EFFECT OF THE IMPLEMENTATION ATTRACTIVE AUGMENTED REALITY FOR MUSEUMS VISIT

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ABSTRACT. *Implementation of Augmented Reality (AR) in a Bank Indonesia Museum attracts people's intention to augmented technology, making people interesting to visit a museum. It can change model service in Museum Indonesia, with AR museum providing better information about museum objects. High visual detail on a virtual object in Bank Indonesia augmented reality application increases the immersive level experience of the visitor when seeing a museum object. Interaction in application also makes increasing immersive, funny and enjoyable experience when visiting a museum. Visitors who were previously forbidden to touch the museum objects can interact with the museum objects; through the virtual images contained in the application, it creates a feeling of immersion, fun and enjoyment. Augmented reality implementation increases the number of Museum Bank Indonesia visitors and increases the museum's income, when income increases, the museum can take care better of their collections, and then have fund to explore or search for new historical objects or collections for the museum.*
Keywords: Augmented reality, Museum service model, Edutainment, Immersion experience, Historical valorization

1. **Introduction.** The museum is an institution dedicated to collecting, caring for, presenting and preserving the cultural heritage of the community for study, research, and providing fun and entertainment purposes. The purpose of the museum can also be used to present the latest technology to the public. A museum can be used as a means of conveying information and a showroom for something.

The interest level of visiting the museum is very low, perhaps because of the museum conveying information about the exhibited items or objects not in an attractive way. Almost all museums' displaying information is still dominated by texts beside the heritage object. This makes people not interested to visit the museums because they are borning. Low interest to visit a museum, causes the opportunity to educate people about history, culture, art, technology, and many other things that cannot be achieved.

One of the challenges faced by the museum in disseminating information about museum objects is that the information itself is old, and needs a more interesting way. It needs to combine multimedia technology with this old information. Game, virtual reality, and augmented reality, a current and trend technology in multimedia, can be used to deliver an old and bored information to become more attractive, enjoyable and give impressive experiences.

Bank Indonesia Museum, at Jl. North Great Door No. 3, West Jakarta, Indonesia, faces a problem with the dissemination of information about financial development revolutions in Indonesia, from the Dutch colonial era until the present. The museum which was

inaugurated on December 15, 2006, has 246,913 visitors on average a year from 2011 to 2014, third rank in terms of the number of visitors after Sejarah Jakarta Museum and Wayang Museum. Compared to other tourist attractions, the museum still has a smaller number of visitors.

In the Bank Indonesia Museum, we can see the history of economic development in Indonesia from ancient times to the present. One of them is the history of the monetary crisis in 1998 and the history of the Bank Indonesia logo. Various collections of currencies and piles of gold bullion were displayed on Bank Indonesia. The currency collection was considered less attractive because it only displayed information in the form of text in Indonesian and English and seemed less interactive. Museum Bank Indonesia has a problem displaying the items of its collection and the information attractively, and for that we need a new way to present the collection.

The museum is an interesting place to introduce Augmented Reality (AR) technology to the general public. The interaction between visitors and mobile devices is used to determine whether AR is working and useful. Based on a preliminary test from Lee and Park [1], AR systems are especially useful in guiding users to exhibit in some specific context, for example, many users learn more about the meaning of the paintings. Also, a study proves that AR can build interactive learning and entertainment scenarios that can change visitors from passive audiences and readers to active actors and players [2].

AR can be a new communication model to users/visitors in a museum by enhancing their experience with immersive experience [3] and give more authentic and accurate acknowledgment of products and services [4]. Virtual Reality (VR) and Augmented Reality (AR) increase attention in tourism and cultural heritage [5]. Based on Trunfio and Campana's research implementation of VR and AR has function as exhibit, service, historical period, city attraction, entertainment, educational and socialization tools for any object or information in a museum. VR and AR can be a new business model with interaction between museum service (exhibition and service) and multimedia technology as a value proposition. An integration between museum heritage and physical element and mixed reality generates unique experiences, also combining edutainment and heritage valorization. Capuano et al. [6] implemented to combine AR with semantic technique to create digital stories associated with museum exhibitions. Combine the cultural resource with external multimedia technology to create a new model museum narrative. Matuk [7] uses AR as an emerging technology with the potential to transform learning. By adding information to the physical world AR creates a new sense that real-world and virtual objects coexist and can enhance people's interaction with a virtual object. Colcol et al. [8] implemented augmented reality in a mobile application for exhibiting Museo Ng Katipunan historical object to increase interest level of visitor.

