JURNAL MULTIDISIPLIN MADANI (MUDIMA)

Homepage: https://journal.formosapublisher.org/index.php/mudima
ISSN: 2808-5639 (Online)
**Research Article**

| Volume 3, No 9, September (2023) | DOI: https://doi.org/10.55927/mudima.v3i9.5744 | Page: 1956-1963 |
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# Design Thinking Testing of AR/VR Application for Bali's Lontar Prasi Preservation

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ARTICLE INFO

*Keywords*: AR/VR Technology, User Experience Testing, Design Thinking Methods

*Received* : *2 August*
*Revised* : *19 August*
*Accepted* : *19 September*



ABSTRACT

This study investigates the use of Design Thinking in the creation of Augmented Reality (AR) and Virtual Reality (VR) applications for the preservation of Bali's Lontar Prasi cultural heritage. As a piece of Indonesian cultural patrimony, Lontar Prasi necessitates a novel approach to its preservation in the digital age. This research identifies UI/UX issues of AR/VR applications based on user problems through the phases of Emphasis, Definition, Ideation, Prototype, and Test. Changes were made to the icon display, 3D character information, and UI positioning as a result. With an average score of 80 (Excellent) on the System Usability Scale (SUS), testing revealed a substantial improvement in user satisfaction. These results demonstrate that the Design Thinking methodology is effective for addressing UI/UX issues and enhancing the app's acceptability. In conclusion, this approach can serve as a foundation for future advancements in the preservation of cultural heritage using modern technology for digitized cultural heritage

## INTRODUCTION

Cultural heritage plays a crucial role in the preservation of a society's identity and history. As part of Indonesia's cultural heritage, Lontar Prasi Bali is a priceless relic that contains Balinese ancestors' knowledge and values handed down from generation to generation. With the advancement of technology and the challenges of the times, however, the preservation of cultural heritage is becoming progressively difficult(Duguleană & Gîrbacia, 2021; Trunfio et al., 2022; Vital & Sylaiou, 2022). To preserve cultural heritage, an innovative approach that combines modern technology and traditional values is required, such as the implementation of Augmented Reality (AR) and Virtual Reality (VR).

The application of AR and VR to the preservation of Balinese lontar prasi has opened up new opportunities in digitally preserving and reviving cultural heritage. This has been realized in previous research by(Aditama et al., 2022)which reviews the implementation of Augmented Reality technology to display the contents of the story in Lontar Prasi through 3D characters, audio, and text. In this study using the Prototyping method and marker testing on 4 different smartphone devices. Follow-up research ie(Sudipa et al., 2022a)who digitize the Balinese lontar prasi so that they can be seen in augmented terms and each character object can move when scanning each lontar prasi sheet, but can also be implemented on smartphone devices. This study used response loading time testing and a user experience questionnaire (UEQ) which was carried out in research by(Setiadi et al., 2023; Sudipa et al., 2022b). From the results of previous research, it is necessary to evaluate the UI/UX in changing the appearance so that it adapts to the needs and comfort of the user in using the Lontar Prasi Bali AR/VR application.

Important aspects such as User Interface (UI) and User Experience (UX) play a very crucial role in the success of these AR/VR applications. This process can analyze the user's interaction with the application, the extent to which the application is able to convey information, and the extent to which the application is able to arouse the user's curiosity and interest in being involved in the conservation of Lontar Prasi Bali.(Maheshwari, 2019), it all relies on careful and effective UI/UX design.

This is where the importance of a design thinking-based approach (Design Thinking) in developing and testing AR/VR applications for the preservation of Lontar Prasi Bali. Design Thinking is a multidisciplinary approach that places the user at the center of the product or service development process(Foster, 2021). This approach drives the discovery of better solutions by understanding user needs, emotions and motivations. In the context of conserving Lontar Prasi Bali, Design Thinking can help direct the development of AR/VR applications to suit the wishes and expectations of users, while still maintaining the cultural values embodied in Lontar Prasi.

This study aims to apply design thinking-based testing to AR/VR applications for the conservation of Lontar Prasi Bali. So that it can have implications in analyzing various aspects related to UI/UX testing, including user experience, interactions, visual interfaces, and how to measure the success of applications in realizing cultural preservation goals as well as the further development of effective and meaningful AR/VR applications in the context of preservation Balinese lontar prasi cultural heritage.

