Application of 3D Augmented Reality Kotta Cinna Site Museum Collection to Enhancing Cultural Tourism Experience

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Abstract. In today's digital era and technological development, museums and historical sites have been interested and adopted augmented reality technology to protect historical objects from the risk of direct touch of visitors as well as to enhance the experience and attractiveness of visitors. The purpose of this research is to display the artifacts of the Kotta Cinna Site Museum collection by applying 3D augmented reality technology that serves to enhance the experience of museum visitors in the context of cultural tourism. This research uses applied research methods while combining qualitative and quantitative research methods. The research stages are divided into 3 stages, namely pre-production, production, and post-production. The pre-production stage begins with observation, interviews, and selection of artifacts that will be used as AR models, followed by the production stage as the application stage, and then ends with post-production. This study resulted in implementing 3D Augmented Reality (AR) on three museum artefacts. Based on the questionnaire results, the application of 3D AR technology at the Kotta Cinna Site Museum positively impacts visitors' experiences, education, and artefact preservation. Strong support from younger generations demonstrates that AR can serve as a vital tool in enhancing the appeal of museums in this digital era.

Keywords: Augmented reality, museum, Kotta, Cinna.

1 Introduction

The Kota Cinna Site Museum was founded by a Universitas Negeri Medan lecturer named Dr. Phill Ichwan Azhari, M.S., in 2008, then inaugurated by the government in 2019, which collects archaeological findings of the Kota Cinna Site. The archaeological site is located on the shores of Lake Siombak, Paya Pasir Village, Medan Marelan District, Medan City. The Museum of Kotta Cinna Site stores 3,000 collections of historical objects resulting from archaeological findings in the area. The museum's collections include coins for trade transactions in the era, beads, wood from ancient ships, ancient animal fossils, and inscriptions. The museum is currently managed by its founder and still needs financial support from other parties. To meet the needs of maintenance and management, the museum still uses the founder's personal funds, assisted by the museum entrance ticket fee [1]. With the lack of management funds, care for the artefacts of the museum collection also requires more attention, as well as the governance of spatial arrangements so that many artefacts can be well preserved and protected.

JICOMS 2024, November 11-12, Jakarta, Indonesia

DOI 10.4108/eai.11-11-2024.2354465

With the many museum collections that correlate with the history of the Aur kingdom civilization, the Kotta Cinna Site Museum has the potential to be developed into cultural and educational tourism for local and international communities, which is very beneficial for the surrounding community. This is relevant to the expression [2], which states that the Kota Cinna Site Museum needs to be developed, and it is necessary to carry out a strategy that attracts tourists in the context of cultural tourism because it contains the history of civilization with evidence of archaeological findings.

In today's digitally connected era and the rapid development of technology, museums and historical sites are increasingly interested in adopting 3D augmented reality technology as a means to increase the attractiveness and interactivity of their cultural tourism experience. 3D augmented reality technology thus offers the potential to bring digital content directly into the physical environment, allowing visitors to interact with historical artifacts and surrounding scenery in a more dynamic and immersive way. The advantages and appeal of augmented reality with its various visual models, have been researched by [3], who collected multiple models of 3D Augmented Reality and others in the context of the digitization and technology transfer of cultural heritage.

The effectiveness of using 3D augmented reality-based video in the context of the Kotta Cinna Site Museum experience is quite relevant regarding the use of android technology, which is expected to increase visitors' understanding and appreciation of the cultural and historical heritage presented. The positive impact of the results of this research is to increase the insight of visitors and museum managers, as well as the government and the community, to improve the promotion and preservation of the rich cultural heritage in the region.

2 Methodology/Material

This research uses 3 research methods, namely applied, qualitative, and quantitative research methods. The combination of these three methods provides a holistic approach, integrating practical solutions, in-depth understanding, and measurement of the impact of the application of 3D AR in the context of cultural tourism. The applied research method was conducted to realize 3D augmented reality on 3 artefacts of the Kota Cinna Site Museum collection. This method aims to solve practical problems and provide relevant solutions in the context of cultural tourism through the application of 3D augmented reality (AR) technology at the Kotta Cinna Site Museum to enhance the tourist experience. This method is focused on developing applications or technologies that can be used directly by museum visitors.

Qualitative research methods are used to deeply understand tourists' experiences and perceptions of the use of 3D AR in the museum. Through observation, in-depth interviews, and data collection from participants, this method provides insight into how technology affects the cultural tourism experience. The main focus of this method is the exploration of the research subjects' perspectives to gain a comprehensive understanding of visitors' interactions with AR technology.