For this reason, we propose a more interesting way by using AR technology and mobile technology, an immersive AR mobile application as part of a visit to the Bank Indonesia Museum. An AR application provides new experiences or giving immersive and historical valorization experience. Provide new experiences for visitors because they interact digitally with museum collections, make displayed objects in the museum to be more interesting, so it can attract more visitors to visit the museum. This application is used to promote historical economic development and monetary historical object to make visitors know and understand Indonesia's economic history. This application also aims to create a new business model for museum Bank Indonesia, to give better service to visitor. This paper will present a literature review about AR, related work, research method, discussion, evaluation, and conclusion for this study.

2. **Literature Review.**

2.1. **Smartphone use.** In a survey of smartphone ownership conducted by the Pew Research Center with 30,133 respondents from 27 countries, it is known that 42 percent of Indonesians already own a smartphone [9]. One smartphone operating system that is used by many people is Android because it has many interesting features and applications. One of the types of applications that can be applied to Android is AR. Based on this information authors decide to develop the application in an Android platform.

2.2. **Augmented reality.** Augmented Reality (AR) is a new technology that gives an interactive experience in a real environment where virtual objects are mixed on display output. Virtual objects can be in the form of images, videos, animations, or text. AR has three basic features: the combination of the real world and the virtual world, real-time interactions, and the depiction of virtual objects that are made in such a way with real-world objects. A technology can display virtual object in real environment, and make it easier for people to capture the information conveyed compared to text because it contains attractive visual animations. Augmented Reality (AR) is an experience where designers enhance parts of users' physical world with computer-generated input. Designers create inputs – ranging from sound to video, to graphics to GPS overlays and more – in digital content that responds in real time to changes in the user's environment, typically movement [10]. According to Billinghurst and Dünser [11], AR is a technological capability that allows a seamless connection between digital and physical domains. Unlike immersive virtual reality (which produces 3D images that seem to surround the user), the AR view allows the user to see the real world at the same time with virtual images attached to real locations and objects. AR has clear advantages over traditional virtual reality. Alkhamisi and Monowar [12] say that one of the advantages obtained by AR is having better feelings throughout interactions, whereas it emphasizes the organic integration of the virtual environment and the real world. There are two types of marker: marker and markerless use in AR [13,14]. Interacting with a QR code printed on a card is called a marker, which can be thought of as being akin to interaction with a real interface. Using gestures to interact with the virtual environment and understood as a natural interface, where there is no fiduciary marker, is markerless AR.

2.3. **Augmented reality implementation.** The number of applications using AR continues to increase and the results are clear across many domains, for example, in health care, business, education, design, and entertainment [12] such as: 1) **Medical**: medical learning and practice, 2) **Education**: hybrid AR with a book or other learning, 3) **Commerce**: mobile coupons, product shopping, product shopping, and shopper browsing through different references using AR, 4) **Advertising**: AR on printed multimedia campaign augmented, 5) **Entertainment**: In the world of entertainment, AR is used in the film or game industry and 6) **Design**: AR has been used in the world of design, where users can more easily do designs, especially in 3D.

3. **Related Work.**

Implementation in the museum. Ghouaiel et al. [15] implemented Mobile Augmented Reality Touring System (M.A.R.T.S) in a museum in France, and they implemented a virtual guide tour in their application. They give experiences virtual guided visiting tourism in a museum. Another kind of implementation of AR in museum is proposed by Hammady et al. [3], and they implemented gamification in the AR application to enhance the existing AR guided systems in the Egyptian Museum in Cairo. He et al. [16] research about influent factor in imagery in AR, they found high-level virtual presences giving psychological effect for the visitor, making them willing to pay more when visiting the museum. Torres-Ruiz et al. [17] said hybrid implementation with the Internet of Things

(IoT) sensor as visualization tools, and customized recommendation when visiting museum gives better experience. Paliokas et al. [18] implemented gamification to enhance AR experience in a museum, combining user environment, physical and perceptual abilities, know metaphor, user position, and motion in 3D, user can take advantage of enhancing museum experience to maximize their satisfaction and learning outcomes. According to Capuano et al. [6] use of AR increases the interest and curiosity of children in a given topic because of allowing them to get involved in historical contact to learn material and intangible heritages.