## METHODS

Design Thinking is a method for creating value for potential users and identifying specific and comprehensive market opportunities; not limited to the basis of appearance and function only(Nurbekova et al., 2020; Piras et al., 2019). Design Thinking includes an innovative approach to solving problems that emphasizes deep understanding of user needs.

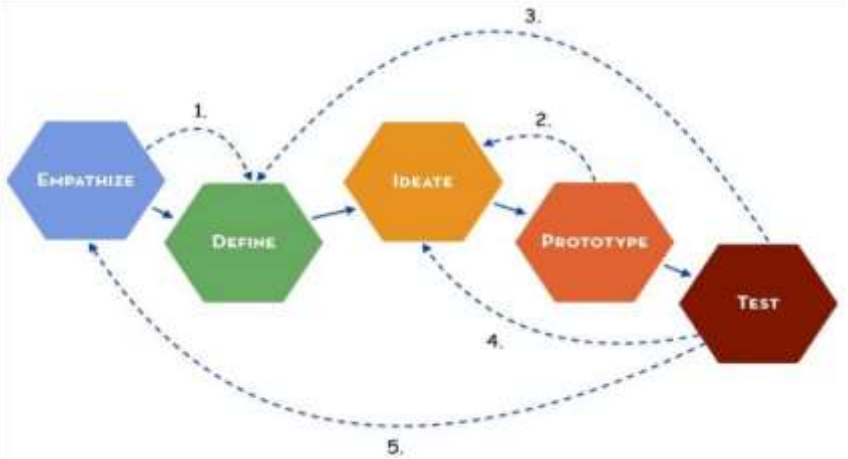

Figure 1. Stages of the Design Thinking Method

Based on Figure 1, it can be explained that each stage of the Design Thinking method starts with problem deconstruction, concept mapping, brainstorming, selection of the best ideas, then implementation.(Clarke et al., 2020; Micheli et al., 2019; Pereira & de FSM Russo, 2018). These stages are then known as the 5 components which include the following elements:

1. Emphatize, at this stage aims to discuss data collection which will later be used for research purposes. an important first step in understanding user needs and perspectives in depth
2. Define, at this stage aims to define the problem, the design team analyzes and synthesizes the information obtained during the empathize stage to identify important aspects that need to be solved.
3. Ideate, at this stage aims to generate ideas or ideas as a basis for making a prototype design that will be made.
4. Prototype, at this stage aims to pour out the solution to the problems obtained in the previous stages. from the ideas generated in the previous stage. At this stage, the design team uses various techniques and tools to produce prototypes that can be tested and evaluated
5. Test, at this stage testing is carried out from the prototype User Interface (UI) and User Experience (UX) that have been designed and designed in the previous steps obtained from the solution to the problem in the previous step. During testing, researchers will analyze how customers interact with pre-designed prototypes(Syah & Helmiah, 2021). At this stage it is important where the solution that has been made in prototype form is tested and evaluated directly with the user.

## RESULTS AND DISCUSSION

### Implementation of the Design Thinking Method

The application of the design thinking method to the Bali Lontar Prasi AR/VR application is shown in stages which can be explained as follows.

### Empathize Stage

At this stage it is carried out to find out the problems and needs in the development of the mobile-based AR/VR Lontar Prasi Bali application. The stage of the user needs research process with a focus on the problems experienced by users as many as 20 respondents when using the application.

Table 1. User Problems

| No | Problems |
|---|---|
| 1 | The flow of using the application is confusing |
| 2 | Monotonous application button display |
| 3 | Lack of consistency in display design |
| 4 | 3D character display less informative |

Based on table 1, several user problems can be explained when using the Lontar Prasi Bali AR/VR application, so that it becomes the focus in the application improvement process.

**Define Stage**

At this stage the aim is to define and formulate the main problems experienced by application users. Based on the data obtained from the results of the empathize stage, it can be seen that the focus of the problem is on the application UI display, the position of the application button and the display of characters that are less informative.

**Idea Stage**

At this stage propose solutions and ideas for problems that have been known in the previous stage. By applying new innovative ideas to the development of AR/VR Lontar Prasi Bali applications. This idea is used as a basic reference for designing prototypes that will be tested on users at the prototype stage. Solutions and ideas from user problems can be seen in table 2 below.

Table 2. Ideas and Solutions

| No | Ideas and Solutions |
|---|---|
| 1 | Create web-based and mobile AR/VR applications |
| 2 | Updating the process of using the application to make it easier to use |
| 3 | Change the display position of the application button to make it easier to use |
| 4 | Added information on 3D characters |

Based on table 2, ideas and solutions to problems can be explained by application users, so that ideas and solutions are formulated for problems on the application display, application buttons and information from 3D characters which are displays from the Lontar Prasi Bali AR/VR application.

