Conducting low-fidelity prototyping (wireframes) followed by high-fidelity prototyping using Unity 3D.
3. Prototype Development
   • Implementing the Android-based prototype.
   • Integrating 3D content of artifacts selected based on curatorial results.
   • Conducting internal technical testing before user evaluation.
4. User Testing
   • Respondents were asked to use the prototype for 20–30 minutes.
   • Afterward, respondents completed a SUS questionnaire and participated in a semi-structured interview.
5. Evaluation and Revision
   • Quantitative data from the SUS was analyzed to determine usability categories.
   • Qualitative data from interviews was thematically analyzed to identify the strengths and weaknesses of the prototype.

### 2.2 Development System Methode

In creating this website, the author applied the prototype-based system development method. This approach serves as a bridge between developers and users to reduce the gap in technical understanding, while also helping to clarify the requirements expected by users. [15].

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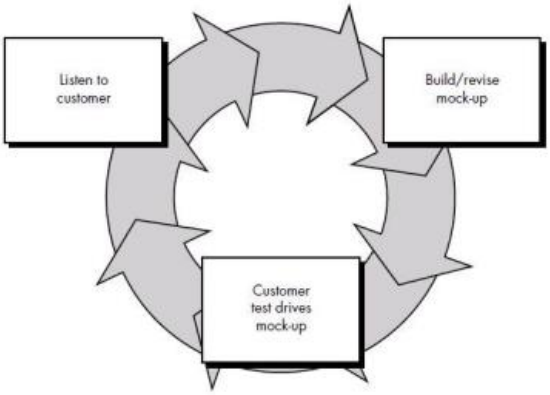


**Fugure 2.** *Prototype*

**a.** ***Listen To Customer***
This includes carefully listening to the needs, desires, and problems experienced by users, specifically the management of the Information Systems Study Program Student Association at Sultan Thaha Saifuddin Jambi State Islamic University, regarding the design or features currently being developed. At this stage, the researcher needs to interact with users thru interviews or Q&A sessions to gain a deep understanding of their expectations directly.

**b.** ***Build/revise Mock-up***
After carefully listening to the needs and expectations of users, the next step is the Build and Revise Mock-up stage. In this stage, researchers create an initial prototype based on the information obtained from users and make continuous revisions to improve the functionality, interface, and features of the website. This process helps ensure that the prototype accurately reflects the needs and expectations desired by users. [16].

**c.** ***Customer Drivers Mock-up***
After carefully listening to the needs and expectations of users, the next step is the Build and Revise Mock-up stage. In this stage, researchers create an initial prototype based on the information obtained from users and make continuous revisions to improve the functionality, interface, and features of the website. This process helps ensure that the prototype accurately reflects the needs and expectations desired by users.

## 3. RESULT AND DISCUSSION

### 3.1 Skor System Usability Scale (SUS) Score Interactive Prototype Museum

Usability testing was conducted using the System Usability Scale (SUS), which consists of 10 questions with a 1–5 Likert scale. Respondents were asked to rate various aspects of the interactive museum prototype's usability. The System Usability Scale (SUS) is a measurement tool consisting of 10 questions with a 1–5 Likert scale. The score for each item is calculated to obtain the overall usability value of the system.

**Given SUS Score:**

- For questions with odd numbers (1, 3, 5, 7, 9): The score is calculated by subtracting 1 from the respondent's given value (e.g., if the respondent gives a score of 4, the score will be calculated as 4 - 1 = 3).
- For questions with even numbers (2, 4, 6, 8, 10): The score is calculated by subtracting 5 from the respondent's given value (e.g., if the respondent gives a score of 4, the score will be calculated as 5 - 4 = 1).

**SUS Score Total:**

After performing the calculations above, the scores for each item are summed, and then the result is multiplied by 2.5 to obtain the final SUS score.

**SUS Formula**

$$\text{Total Skor SUS} = \left(\sum \text{Skor untuk tiap item}\right) \times 2.5$$

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**SUS Calculation For example,**

The results of the SUS questionnaire for 10 respondents are as follows:

**Tabel 1**. Contoh SUS

| Responden | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | P10 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R1 | 4 | 3 | 5 | 4 | 5 | 3 | 4 | 5 | 4 | 5 | 38 |
| R2 | 5 | 3 | 5 | 4 | 5 | 3 | 5 | 5 | 5 | 4 | 42 |
| ... | | | | | | | | | | | |

**For each odd question, calculate it like this:**

- P1 (R1) = 4 - 1 = 3
- P3 (R1) = 5 - 1 = 4
- P5 (R1) = 5 - 1 = 4

**For even numbers, calculate like this:**

- P2 (R1) = 5 - 3 = 2
- P4 (R1) = 5 - 4 = 1

After that, add up all the scores per respondent and multiply by 2.5. The final calculation for R1 is: SUS R1 = (Score R1) × 2.5 = 38 × 2.5 = 95. The total score will indicate how well the usability of the interactive museum prototype being tested performs. The final score ranges from 0 to 100, with higher values indicating better usability.