We also do comparisons with several similar applications to find out what good features we can implement in our application. Keraton Sumenep Museum, Sonobudoyo Museum Yogyakarta, and Badan Pemeriksa Keuangan RI Museum implemented AR application on their museum, to explain the paintings/images or exhibited objects in the museum, it can make the displayed object be more interactive.

4. **Research Method.**

4.1. **Framework.** Bank Indonesia Augmented Reality (BIAR) application functioned to display objects and give information about a historical object in Bank Indonesia Museum. Delivering information using an attractive and interactive way, the application can display descriptive text and audio, displaying virtual 3D object of a historical object, and the user can interact with this virtual object by hand. The applications is built using AR SDK such as EasyAR and developed in Game Engine Unity.

BIAR is developed using the Waterfall framework with the following stages.

1) **Communication**: Interviewing the stakeholder to know about user requirements for application, we also observe other application to know what feature can we build.

2) **Analysis and Planning**: Based on user requirements, we analyze the project, design the feature on the application which wants to build, make a project plan, allocate human resources, and make budgeting to finish the project.

3) **Modeling**: The modeling stage is carried out by designing an application, a wireframe, and designing a system, namely use case diagrams, activity diagrams, and class diagrams, and several other diagrams. Design features and functionality for the developed application.

4) **Construction**: In the construction stage, write code using the Unity and EasyAR game engine by following the application and system design that has been previously made and can repair bug error if found.

5) **Deployment**: The deployment stage is the stage to implement the application to the user, followed by an evaluation of the AR application that has been developed. Evaluation makes sure the functionality and performance of the application meet the user's needs. Evaluation is conducted by user and developer.

4.2. **User requirement.** In the communication stage, the authors interview 50 respondents to determine the user's needs for AR applications that will be applied in the museum. From interviews and questionnaires the results (Figure 1) are as follows.

1) Visitors who are interested in using AR are visitors aged 20-24 years old as much as 50%, followed by visitors aged under 20 years as much as 20%, and more than 24-year-old is 30%.

2) Most visitors visited the museum less than 5 times in one year (89%), and 5-10 times only 9%, and 2% more than 10 times.

3) The motivation for visiting the museum varies if sorted according to the number of respondents who answered the motivation as follows: objects displayed in the museum, history of the museum, museum design, ticket prices, and following the trend.

4) 80% of respondents, were already familiar with AR, and from these people, 60% of respondents, were already using AR.
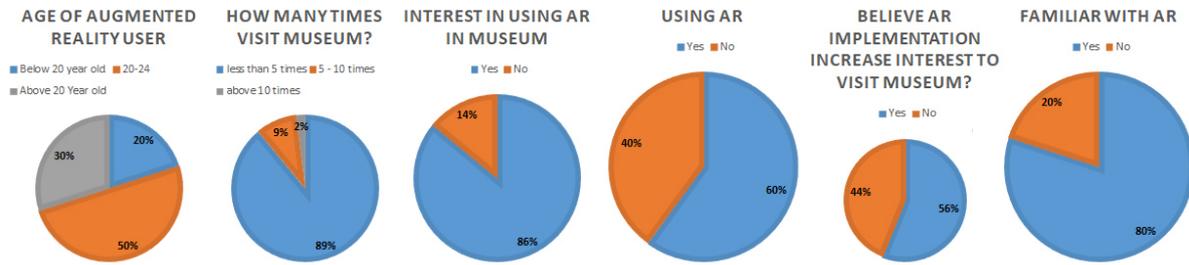
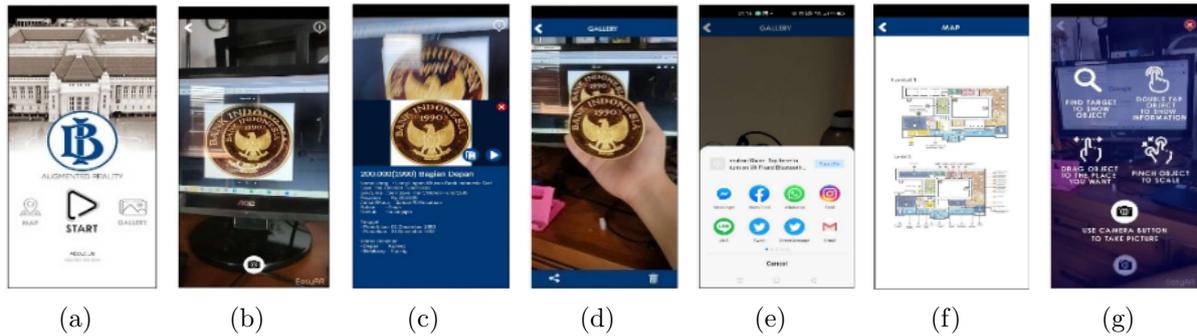FIGURE 1. Questionnaire result for user requirement

