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# Development of Interactive Virtual Tour Based on 360-Degree Panorama Technology at the Bandung City Museum

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**Abstract**

Virtual tours have been widely used to introduce sites or buildings, but not much in education and tourism fields. The Covid-19 Pandemic has encouraged the growth of digitalization in all fields, including the development of museum virtual tours as an effort to provide visitor access among various restrictions. Along with these developments, the Bandung City Museum seeks to present an interesting museum virtual tour that can provide the best experience to its user. The purpose of this research is to find out the development and evaluation of an Interactive Virtual Tour Based On 360-Degree Panorama Technology At The Bandung City Museum. The research method used is Research and Development, with an analysis of potential and problems to improve the final product. The Virtual Tour allows users to navigate around the Museum building and listen to the narration, as well as read brief information about each object. For improvement, the virtual tour was also evaluated for usability by the users. Overall responses show that the virtual tour received positive feedback and was able to create satisfaction for the users, with several things to improve such as sound, images, and navigation quality.

*Keywords*: Virtual Tour, 360 Degree Panorama, Museum of Bandung City

## 1. Introduction

The Covid-19 pandemic has led to digital transformation in all fields, including in the field of tourism, education, and museum. The virtual museum concept was adapted from a virtual tourism tour and introduced as an alternative to conventional museum visits which were limited during the pandemic. The virtual museum tour is a combination of the traditional museum concept with multimedia technology and internet communication technology. Museum virtual tours dematerialize objects to provide more information about objects: images in all their manifestations (2D, 3D, detail, etc.) and knowledge of images (intrinsic information about objects, extrinsic information about object contexts, historiographical information, reference information, etc.). Museum virtual tour also allow the implementation of "remote visits" from all around the world. Museum virtual tours thereby offer the possibility of viewing various collections to the public and various other types of services; in this way, it becomes also a true commercial medium for the promotion of site-related products, services, and knowledge. At the computer level, museum virtual tours are portals that offer a wide variety of functions and services.(Djindjian, 2018) Now, the Museum Virtual tour has grown to become an all-encompassing term, referring to all types of digital representations of both digitized physical objects and born-digital ones that can be related to physical objects (Perry et al., 2018).

The Bandung City Museum was planned in 2015 by the Mayor of Bandung M. Ridwan Kamil, to comprehensively introduce the history of Bandung to the public. Currently, the museum is still in the first phase of construction, namely the completion of the physical reconstruction of its heritage buildings. Bandung City Museum was planned to have 2 (two) main visiting areas. First, the Heritage Building and the New Building which exhibits a collection of photos, films, images, sound recordings, and artifacts with the following composition: Photo/Film (60%), Pictures/Graphics (10%), Documents/Archives (20%), and Artifacts/Sound Recordings (10%). The Cultural Heritage Building consists of several exhibition rooms, namely: the main lobby and 4 (four) exhibition rooms. The main lobby contains murals and highlights of Bandung City Museum. Next up is the Bandung Early Beginning Showroom, which contains material on the journey of Bandung from its birth to the classic era. The next exhibition room is the Bandung Europe in de tropen (Europe in a

Tropical Country) room, which contains material about the journey and development of Bandung as a colonial city. The third exhibition room is named Bandung Bergerak, which provides stories of physical and non-physical national movements and struggles that took place in the city of Bandung. The last showroom is named Bandung Bergiat, which contains materials about the city of Bandung from the early days of Indonesian independence until the modern era (Wiryawan, 2018).

Along with the development of visitor preferences, virtual tours are designed so that museum visitors can access museum content more pleasantly without the need to be physically present at the museum. This research uses descriptive research methods to obtain responses and feedback from the user for future improvement. The virtual museum will be presented using virtual 360$^{o}$ panorama techniques, and interactive audio and visual displays using popular scientific language styles, to give the best experience to its user. However, this museum virtual tour is not supposed to replace the traditional museum, as Perry et al. (2018) states that virtual tour still has limitation in order to connect the museum and its visitors in term of emotional, participatory, interactive and social fashion (Perry et al., 2018).