This study incorporates quantitative research methodologies to assess the level of satisfaction and effectiveness achieved through the implementation of 3D Augmented Reality (AR) in enhancing cultural tourism experiences. Surveys and questionnaires were disseminated to visitors of museums and the general public, categorized by the following age brackets: 15–25 years, 25–35 years, 35–45 years, and 45–55 years. The questionnaires were distributed via Google Forms, featuring predefined response formats and accompanied by augmented reality

video demonstrations. The collected data were subsequently analyzed to evaluate the extent to which this technology adds value within the spheres of tourism and education.

The questionnaire comprised ten inquiries, including: (1) the extent to which Augmented Reality (AR) enhances visitor experiences, (2) the role of AR in facilitating visitor education, (3) the primary advantage of AR in visualizing historical context, (4) the positive influence of AR on visitor attendance at the Kotta Cinna Site Museum, (5) AR's contribution to supporting artifact preservation, (6) AR's effectiveness in increasing the appeal of the Kotta Cinna Site Museum to younger audiences, (7) expectations regarding the future development of AR technology within the Kotta Cinna Site Museum, (8) the potential of AR to broaden the museum's reach to an international audience, (9) anticipations for the integration of AR with other technological advancements at the Kotta Cinna Site Museum, and (10) AR's long-term contribution to historical education at the Kotta Cinna Site Museum.

2.1 Research Stage

This research has a flow or stages of research that can be seen in table 1.

Table 1. Flow of Research Stages

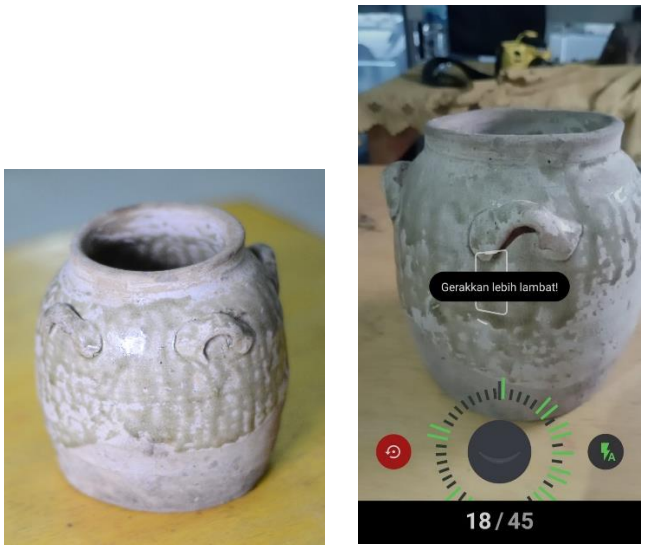
(1) Pre-Production	(2) Production	(3) Post Production	(4) Validation & Measurement of User effectiveness
1. Validation & Measurement of User effecti1. Problem identification 2. Literature study 3. Together with the museum, determine the artefact model that will be applied to 3D AR. 4. Determine the expert team veness 5. Conceptualising, AR design and software testing	1. Photographing & 3D scanning of museum collection artefacts with 3D MagicScan application. 2. Image integration using 3D Blender 3. Continued using the Vuforia Engine website 4. Continued to the Unity 3D website 5. Sound recording 6. Marker & QR code creation 7. Creation of special application for AR scanning	1. Prototype testing 2. Visual revision 3. Revision of tone of voice (doing 4. voice re-recording) 5. Re-scan the artefacts using 3D Magicscan 5.	1. 3D AR validation to AR experts and museum managers 2. Analysis of questionnaire data on 3D AR user satisfaction

AR Pre-Production Stage

The pre-production stage is a research stage starting with the identification of problems at the Kotta Cinna Site Museum, which is currently trying to digitalize the artefacts of the Kota Cina Site findings, which are a collection of the Cinna Kotta Site Museum. 3D-based Augmented Reality (AR) is one option that should be developed. Of course, this is supported by literature studies with other museums that are also developing augmented reality as an effort to preserve and increase visitor interaction. Furthermore, the museum determines the artefacts of the museum collection that will be applied to 3D AR. Three artefacts were chosen as test models, namely perfume bottle artifacts, jars and ancient furnaces. At the same time, the researcher determines the expert team as well as makes AR concepts, designs, and tests other prototypes.

