

Museum Maya Indonesia: an immersive museum prototype for cultural education

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Abstract. The development of this virtual museum was a collaborative project of lecturers and students as an effort to create learning media about Indonesia's cultural identity and history. This was practiced-based research that culminated in the creation of a high-fidelity prototype. Design thinking was used to realize ideas by considering existing problems. The empathize and define stages were conducted on 33 high school students to find out students' insights about museums and their experiences in real or virtual museums. Visualization of objects with 3D photogrammetric techniques was used to achieve a realistic impression and a more immersive feeling. The museum also features audiovisuals, infographics, motion graphics, and animated objects. This prototype was tested directly on 12 students who were divided into three user groups, namely mobile phones, laptops, and VR. Mobile users experienced problems in accessing this museum, while laptop users managed to access the museum and had a very positive reaction. VR users felt a much more emotional experience. The test of a prototype in a school has shown that such a virtual museum will be attractive and engaging for students and schools, especially in remote areas, and should be further developed.

1 Introduction

A museum is a place to store, maintain, research, and display objects or artefacts related to culture, art, science, or history to be communicated and published to the wider community. Museums are a learning space for people to understand the development of a country's art and culture [1]. Therefore, it is only natural that museums are said to be a mirror of the level of civilization of a nation.

Indonesia has different ethnicities that leave cultural traces, from fine arts to written arts, from tangible to intangible cultural artefacts. The Indonesian government also realizes the importance of museums. This is proven by the existence of 450 museums throughout the country. However, not all museums have the funding needed to be well managed by

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scientists, so the function of such museums is limited to the storage of ancient objects. This has resulted in some reluctance by people to visit museums [2]. Only a few museums are worth visiting and provide flexibility to develop alternative learning processes for schools and universities. Museums like this in Indonesia are only located in big cities or even only in the capital city, so people who live far from the capital rarely, if ever, have the opportunity and desire to visit museums. So, apart from a lack of interest in museums by the younger generation in general, the vast distances in the insular nation make it particularly difficult for teachers or scientists in remote areas to explore the rich cultural artefacts.

The development of internet technology today provides opportunities to create virtual learning and publication spaces, which allow access independent of space and time without limits [3]. During the Covid-19 pandemic, innovations in the field of museum and art gallery services were encouraged to open virtual tours, so that people could still access information from such places from their homes. Even though the pandemic has slowed down, innovation in this area has not subsided. The development of virtual reality and metaverse technology offers a more advanced user experience, where users can explore space freely like in the real world. In addition, the development of game design that already offers 3-dimensional architecture and objects, is an opportunity to develop a virtual public space, which can provide a true exploration experience. Such a virtual museum should also be able to provide conference rooms that are not only easily accessible but can be perceived immersively by users. Virtual experiences that evoke a sense of imagination will certainly touch the emotional side of users [4].

In Indonesia, there are five museums that provide virtual services, namely the National Museum of Indonesia, West Java Presidential Museum, Sangiran Museum, Vredeberg Fort Museum, and Jakarta Museum of Fine Arts and Ceramics. The five museums use older technology from Quick Time Virtual Reality (QTVR). This technology was developed by Eric Chen and Ian Small of Apple's Human Interface Group and popularized in 1995 [5]. Similar approaches continued to evolve from the start of the 2000s until now, but the principle is still the same. There are two types of displays that we can see from these virtual museums in Indonesia, which are as follows:

- All museums use panoramic, and 360° images converted into rectilinear views in real time. If the user wants to move to another location, the user must activate a button or area available (called hot-spot), including to activate the sound or link available as information to be displayed.
- Only the National Museum of Indonesia displays 3D objects that can be rotated and enlarged by the user so that the information can be seen in full. The drawback of this display is that very high numbers of images are needed for each object, so that the appearance of the motion can be very smooth, like in the real world.

The immersive approach or feeling in these five museums still cannot be perceived, because users cannot move freely in the virtual world. The display of objects still lacks smooth movement and is very time consuming to record. Such technologies do not offer "real" involvement from visitors, neither when visitors interact with objects and information displayed, nor in conference rooms and virtual classes that can be attended in real-time. All of these are now possible to facilitate, even using visitor avatars so that the immersive sensation and interaction between attendants can be fully realized.

The issue of accessibility and scientific level of museums in Indonesia in general, as well as the recent advances of immersive technology, are the starting points of this research, which targets the development of a prototype of a virtual museum for Indonesia. This virtual museum is intended to target high school and university students, especially those who are living far away from big cities, to improve their knowledge about their history and cultural identity. What needs to be achieved is a museum that offers a learning experience with an interactive and playful approach, because this is closely related to a positive emotional side

of visitors and encourages them to be more involved with their environment [6]. The design work of the museum will be done in collaboration with students of visual communication design of Itenas, Bandung. The contents of the museum are chosen by the students, and it will not be discussed in this research.