FIGURE 2. (a) Start screen, (b) marker scan screen, (c) information windows, (d) galery, (e) social media share, (f) museum map, and (g) frequently asked questions

5) 86% of respondents were interested in using AR at the museum.
6) 56% of respondents, believe AR increases interest to visit museums.

5. Discussion.

5.1. **Development stage.** BIAR application was developed to broaden the insight of visitors who come to the Bank Indonesia Museum. BIAR application gives visitor to get new experiences using AR technology and get information in new ways. This application is implemented on Android smartphones with many users in the world. With this new way like 3D graphics, it is hoped that users will be more interested in visiting museums and find it easier to get information about objects in the Bank Indonesia Museum. The markers used in this application are objects contained in the museum, in the form of banknotes or metal on display.

Museum visitors will walk around the museum, from one object to another, and visitors can scan the surrounding environment of the objects on display to get markers embedded in these objects. When the visitor successfully scans the object, the application will explain the object of the exhibition, using text, sound, and animation through a virtual object that is precisely placed on the object. Of course, this display can only be found on the smartphone screen of the user, who runs this AR application. User can interact with the object, touch it, rotate it, flip the object back and forth, and all forms of interaction that have been programmed in the application.

Applications built for the Android platform, minimum Android specifications to install this software are Jelly Beans. Applications are built using standard design rules for a good user interface. Design using a modeling diagram of the Unified Modeling Language (UML). The programming language used is C #, use Easy AR Software Development Kits, and built in the Unity Game Engine. On stage before implementation, the authors test the application to remove bugs and errors in the program, the testing used is black-box testing and white-box testing.

5.2. **Evaluation.** After the application is implemented, we also evaluate the application for user acceptance, we ask 30 museum visitors and get the result (Figure 3).

1) 76.7% of respondents stated the application works well, and smoothly, and 23.3% of respondent stated the application works fair enough.

2) 53.3% of respondents stated the application is very easy to use, and 46.7% stated that the application is not easy to use.

3) 53.3% of respondents answered that the tutorials were very helpful used the app and 46.7% answered helpful tutorials.

4) 50% of respondents answered applications giving clear information, 30% said very clear information and 20% sufficient information about the object presented at the museum.

5) 60% answered a high-level visualization application is very interesting, 40% of respondents answer it is interesting and they will pay more when visiting that museum.

6) 60% of respondents became more interested in going to museums, 33.3% may be interested, and 6.7% not interested.

7) 56.7% answered the applications make them interested in AR, and 43.3% may be interested if AR is implemented in the museum.

8) 66.7% of respondents got an immersive experience when AR is implemented at an exhibited object and 33.3% find it little impact.

9) The reason for the immersive experience is because they can interact with the virtual exhibited object, which gives funny experience and enjoyment when they visited the museum.