AR Production Stage

In the production stage, shooting using a DSLR camera and 3D scanning of museum collection artifacts using the 3D MagicScan application. Photographing artefacts using a DSLR camera aims to back up data for integrating images later in Blender 3D software. In the 3D MagicScan application, the scanning results will be perfect if you have scanned by circling the artefact model 3600 until the entire model is scanned, totalling 45 according to the application instructions. After the scanning process is complete, followed by scanning, then continued with the export of the artefact model in GLTF format. If the artefact model has become GTLF format, it's time for work to continue the Blender 3D software on a laptop to improve the shape and texture until the shape matches the original.



(a) (b)

Fig.1. (a) The result of the photo image of the urn artefact with a DSLR camera; (b) Capture of the MagicScan 3D artefact scanning process.

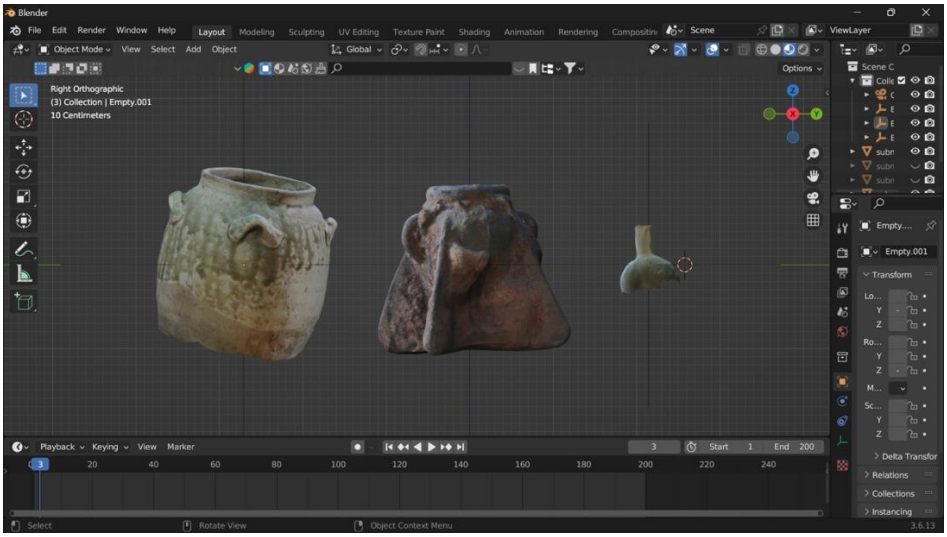


Fig. 2. Capture of the artefact model view in Blender 3D Software

After the artifact model in Blender 3D software has been completed, the next step is to enter the developer.vuforia.com website to get the license code and database, followed by work on the Unity 3D software. Next, enter the 3D object with fbx format into Unity. Then drag the 3D object into the target image that has been added.

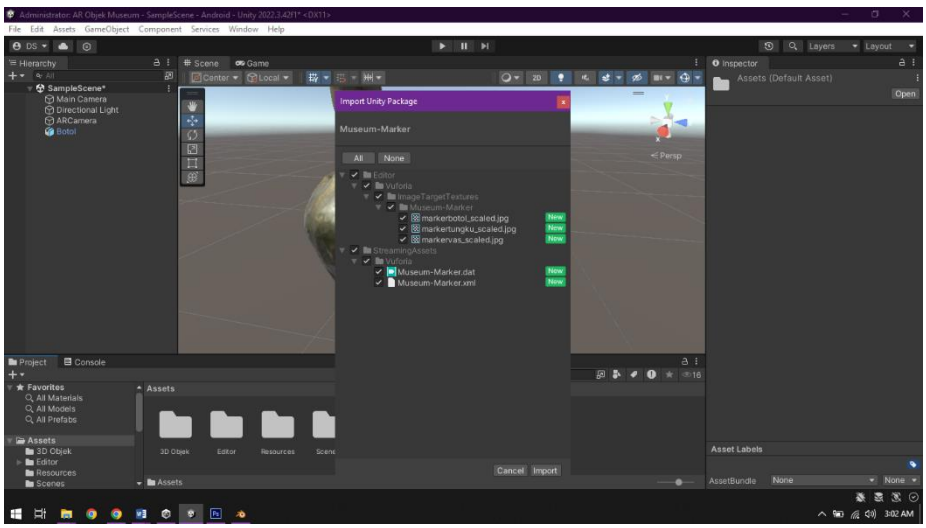


Fig. 3. Capture the view of the Hierarchy panel ─ Vuforia Engine ─ AR Camera, to add an AR camera.