## 2. Literature Review

The museum interactive virtual tour is the result of a combination of the physical concept of the museum with the concept of a multimedia computer supported by the development of communication technology (Meng et al., 2023). Museum Virtual Tour certainly presents a simulation of a place that exists, usually consisting of a collection of panoramic photos, a collection of images connected by hyperlinks, or videos, and can also use other multimedia elements such as sound effects. , music, narration, and writing. In contrast to actual tours, Virtual Tours are usually accessed via desktop computers, information kiosks, or other electronic media (Kaminski et al., 2013). The implementation of virtual tours is often used to introduce tourist attractions or historical places (Ceulemans et al., 2018).

The virtual tour can also be defined as an immersive technology that places the viewer in the image, enabling them to significantly increase situational awareness and providing the highest level of functionality for viewing, capturing, and analyzing virtual data. A virtual tour can be clarified as a simulation of an existing location, consisting of a sequence of images and videos. In addition, it can be developed from photography-based media or panoramas that have an unbroken view (Osman et al., 2009).

The use of 360 Degree Panorama Technology in this case to produce uninterrupted visual and audio designs of real environments. 360 Degree panorama representation strengthens visitors' perceptions of the site by generating multiple layers of information such as audio, text, video, and 2D and 3D objects (Eiris Pereira et al., 2017). 360 Degree panorama technology also allows users to move through an environment, without being there physically, by presenting an immersive simulation of a specific environment (Eiris Pereira et al., 2017).

## 3. Material and Method

### 3.1 Material

The following are product specifications and designs that will explain the media design consisting of graphic design, music and sound design, interface design, algorithm design, and gameplay of the interactive virtual tour of the Bandung City Museum. The museum virtual tour architectural design stage can be seen in Figure 1 below:

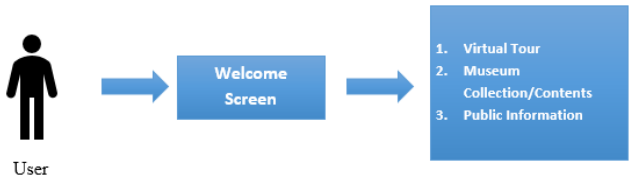


**Figure 1**: Museum virtual tour architectural design

The Bandung City Museum virtual tour application is designed with the following specifications:

a). Can be run on various platforms and gadgets (smartphones and tablets) with a minimum specification of 1 GB of memory and 100 megabytes of storage.

b). Having an attractive graphic design to avoid boredom of teenager users.
c). Having an Audio-visual design including the composer's design of text, speech, Music, and SFX (sound special effects) allows users to get an experience like visiting a museum directly.
d). Attractive interface design so that users are not expected to have difficulty in running this media.

## 3.2 Software Used

The main software used in developing this virtual tour application were PTgui, Izotope RX8, and Adobe Photoshop. PTgui software was used as a tool for sewing images (image stitching). The image that has been obtained from the results of data collection in the form of .jpg files will be stitched using the PTgui application. In the process of sewing the image, the RANSAC (Random Sample Consensus) method is used to find the homographic matrix. Homographic matrices are used to project one image onto another image according to the features of the match found. A feature match is part of two overlapping images. In the PTgui application, suitable features are searched by determining several key points of an image on another image. the image will undergo geometric transformations such as translation, rotation, scaling, skew, shear, etc.(Wani et al., 2022). Moreover, the process of editing and recording the sounds was done by using Izotope RX8 software.

## 3.3 Product Overview

The Table 1 below is the product overview:

**Table 1**: Product Overview

| No | Overview | Description |
|---|---|---|
| 1. |  | This is the opening page, consisting of the introduction, welcome speech, location, map, and team. |
| 2 |  | The Lobby, consisting the history of the museum, and the description of the murals and highlights. |
| 3 |  | Exhibition Rooms contain panels of pictures and descriptions. Visitors can listen to the speech of each content. |

## 3.4 Method

This study uses Research and Development research methods, with stages consists potential and problems to produce the final product. According to Gustiani (2019), the research development method is a method used to produce certain products, and test their effectiveness of these products (Gustiani, 2019). This method was chosen to provide design, expert tests, and responses from various sources of the Development of an Interactive Virtual Tour Using 360 Degree Panorama Technology at the Bandung City Museum.

