Development of a Web-Based 360° VR Virtual Tour of Istana Maimun as an Educational Medium for Malay Deli Culture

Heri Kurniawan, Ahmad Akbar, Feri Rinto Bashari

Abstract

This study aims to develop a web-based 360° Virtual Reality (VR) virtual tour of Istana Maimun as a learning medium to introduce Malay Deli culture. The development process follows the ADDIE model, which consists of the Analysis, Design, Development, Implementation, and Evaluation stages. This research is limited only to the development and functional testing stages and does not include the measurement of learning effectiveness. The study resulted in a responsive website that integrates 360° panoramic views, interactive hotspots, and cultural descriptions to support immersive learning. Functional testing was conducted through system performance validation and functionality testing with a limited number of users to ensure that all interactive elements operated properly on both desktop and mobile devices. The findings indicate that the virtual tour functions well and can be accessed as a learning medium for cultural exploration, particularly of Malay Deli Culture. This development demonstrates the potential of web-based VR technology in preserving and introducing local cultural heritage through digital learning experiences.

Keywords: *Virtual Reality,* 360° *Virtual Tour, Web-Based Learning, Cultural Heritage, Malay Deli Culture*

Heri Kurniawan[1]
[1]Department of Technology Information, Universitas Pembangunan Panca Budi, Indonesia
e-mail: herikurnia@pancabudi.ac.id[1]

Ahmad Akbar[2], Feri Rinto Bashari[3]
[2,3]Department of Technology Information, Universitas Pembangunan Panca Budi, Indonesia
e-mail: akbarmuno@pancabudi.ac.id[2], feririnto2005@gmail.com[3]

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Introduction

Culture is one of the important identities of a nation that needs to be preserved and introduced to the younger generation. One way to do this is by using digital technology, such as Virtual Reality (VR) and 360° Virtual Tours, which provide users with interactive and immersive experiences.

Web-based VR technology allows people to access virtual environments using only a web browser. [1], [2] [3]. Frameworks like A-Frame and WebXR provide user-friendly infrastructure for web-based virtual tour development. [1], [2].

Previous studies have developed virtual tour systems accessible via the internet to preserve culture and attract tourists. Wiryawan dan Nuraisyah [4] [5]creating an interactive 360° panorama-based virtual tour for local museums, and Argiriou et al. [6] suggesting design methods for the use of immersive 360° video in the context of cultural heritage. Additionally, research by Kurniawan dan Haryanto [7] showing that using the A-Frame WebVR framework is very effective in creating web-based historical tours.

Interactive digital media has proven capable of increasing user interest and understanding of cultural content. [8], [9]. Therefore, web-based virtual tour applications can be an effective learning tool for introducing local cultures such as Deli Malay culture.

This study uses the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation) to support the user interface design process [2], [10]. This model is widely used in the development of digital learning media because it is flexible and systematic in meeting design needs. [11], [10].

Based on this background, the purpose of this research is to create an interactive web-based virtual tour of Maimun Palace that introduces Deli Malay culture [12], with a special emphasis on the system's development and functionality testing stages. [13], [4], [14].

Literature Review

Virtual reality (VR) has been widely used in various fields, such as education, training, and cultural preservation [15], [9]. VR allows users to interact with the real world in a three-dimensional environment [15], this makes learning more interesting [15].

In terms of cultural heritage, virtual reality (VR) and 360-degree virtual tours have proven effective in enhancing the appeal and accessibility of cultural sites without the need to physically visit the location [6], [4]. In terms of cultural preservation, a study by Argyriou et al. [6] developing a methodology for 360-degree video-based virtual tour design for cultural preservation, and Wiryawan and Nuraisyah [4] implementing 360-degree panoramic technology at the Bandung City Museum.

Additionally, because they are lightweight and support interactive elements such as hotspots, info pop-ups, and audio narration. [7] [16], webVR technology based on A-Frame and the WebXR API now allows for the creation of virtual tours accessible thru web browsers without requiring dedicated VR devices [1], [2].

According to some studies, web-based virtual tours can enhance the experiential learning process, particularly in the context of cultural and historical education [8], [9]. This learning model aligns with the multimedia learning approach, which emphasizes the integration of images, text, and interactive experiences to enhance users' cognitive understanding [9].

Therefore, web-based virtual tour applications have great potential to become an innovative learning medium that helps people learn about local cultures, including the Deli Malay culture, which has rich historical and architectural treasures such as the Maimun Palace [6], [14].

Research Methodology

The main framework for the development of web-based 360° virtual tour applications is the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model

[11], [10]. This model is known to be flexible and systematic in the development of digital learning media because it emphasizes iterative processes at every stage of the process [11], [10].

The stage analysis includes determining user needs, learning objectives, and the context of the Maimun Palace cultural site as the main object of development. This stage also includes research on the need for technology for interactive web platforms [10], [7].

In the design phase, principles of visual design and WebVR-based interactivity were used to create an easy-to-understand user interface and user experience [2], [7]. To ensure that the display met user needs, a user-centered design approach was employed [17].

The development process involved implementing A-Frame and WebXR-based VR elements, which enabled the integration of 360° panoramic photos, descriptive text, and interactive navigation into the web application [1], [2].

The implementation phase involved deploying the application to a web-based server for public access using desktop and mobile devices [13], [4].

Evaluation, the final step, was conducted on a limited basis by conducting functional tests to ensure that each feature worked as planned [4], [14]. This phase did not include measuring learning effectiveness, so it can serve as a starting point for further research.