**Prototype Stage**

At this stage it is intended to design a UI improvement from the Lontar Prasi Bali AR/VR application.This stage is the implementation of the concepts that have been obtained from the previous stage with the aim of producing a mobile-based AR and web-based VR application model design that can meet the needs of application users. The final results of this stage will be tested to validate whether the application UI improvements have met the needs and can be a solution to user problems. There were several appearance changes made at the prototype stage, which included changes to the appearance of the AR application login button, display of 3D character information in AR applications and the display of the virtual reality museum of the Lontar Prasi Bali Museum.

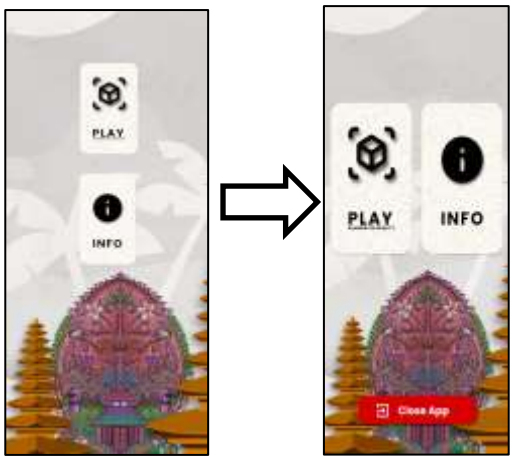

Figure 2. Changes to the AR Application Button Display

Based on Figure 2, it can be explained that there is a change in the appearance of the login button in the AR Lontar Prasi Bali application, this change was made based on the results at the empathize stage which indicated that there was a problem with the application button display.

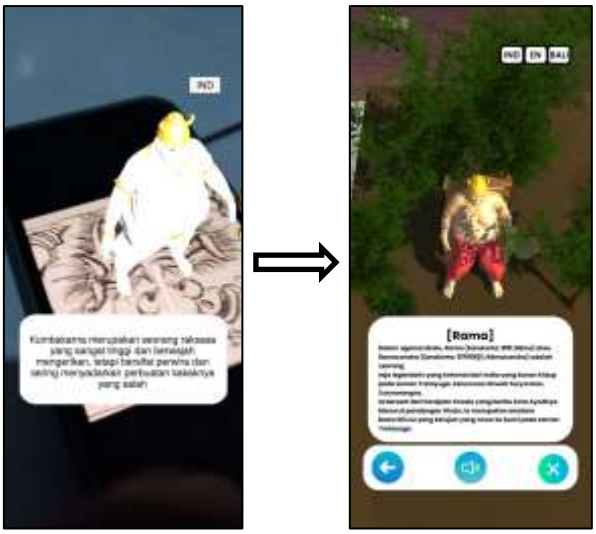

Figure 3. Display of 3D Character Information in AR Applications

Based on figure 3, it can be explained that there is a change in the UI appearance of the 3D lontar prasi character information, at the beginning of the application there are 3D characters displayed along with information on the names and character traits as well as the Indonesian language switch button. After that, changes to character data information were made along with additional buttons for Indonesian, English and Balinese regional languages. And there are back buttons, close and activate voice audio narration.

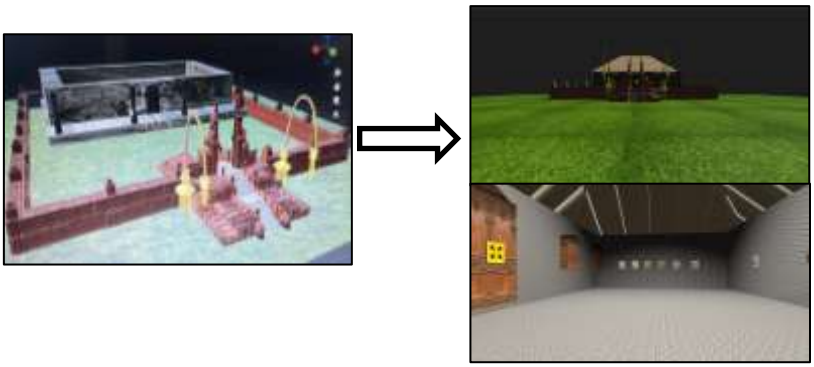

Figure 4. Display of Web-based Lontar Prasi Bali Museum Virtual Reality

Based on Figure 4, it can be explained that the change from the web-based VR appearance of the Lontar Prasi Bali Museum, this change was made to make it easier for users to access the virtual reality Lontar Prasi Museum Bali.