The object of this research is an Interactive Virtual Tour product using 360 Degree Panorama Technology at the Bandung City Museum which was developed in 2021 by PT Tiga Bima Sakti and the Bandung City Museum Team, consisting of Nia Barbo (Project Leader), Rico Hidayat (Programmer), M. Ryzki Wiryawan (Contents Provider), and Julius Tomasowa (digital conservator). The evaluation of the subject will be composed by 50 users.

The Research and Development (R&D) method has eight stages, but only six were used for this study. From the preliminary steps, the products would be designed and developed for later testing and improved/revised), the research and development (R & D) approach in education has ten steps which can be seen in figure 2 below :

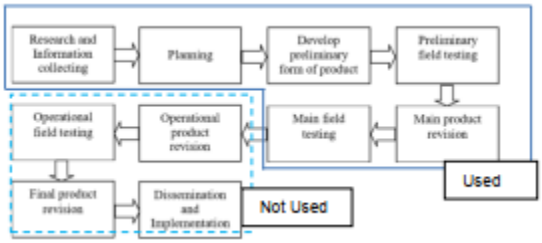


**Figure 2**: R&D Stages (Borg W R & Gall M D, 1989)

In determining the product concept, the design problems will first be determined by selecting and developing an analysis of the potential and problems which should be undertaken first, in this case, the limitations of conventional museum information media which cannot provide interactive aspects to visitors is the main problem. After that, the information collection, planning, development of the preliminary product, self-testing, and revisions will be carried out to determine the feasibility and effectiveness of the museum virtual tour based on 360 Degree Panorama Technology The research design was post-test-only by a group of users.

The data collection technique was an interview, validation, questionnaires, and tests (Wibawa et al., 2018). Interviews were conducted to obtain information directly from the producers. Validation is the evaluation determining the validity of the data managed by the validator. Questionnaires are several written questions used to determine the user's usability of the product.

The usability tests were conducted to gain user feedback and to measure the usability of the prototype on user satisfaction and product effectiveness. The usability tests were conducted in the computer laboratory and on the user's smartphone. One of the researchers acted as the facilitator, who conducted the session. The participant was introduced to the product prototype and was briefed on the purpose of the usability test. The sample users came from random various backgrounds, and have never seen or used this virtual tour before. However, all of them have used the computer for more than five years. All participants were required to interact with the prototype for a minimum time of 5 minutes. The tasks centered on navigating the prototype such as exploring a destination, entering a hotspot, and viewing its surroundings as well as using the navigation tools and listening to the information. Once they had accomplished all tasks, they were asked to fill in an evaluation questionnaire to rate their satisfaction towards the speed of scene movement, image quality, sounds, and attractiveness of the virtual tour. In addition, they had to rate the effectiveness of the application of the terminologies used, its navigability, and the textual description. The answers ranged from 1 (Strongly Disagree) to 4 (Strongly Agree). The usability test adapted from Osman et al. (2009) study, elicited a few requirements and useful suggestions about Speed of scene movement, Navigation, Background sounds, Terminologies/Description, Quality of scenes/images, Voice description, Information Quality, Attractiveness, and Suggestions (Osman et al., 2009).

## 4. Results and Discussion

### 4.1 Validity test

The validity test was used to show the extent to which a measuring instrument can measure what it wants to measure, along with the results of the calculation of the validity of the virtual tour user questionnaire.

Calculations on the SPSS program show that the value of the Speed of scene movement is 0.757; ease of navigation is 0.757; background sound quality is 0.666; description quality is 0.777; Image quality is 0.614; voice quality is 0.729; Attractiveness quality is 0.762; Information quality is 0.689. The value of with df (N-2) = 48 is 0.2353, this value indicates that the value of for the questions on the questionnaire has a value of greater than, therefore it can be seen that all indices are valid. The significance value of each question is 0.00 which is smaller than 0.05, so it can be concluded that all questions are valid.