**Table 2.** Score SUS per Item

| Item | Average Score |
|---|---|
| 1 | 4,2 |
| 2 | 3,8 |
| 3 | 4,0 |
| 4 | 4,1 |
| 5 | 3,9 |
| 6 | 4,3 |
| 7 | 3,7 |
| 8 | 4,2 |
| 9 | 4,0 |
| 10 | 4,1 |

From the table, it can be seen that most items have an average score above 4, indicating a positive user perception of the prototype. The results of the SUS score calculation show that the prototype falls into the "Good" category with an average score of 75.6. This category indicates that the prototype has good usability and is acceptable to users.

### 3.2 User Experience (UX) Analysis

In addition to SUS, UX evaluation was conducted using the User Experience Questionnaire (UEQ). The UEQ measures six main dimensions of UX: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. UX measurement was performed using the User Experience Questionnaire (UEQ). The UEQ consists of 26 questions that measure six UX dimensions: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. Each item is scored on a Likert scale from 1 (poor) to 7 (good).

**Score per Dimention:**

- Setiap dimensi diukur berdasarkan rata-rata skor dari item yang terkait.
- Dimensi Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, dan Novelty masing-masing memiliki 4–5 item.

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**Dimention UEQ Score Formula:**

$$\text{Skor Dimensi} = \frac{\sum (\text{Skor untuk setiap item})}{\text{Jumlah item per dimensi}}$$

**UEQ Calculation For example**
For example, the results from 5 respondents regarding the Attractiveness dimension are as follows:

**Table 3.** UEQ Example

| Responden | Attractiveness 1 | Attractiveness 2 | Attractiveness 3 | Attractiveness 4 | Rata-rata |
|---|---|---|---|---|---|
| R1 | 6 | 5 | 7 | 6 | 6 |
| R2 | 5 | 6 | 6 | 7 | 6 |
| R3 | 6 | 6 | 7 | 6 | 6.25 |
| R4 | 7 | 7 | 6 | 7 | 6.75 |
| R5 | 5 | 5 | 6 | 6 | 5.5 |

$$\text{Skor rata-rata dimensi Attractiveness} = \frac{6+6+6.25+6.75+5.5}{5} = 6.1$$

This result indicates that the Attractiveness dimension has an average value of 6.1, which means visitors find the museum prototype sufficiently attractive and adequate.

**Table 4.** UEQ Average per Dimention

| Dimention | Average |
|---|---|
| Attractiveness | 1,8 |
| Perspicuity | 1,6 |
| Efficiency | 1,7 |
| Dependability | 1,5 |
| Stimulation | 1,9 |
| Novelty | 2,0 |

Positive values across all dimensions indicate that the interactive museum prototype is not only easy to use but also engaging and innovative for users. The results of the UEQ analysis show that the interactive museum prototype received high average scores across all dimensions, with the highest scores in the Attractiveness and Novelty dimensions. This indicates that users found the experience offered by the prototype appealing and stimulating.

### 3.3 Qualitative Analysis

Semi-structured interviews were conducted to explore user experiences and perceptions in more depth. The interview results show that the majority of users feel the interactive museum prototype helps them understand the museum's collection in a fun and interactive way.

Some respondents stated that the augmented reality (AR) feature allowed them to view artifacts from various perspectives, while the audio guide feature provided additional information that enriched their experience. However, some users also revealed that the audio quality for some collections needed improvement, and navigation on the digital map was sometimes confusing. This input serves as the basis for improvements in the next iteration of the prototype.

**Discussion**

The evaluation results show that the interactive museum prototype has good usability and user experience. A high SUS score resulted in an average score of 75.6, which falls into the "Good" category according to Brooke's interpretation [21]. This indicates that visitors feel comfortable and satisfied using this prototype. Additionally, the positive UEQ scores across all dimensions indicate that the prototype is not only functional but also appealing and innovative. The UX evaluation using the User Experience Questionnaire (UEQ) showed positive average scores for all UX dimensions, with Attractiveness and Novelty receiving the highest scores (6.1). This indicates that users not only feel satisfied but also feel interested and stimulated to explore the museum further.