2 Methods

This research is practiced-based research and aims for the creation of a prototype that can be used by a wide spectrum of people. In practiced-based research there is used an artifact, which can include digital media, as a means to contribute to transfer of knowledge. The creative artifact, in this case a design object or scene, must be investigated by a critical observation and discussion of its relevance in the intended context of use [7]. Therefore, the design thinking method, which focuses on solving problems based on user needs [8] should be very helpful in building a virtual museum that answers the needs of relevant stakeholders, like users, educators, scientists and museum organizers.

Design thinking is a non-linear and iterative process, which has five stages — empathize, define, ideate, prototype and test. At the empathize stage, open and close questions in a combine questionnaire will be conducted with high school students, which are living remote area far away from the big cities. This is intended to understand the respondents' insight into the museum and their experience of virtual tours or similar presentations (if any). At this stage, the selection of cultural objects that will be displayed in the museum is also carried out, either tangible or intangible.

The ideate and prototype stages are carried out collaboratively with 25 visual communication design students at Institut Teknologi Nasional, Bandung. This stage is used to realize a high-fidelity prototype, where this prototype tries to translate into a virtual museum in accordance with user insight. The use of audiovisual and 3D objects will be the main consideration in realizing an immersive impression. 3D objects will be done by photogrammetric scanning of objects. Photogrammetry is used to create 3D-information from series of 2D-images acquired by cameras. It can be used to reconstruct 3D-representations, shoot virtual videos or make orthorectified images [9]. In addition to a more realistic appearance with more compact data, 3D scanning can also optimize time in production [10] over the classic approach presenting a quick series of 2D photos. One of the publicly available metaverse software solutions will be chosen for the prototype. Utilizing the feature of Hypertext links in the creation of this virtual museum should be considered. If there are users who need comprehensive information, they can get the full information and even download such data via these links. This needs to be considered based on the assumption that virtual museums are now becoming an important source for research and education [11].

Tests will be carried out in stages. Preliminary tests in the form of low-fidelity prototypes are carried out independently with the aim of finding difficulties and weaknesses in design and software performance, while comprehensive tests will be carried out on high-fidelity prototypes and these tests will be tried directly on target groups, namely high school students. These will be followed by a questionnaire and by direct observation.

3 Results and Discussion

3.1 Empathize and define stages

The distribution of questionnaires to find out the extent of students' knowledge and insight into a museum was carried out at SMAN 13 (a senior high school) in Garut, with 33 students. The results are as follows: of those students 93.3% confirmed interest in visiting a physical

museum, but only 51.5% had ever visited one. 15.2% had already visited a virtual tour, but 33.3% found the experience of a virtual museum exciting, while 9.1% had difficulties moving around and 57.6% experienced technical difficulties when trying to access it.

One question regarding the students' opinion of a museum was not multiple choice but text-based, for this the results are: thirteen students connected a museum to historical artefacts and information, three students connected a museum to artworks, two students answered that a museum is a place for fossils, while nine students thought that a museum is a playful place and six students connected it with a place for gaining plenty of information.

From the results of the user questionnaires, it can be concluded that students actually would like to go to museums. They expect a museum that can provide quite a lot of historical information but should at the same time be presented in an engaging way. If they can enjoy a virtual museum, they expect easy access to explore the virtual museum.

3.2 Ideate

The key points that can be distilled from the insights above are that the virtual museum must be created engaging, immersive, and accessible. These points are used as the basic requirements for the design of the museum. These necessities are fulfilled by a metaverse approach. The research team decided to create four museum rooms, containing artifacts from West Java, Central Java, and East Nusa Tenggara, and a central room. The students involved chose Gunung Padang Cianjur (a megalith site), Tarawangsa music, West Java traditional children's games, the economy from Majapahit Era, 3 reliefs from Prambanan, and East Nusa Tenggara sculptures. This virtual museum is named "Museum Maya Indonesia" (Virtual Museum of Indonesia) or "Mu-Ma-In" in short.

The museum is designed to have a basic form derived from a Mandala, the main room is connected to four exhibition rooms, which are arranged based on wind direction of Hinduism mythology. The Banyan tree right in the center of the main room is to symbolize the unity of Indonesian culture. The whole museum is set under environment level as an unobtrusive architecture, but with some external landmarks added.

3.3 Prototype

The main room of the prototype is the entrance area and should be interesting enough to enter and at the same time contain explanations of use and the content to expect. It contains 3D objects (some animated), sound and 2D images and text.



Fig. 1. Main room of the virtual museum

The core of Gunung Padang room (Fig. 2) is a 3D representation of one of the terraces of this pre-historic, monolithic site. A very detailed video on the left wall is explaining the

archeological importance of the site. Further explanations are given on the right side in text, which can be viewed page-by-page or downloaded.



Fig. 2. Gunung Padang room

The Prambanan and Majapahit Economy room (Fig. 3) is dominated by a 3D model of the ancient ship, according to the reconstruction from the Borobudur relief, and a giant statue of Shiva. Infographics on the left give further explanations. On the right is a 3D reproduction of reliefs from Prambanan with an audio commentary.