By utilizing AR, the level of clarity of the information to be conveyed from the exhibited objects can be improved, utilizing multimedia elements such as text, audio, video in AR. This multimodal method improves the clarity when conveying information to a user. Interaction features to exhibited objects through its virtual object representation will
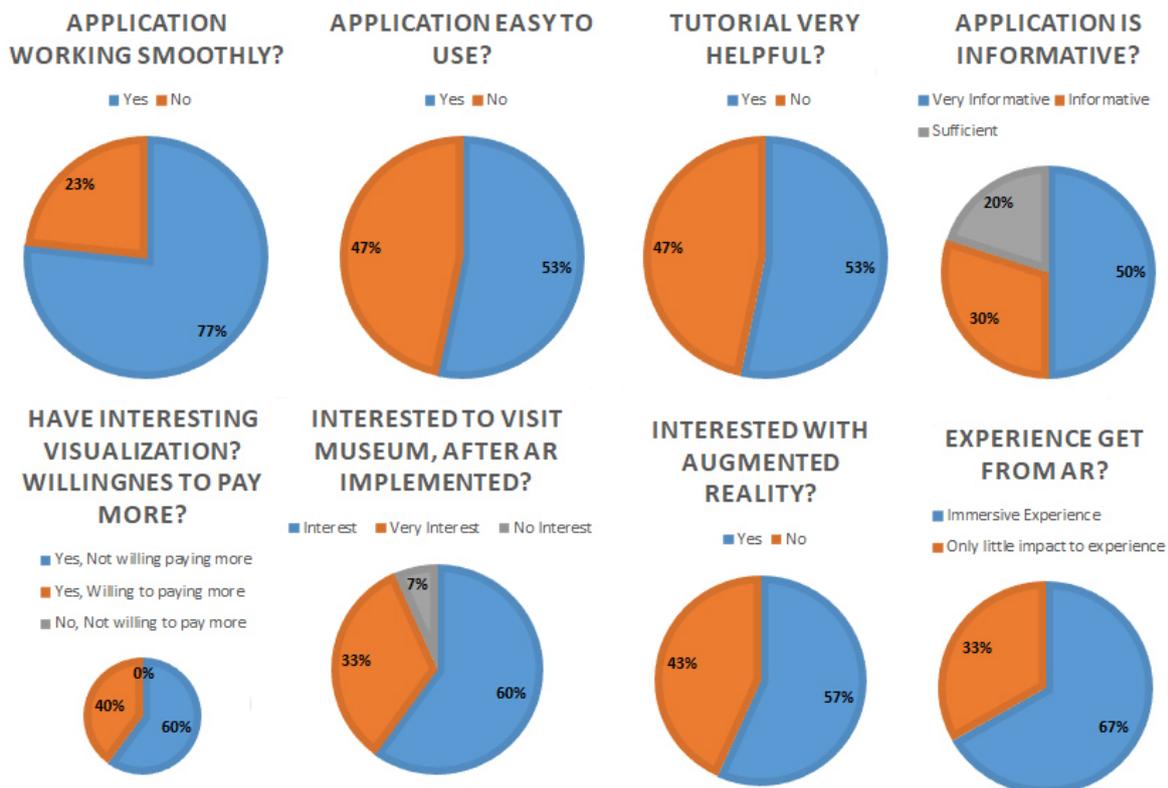

FIGURE 3. Evaluation result from the acceptance test

have a greater impact. Interaction features in museum AR application are increasing of immersive, funny, and enjoyable experiences when they visit the museum.

6. **Conclusion.** Based on the evaluation of Bank Indonesia Augmented Reality (BIAR), we can conclude, the BIAR application can attract people's attention to AR technology, and it can make people more interested in coming to the museum. AR technology changes the model museum service, with AR museum providing better information about museum object. High visual detail in AR application increases the immersive level experience of visitors for objects contained in the museum. The clearance of information about the exhibited objects and immersive experience from AR, makes the visitor willing to pay more when visiting the museum. Interaction on application also makes increasing immersive, funny, and enjoyable experience when visiting a museum.

For the further research, the application can be developed by adding animation to displayed object, interaction features to virtual object, to foster, impressive, funny, happy and enjoyable feeling, when visit the museum. We also will be adding a positioning/global positioning system feature to give more good experience for users because they know their position at the museum. If possible, we will add a 3D marker feature to make the 3D object as a marker.

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