Input from qualitative interviews provides valuable insights for further improvement. Improving audio quality and simplifying digital map navigation will be the main focus in the development of the next prototype. Overall, this research proves that the implementation of interactive technologies, such as AR and audio guides, can enhance the museum visitor

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experience. This aligns with previous research findings indicating that interactive technology can make museums more engaging and educational for young visitors [19][20].

Additionally, this research also highlights the importance of usability and UX evaluation in the development of interactive museum prototypes. Without proper evaluation, developers cannot know if the developed product meets users' needs and expectations [21]. This study supports existing findings in the literature that show interactive technologies, such as AR and QR codes, can enhance visitor engagement and understanding in museums [22]. Additionally, this prototype is also relevant to local research stating that the use of technologies like AR can enhance presence in the context of museum education.

Thus, this research contributes to the development of an interactive museum prototype that not only relies on technology but also focuses on user needs and experiences.

**Table 5.** Summary of Test Results

| Evaluation | Score | Description |
|---|---|---|
| SUS Score | 75.6 | Category "Good" |
| Attractiveness | 6.1 | Users find the prototype interesting. |
| Novelty | 6.0 | Users feel the prototype is innovative. |
| Feedback Audio | - | The audio guide quality needs improvement. |
| Map Navigation | - | The navigation interface needs improvement. |


**Figure 3.** Museum Interaktive Display

Here is the first image of the interactive museum prototype app on a smartphone. The screen highlights a digital map with key icons for various features, such as the digital map, AR artifacts, QR scanner, and audio guide.

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**Figure 4.** AR Display

Here is the second image of the interactive museum prototype, featuring an augmented reality (AR) artifact. The screen shows a 3D model of an ancient amphora with clear descriptions in both English and Indonesian.

## 4. CONCLUSION

This research successfully designed and developed a digital technology-based interactive museum prototype that is expected to increase visitor engagement and the effectiveness of cultural education. Based on user testing results, several key conclusions were drawn: (1) System Usability: Evaluation results using the System Usability Scale (SUS) showed that the interactive museum prototype received an average score of 75.6, which falls into the "Good" category. This indicates that visitors feel comfortable and satisfied using the prototype. Most respondents found the interface used to be quite easy to understand and provided an adequate experience. (2) User Experience: Based on the User Experience Questionnaire (UEQ), the average scores for the Attractiveness and Novelty dimensions were high (6.1), indicating that the prototype was quite appealing and innovative for visitors. Additionally, other dimensions such as Efficiency and Dependability also received positive ratings, indicating that the prototype ran smoothly and met functional expectations. (3) Qualitative Evaluation: Interviews with users showed that the 3D artifact AR feature and audio guide were highly valued, enhancing their understanding of the museum collection. However, some users provided feedback regarding the audio quality and digital map navigation, which still need improvement to be more user-friendly. (4) Museum Transformation Potential: Based on the results of this study, it can be concluded that interactive technologies such as AR and QR scanners can enrich the museum visit experience, especially for younger generations who are more familiar with technology. With further development, this prototype has the potential to be widely implemented in other museums across Indonesia. Some recommendations that can be implemented for the further development of the interactive museum prototype are: (1) Audio Feature Improvements: Some respondents stated that the audio quality was not clear, especially in noisy environments. Therefore, it is necessary to improve the quality of audio recordings and add language selection features as well as more flexible volume settings. (2) Simplification of Digital Map Navigation: Although most respondents appreciated the presence of digital maps, some visitors found it difficult to operate the interactive maps. Developers are advised to simplify navigation and add clearer instructions on how to use the maps effectively. (3) Increased Device Accessibility and Compatibility: To ensure that more visitors can access the interactive museum prototype, developers need to consider device compatibility. Most users use mid-range smartphones, so developers need to ensure that the application runs smoothly on various devices. (4) Future Development with Other Technologies: In addition to AR, Virtual Reality (VR) technology can be applied to museum prototypes to enhance the immersive

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experience. With VR, visitors can have a more in-depth experience, such as viewing and interacting with cultural collections in a three-dimensional space. (5) Implementation in Other Museums: Another recommendation is to pilot the prototype in other museums in Indonesia. This will provide more data on the effectiveness of using interactive technology in different cultural contexts. Thus, the specific needs of each museum in implementing this technology can be mapped. (6) Design Guidelines: Based on the evaluation results and user experience, the design guidelines developed in this study can be used by other museum managers to create interactive prototypes that meet the needs of their visitors and collections. This guideline may include interface layout, icon usage, and the arrangement of other interactive features.

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