### 4.2 Reliability Test

A reliability test is to determine the extent to which the measurement results remain consistent if the measurement is carried out twice or more on the same symptoms using the same measuring instrument. The reliability test shows that Cronbach's Alpha value is 0.864 or 86.4% as shown in Figure 3 which is greater than the minimum Cronbach alpha value of 0.6, so it can be concluded that the instrument used to measure Virtual Tour usability is reliable can see Table 2.

**Table 2**: Reliability Test

| Cronbach's Alpha | N of items |
|---|---|
| 0.864 | 8 |

### 4.3 Usability Evaluation

After testing the validation and reliability of the usability virtual tour questionnaire data, then a descriptive analysis is carried out on all usability indicators. The virtual tour app was shared with 50 random users. Then the usability tests were conducted to receive user feedback and to measure the usability of the product including user satisfaction and product effectiveness. The usability tests were conducted from users' smartphones or personal computers. They were given 10 minutes to explore the museum virtual tour laboratory of the university. Besides the questionnaire, the open question was delivered to users' to gain suggestions for product development. They are summarized in Table 3.

**Table 3.** Results of Usability Test

| **Evaluation Criteria** | **Feedback (50 Respondents)** |
|---|---|
| Good quality of Speed scene movement | Strongly Agree = 37.5%<br>Agree = 60.4%<br>Disagree = 2.1%<br>Strongly Disagree = 0 |
| Good Navigation (Easy to Navigate) | Strongly Agree = 37.5%<br>Agree = 60.4%<br>Disagree = 2.1%<br>Strongly Disagree = 0 |
| Good quality background sounds | Strongly Agree = 41.7%<br>Agree = 50%<br>Disagree = 8.3%<br>Strongly Disagree = 0 |
| Good / clear Terminologies/Description | Strongly Agree = 35.4%<br>Agree = 52.1%<br>Disagree = 10.4%<br>Strongly Disagree = 2.1% |
| Good quality of voice description | Strongly Agree = 41.7%<br>Agree = 50%<br>Disagree = 8.3%<br>Strongly Disagree = 0 |

| | |
|---|---|
| Ability to provide good and useful information | Strongly Agree = 54.2%<br>Agree = 43.8%<br>Disagree = 2.1%<br>Strongly Disagree = 0 |
| Good quality of scenes/images | Strongly Agree = 43.8%<br>Agree = 54.2%<br>Disagree = 2.1%<br>Strongly Disagree = 0 |
| Good quality of Attractiveness | Strongly Agree = 52.1%<br>Agree = 43.8%<br>Disagree = 4.2%<br>Strongly Disagree = 0 |

Overall the usability test shows that majority of users were satisfied and attracted to the application. However, based on the score, some improvements are needed to make the virtual tour more appealing. For example, it should be the improvement of background sounds, descriptions, and images. Good suggestions were also compiled from the users such as:

- Some users receive a bad quality of sound and image, which might have been related to unsupported hardware specs.
- The use of Sundanese traditional music as background music.
- More clues for navigation and clear description.
- More freedom for the user to navigate all around the museum space.
- To add more exhibition rooms, including a map of the museum, so it will be easier to navigate.
- Short tutorial at the beginning of the application.
- On/Off sound panel so the user can focus on the explanation voices.
- Portrait view.
- Add more animations.
- English version of the contents.

Nonetheless, it was observed that users could easily navigate and enjoy the museum virtual tour. Some complaints were gathered in terms of sound, image, or speed that might depend on the users' device quality, due to the fact, that the device will adjust the image and sound quality according to its capabilities. The addition of a tutorial and navigation sign also contributed to user feedback. All the above suggestions will be adapted to the development of the virtual tour app.

## 5. Conclusions

The research discovered user preferences and suggestions for the improvement of the Interactive Virtual Tour Based On 360-Degree Panorama Technology At The Bandung City Museum. It was found that the overall aspects of the virtual tour already pleased the users and they can receive museums' material the same as they visit the museum physically. This virtual tour also can be applied in another museum or place such as a historical place to promote its attraction. However, since the users come with various types and quality of devices, the programmer should think about creating a product that can meet minimum requirements.

## 6. Acknowledgments

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