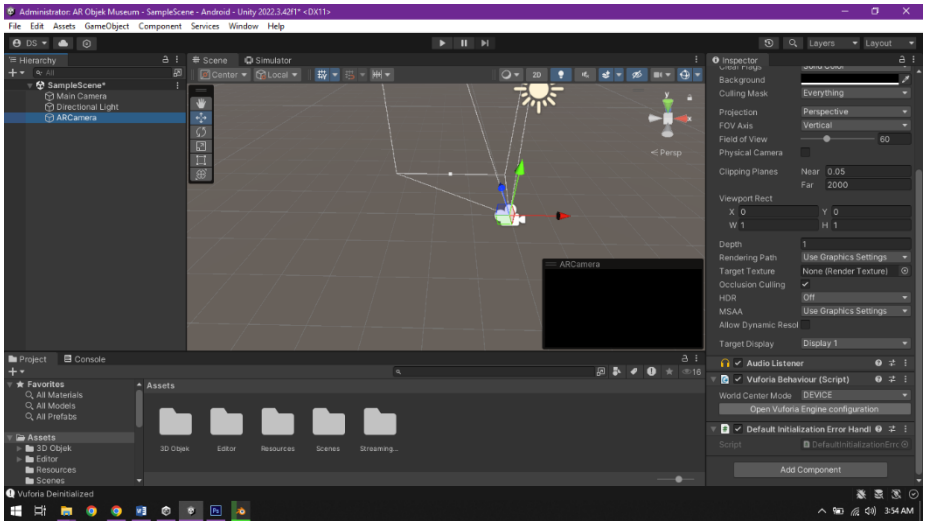


Fig. 4. Capture the App License Key display by filling in the license key that was previously created on the Vuforia website.

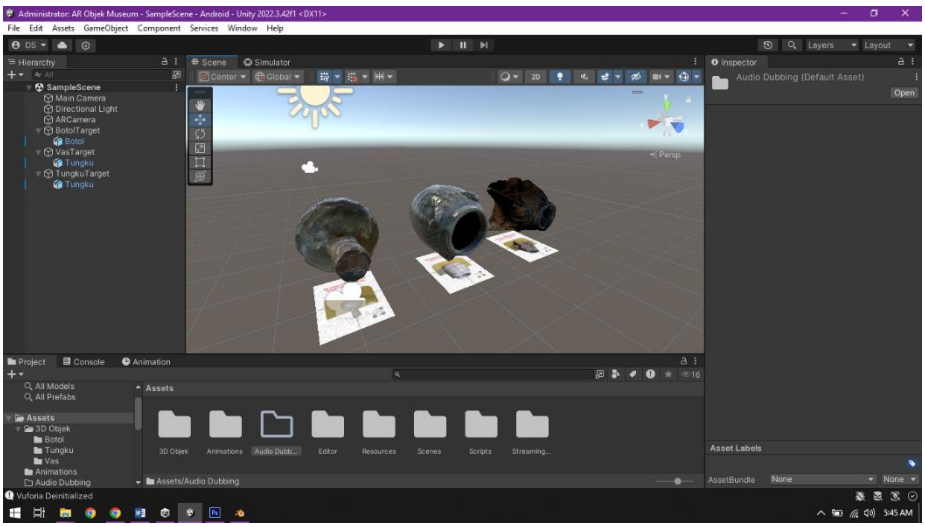


Fig. 5. Capture the 3D object view in fbx format into Unity and then drag it into the target image that has been added.

AR Post-Production Stage

In this AR pre-production stage, prototype testing has been carried out. Based on the visualisation of the prototype trial, it was found that there were errors such as the texture of the artefact model that was not like the original so further action was needed such as revising the texture of the artefact model. Then the revision of the voice actor tone was carried out by re-

recording and re-scanning the artefact using 3D MagicScan. At this stage, the feasibility of AR was also tested.

2.2 Validation & Measurement of User effectiveness

In research on the application of Augmented Reality (AR) in the Cinna City Site Museum, it is important to create measurable and relevant questions to be validated by the validator. The validator will usually check the clarity, relevance, and validity of the questions against the research objectives In research on the application of Augmented Reality (AR) in the Cinna City Site Museum, it is important to create measurable and relevant questions in order to be validated by the validator. The validator will usually check the clarity, relevance, and validity of the questions against the research objectives. The validator of this research is an IT expert and a museum curator. The aspects of functionality, time efficiency, ease of use, and aesthetics were considered in the direct observation of the resulting 3D AR. To measure user effectiveness and perceptions of the AR, questionnaires were also distributed to museum visitors and the public using Google Forms, with response analysis based on the percentage of answers to questions with four predetermined answer choices. The validator of this research is an IT expert and a museum curator. The aspects of functionality, time efficiency, ease of use, and aesthetics were considered in the direct observation of the resulting 3D AR. To measure user effectiveness and perceptions of the AR, questionnaires were also distributed to museum visitors and the public using Google Forms, with response analysis based on the percentage of answers to questions with four predetermined answer choices.