**Test Stage**

At this stage testing of the AR/VR Lontar Prasi Bali application was carried out using the System Usability Scale (SUS) test. This test is intended to determine the suitability of ideas and solutions from changes in the UI appearance of the AR/VR application, user response tests were carried out on 20 people, 20 respondents participated, the data obtained is an assessment of the use of AR/VR applications in the form of questionnaires consisting of 10 statements with 5 questions. The assessment is carried out using a Likert scale, namely a value of 1 to a value of 5. The results of the SUS test can be seen in Table 3 below.

Table 3. SUS Test Score Data

| Result Score | | | | | | | | | | Amount | Value (Total x 2.5) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | | |
| 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 38 | 95 |
| 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 2 | 2 | 28 | 70 |
| 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 28 | 70 |
| 4 | 2 | 4 | 2 | 4 | 3 | 4 | 2 | 4 | 2 | 31 | 78 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 30 | 75 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 29 | 73 |
| 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 4 | 3 | 34 | 85 |
| 4 | 3 | 4 | 3 | 4 | 4 | 4 | 3 | 2 | 3 | 34 | 85 |
| 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 33 | 83 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 30 | 75 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 30 | 75 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 30 | 75 |
| 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 39 | 98 |
| 3 | 3 | 3 | 3 | 4 | 3 | 4 | 3 | 3 | 3 | 32 | 80 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 30 | 75 |
| 4 | 4 | 4 | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 37 | 93 |
| 3 | 3 | 3 | 3 | 4 | 3 | 4 | 3 | 3 | 3 | 32 | 80 |
| 4 | 3 | 4 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 35 | 88 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 24 | 60 |
| 4 | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 32 | 80 |
| Average Score (Final Result) | | | | | | | | | | | **80** |

From table 3 above it can be explained that the SUS rating gets a score of 80, then the score is included in the Excellent category with a grade scale B. This means that in terms of usability based on these data an assessment is acceptable or feasible because the value obtained is 80, which means it is above average flat. The final conclusion is determined through an assessment as shown in Figure 3 below.

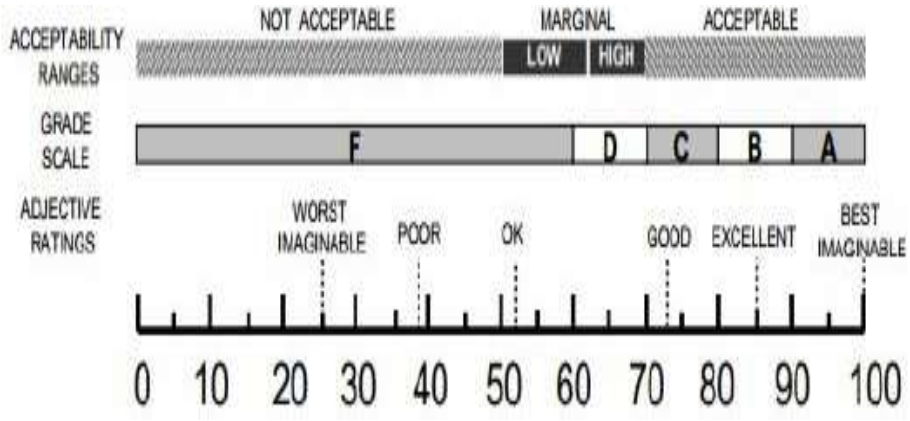


Figure 4. SUS Score

## CONCLUSION

The primary conclusion of the research is that the application of Design Thinking to the development of the Lontar Prasi Bali AR/VR application through stages can significantly contribute to the application's enhancement. The Define stage identifies the focus of improvement, which includes UI appearance, button position, and 3D character information, while the Emphasis stage aids in gaining an understanding of the issues confronted by users. At the Ideate stage, solution concepts were generated, and at the Prototype stage, prototypes were created. The System Usability Scale (SUS) test results revealed a marked improvement in the UI/UX of the application, with an average score of 80, which places it in the Excellent category. This demonstrates that the modifications effectively enhanced the user experience, and that the application was well received. The following suggestion for future research is to examine user interaction with the Lontar Prasi Bali AR/VR application. Focus on how application users interact with 3D characters, audio, and navigation.

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