Results

This section explains the results of the 360° Virtual Tour application development process for Maimun Palace as a learning medium to learn about Deli Malay culture. This application was developed using the ADDIE model, and in this study, it was used up to the development and functional testing stages. Three main components are included in the results obtained: user interface design, system development, and application functionality testing. To explain how each step supports the creation of interactive and contextual digital learning media, the discussion is structured.

4.1 Interface Design

In the ADDIE model's design phase, the interface design stage is carried out with a focus on applying user-centered design principles to create an easily understandable and informative exploration experience. For the interface design, the navigation menu is positioned on the left side, which can also be hidden so that users can have a more immersive experience.
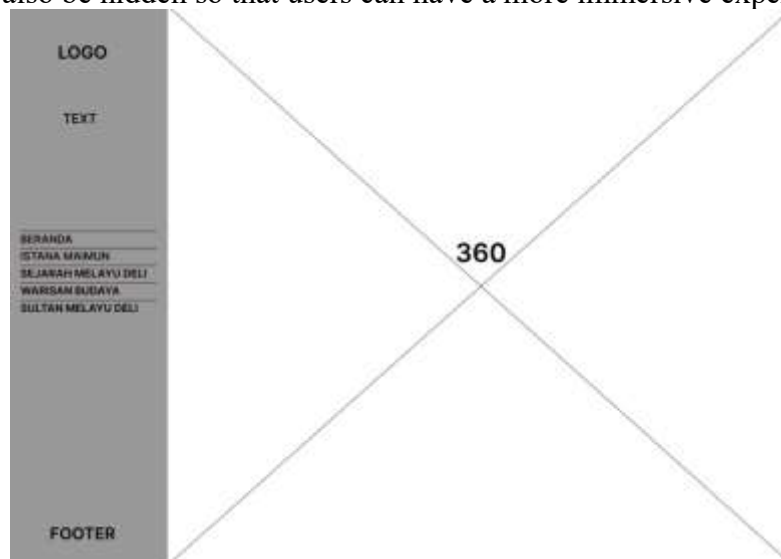

Figure 1. Interface Desain

4.2 System Development

The development stage produces a Web-Based 360° Virtual Tour application of Istana Maimun, which consists of several main menus, namely:

1. **Home Menu**

The initial screen displays a panoramic background of the front of Maimun Palace and navigation buttons to the main menu. This section also includes a brief introductory text explaining the application's purpose as a learning medium for introducing Malay Deli culture.

Figure 2. Home Menu

2. **Maimun Palace Profile Menu**

Contains brief historical information about the palace's construction, architectural styles, and the influence of Malay, Indian, and European cultures reflected in the building's structure. This page features photos and informative text to provide users with historical context before they explore the virtual tour, including information about Maimun Palace, which is a Medan City Cultural Heritage Building.

Figure 3. Maimun Palace Profile menu

3. **History of Malay Deli Menu**

Presenting a historical summary of the Deli Sultanate, its role in the development of Malay culture, and the relationship between the palace and the social life of the Medan community in the past. This material supports the educational aspect of the application by linking historical context to the visualized locations.

Figure 4. History of Malay Deli Menu

4. Malay Culture Heritage Menu

Showcasing a collection of cultural artifacts such as traditional clothing, musical instruments, and typical Malay carving motifs. Content is displayed in the form of interactive popups on a 360° panorama, allowing users to click on specific points to view cultural explanations directly within the tour view.

Figure 5. Malay Culture Heritage Menu

5. The Deli Malay Sultanate Menu

Contains information on the sultans who once ruled the Deli Sultanate, complete with their periods of reign. This section aims to instill historical values and introduce important figures in the development of Deli Malay culture.

Figure 6. The Deli Malay Sultanate Menu

The entire menu is connected within an interconnected navigation system, allowing users to move from one content to another without leaving the virtual tour experience.

4.3 Function Testing

Testing was conducted using the black box testing method to ensure the system's main functions were working properly. The testing focus included aspects of navigation, panoramic display, cultural interactivity, and device compatibility.

Table 1. Functionality Testing Results

No	Tested Components	Test Results	Description
1	Navigating between menus and panorama hotspots	Works well	Smooth panorama and page transitions
2	360° panoramic view	Works well	The image is clear and undistorted.
3	Interactive cultural content	Works well	Descriptions and images appear at interactive points.
4	Display responsiveness	Works well	Adjusting the desktop & mobile display
5	Cross-browser compatibility	Works well	Works well in Chrome, Firefox, and Safari

The test results show that the system is stable and responsive, and all features can be used without significant constraints. Users can easily explore the palace rooms and learn about cultural elements. The 360° visual approach, which enables experiential learning and strengthens users' understanding of local cultural values, allows this application to be used as a digital learning medium where users can learn about Deli Malay culture interactively and contextually.

Conclusion

This research has successfully developed a web-based interactive learning medium for a virtual tour of Maimun Palace, which introduces the Malay Deli culture. This application was developed using the ADDIE model, which includes the Analysis, Design, and Development stages, followed by system functionality testing.

The development results show that this application has the ability to display educational content in 360° visual form, allowing users to take an immersive journey thru the historical rooms of Maimun Palace. The value of contextual and experiential learning is reinforced by interactive features of the Deli Sultanate, such as cultural hotspots, historical information, and artifact descriptions. This application can be easily accessed thru various devices without requiring additional installation, supporting the flexibility of digital learning activities.

The functionality test results show that the system works well in terms of navigation, panoramic view, responsiveness, and cross-platform compatibility. This shows that WebVR technology can be used effectively to support local cultural learning media. This is especially true for introducing the cultural heritage of Malay Deli to students and the general public.

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