Fig. 3. Prambanan Reliefs and Majapahit Economy room

The Tarawangsa room (Fig. 4) is dominated by a spiritual, musical tradition, which is shown on the rear as video and sound of the musicians playing and a 3D static representation of the constellation when playing. Infographics explain the background of this tradition and two of the instruments are shown in greater detail.

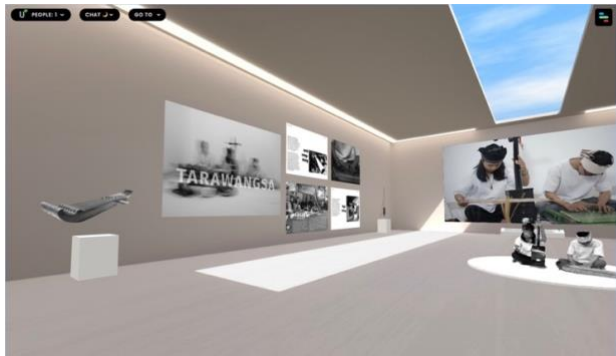


Fig. 4. Tarawangsa room

The room of traditional childhood games (Fig. 5) is the only one with full 3D animation, which can be critical on the performance side. A video with sound in back is giving background information an 2D infographics are giving the rules of the games.

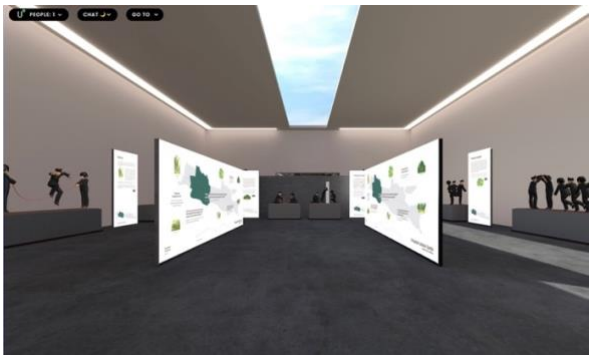


Fig. 5. Traditional children’s games room

To indicate that the museum is “located” in Indonesia, there is an imaginary landscape (Fig. 6) with a 360 degree spherical environment and a few 3D objects. Large 3D statues are intended to attract the visitor to the location of the four entrances.



Fig. 6. The environment on the top ground

3.4 Testing

The high-fidelity prototype test was conducted on twelve high school students for three hours. Students were divided into three groups, the first group of students accessed Mu-Ma-In using a cell phone, the second group of students accessed Mu-Ma-In using a laptop, and the third group of students accessed Mu-Ma-In using Meta Quest 2 VR glasses. After that, they filled out a questionnaire to express their opinions, and the results are as follows: 91.7% had no difficulties with login to the prototype, only 8.3 experienced it as problematic. Navigation was easy for 91.7% as well. Animated objects had the highest value for attraction at 41,7%, video presentations followed at 33.3%. The static 3D environment and relief had considerably lower attraction values at 8.3% each, similar to the ship model. Understanding of the content by rooms was as follows: The Gunung Padang room was the easiest to understand at 9.1% of complexity, followed by the Children’s Games room at 18.2%. Both the Tarawangsa room and the Main room were harder to understand at 36.4% with issues for

each room. Nevertheless, the emotional experience was valued by 91.7% as positive and only 8.3% found it less touching.

The results show that most of the users can easily access the software, and they do not have any difficulties to navigate in the virtual tour. There is some information still indicating a lack of convenience. One question regarding the students' perception and emotional reaction to this virtual museum was not multiple choice but text-based answer. The results are as follows: One respondent was happy to meet a classmate virtually in the museum (represented by an Avatar). Two respondents did not answer. One respondent got reminded of Museum Dirgantara Indonesia, two respondents felt happy to be virtually visiting a museum, one respondent felt happy and excited, but suggested to have better operational instructions. Two respondents were enjoying to be in the Tarawangsa room, and one respondent complained about difficulties to get into the same room. Observation is consistent with the results of the questionnaire regarding engagement and positive experience to learn, as shown on the figure 7, 8 and 9.



Fig. 7, 8, 9. Test with different devices (smartphone, VR and laptop)

4 Conclusion

The test of a prototype in a school has shown that such a virtual museum will be attractive and engaging for students and schools, especially in remote areas, and should be further developed. In line with design thinking this will need improvements in navigation, explanation, and content by further iterations. Such development would need support by existing museums, government institutions and private funding to develop a full-scale project after refining the prototype and later keeping it growing and accessible on a large scale for cultural education.

Further usability tests in schools should be carried out. On the technical side these will need mobile access points with sufficient bandwidth, since many schools do not have WLAN in all classrooms, and we should not expect the students to use their personal quota on cellphones. A portable projector for basic instructions and a reasonably dark room will be desirable. Some technical issues with the metaverse software still exist but given the rapid development we expect them to be overcome very soon.

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