3 Results and Discussion

The application of 3D Augmented Reality (AR) technology to the Kotta Cinna Site Museum Collection aims to enrich the cultural tourism experience for visitors. 3D AR technology allows museum collections to be displayed in a more interactive and immersive visual form. Users can see digital representations of historical objects in a more vivid three-dimensional form, thus increasing their understanding and engagement with the history and culture presented.

In traditional museums, visitors are usually only able to observe artefacts from a distance or in vitrines that limit direct interaction. However, with 3D AR, visitors can observe artefacts in detail from various angles and even see animations or additional information related to the history of the object. This is in line with the results of previous research showing that the use of AR in museums can increase visitors' sense of engagement and satisfaction through increased interactivity [4].

This study found that the application of 3D AR in the Kotta Cinna Site Museum provides several significant benefits. Firstly, visitors get a more immersive and interesting visual experience, as the digital objects displayed with 3D AR have depth and detail that cannot be presented by traditional displays. Secondly, the use of AR technology reduces the need for lengthy descriptive text, as information can be conveyed visually and directly on top of objects through visitors' smart devices [5].

However, the implementation of 3D AR also has some challenges. One of the main ones is the limitation inaccessibility of the technology for all visitors. Visitors who do not have AR-enabled devices, such as smartphones with certain specifications, may not be able to enjoy the same experience. In addition, there is a need to conduct training and socialisation on the use of

this technology, especially for visitors who are less familiar with AR. Nonetheless, the benefits provided by 3D AR far outweigh the challenges, especially in enhancing the attractiveness of museums as modern and interactive cultural tourism destinations [6].

The use of 3D AR in museums also plays a role in providing a new narrative for historical collections that may not have previously attracted visitors' attention. With this technology, history can be presented in a more dynamic and relevant format, bridging the gap between tradition and innovation in the context of cultural tourism. This research supports the idea that 3D AR can be an effective tool in enriching learning and tourism experiences, by providing visitors with a broader and more interactive context.

(a)

(b)

(c)

Fig. 6. (a) 3D AR Capture of urn artefacts (b) 3D AR Capture of artefacts (c) 3D AR Capture of Metal Furnace artefacts

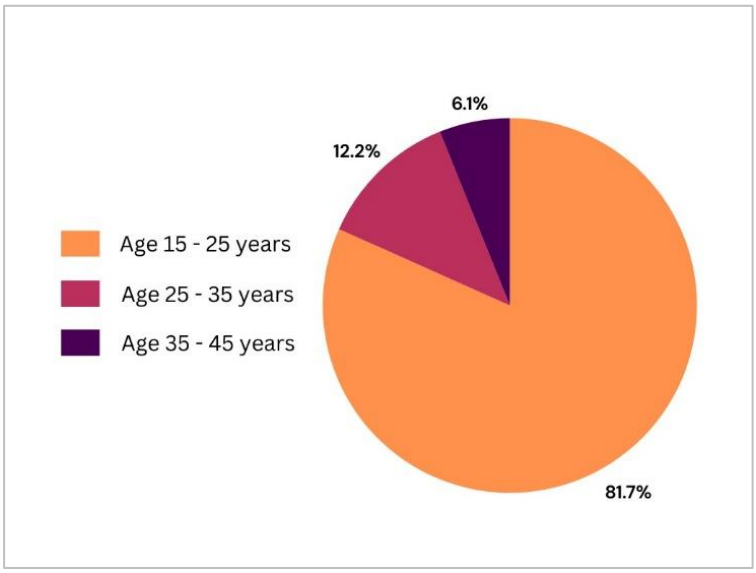


Fig. 7. Pie Chart Showing the Percentage of Respondents by Age

The results from the questionnaire distribution can be seen in a pie chart, showing the percentage of respondents by age group. The majority of respondents are aged 15 - 25 years, accounting for 81.6%, followed by those aged 35 - 45 years at 12.2%, and the remaining respondents aged 25 - 35 years with a percentage of 6.1%

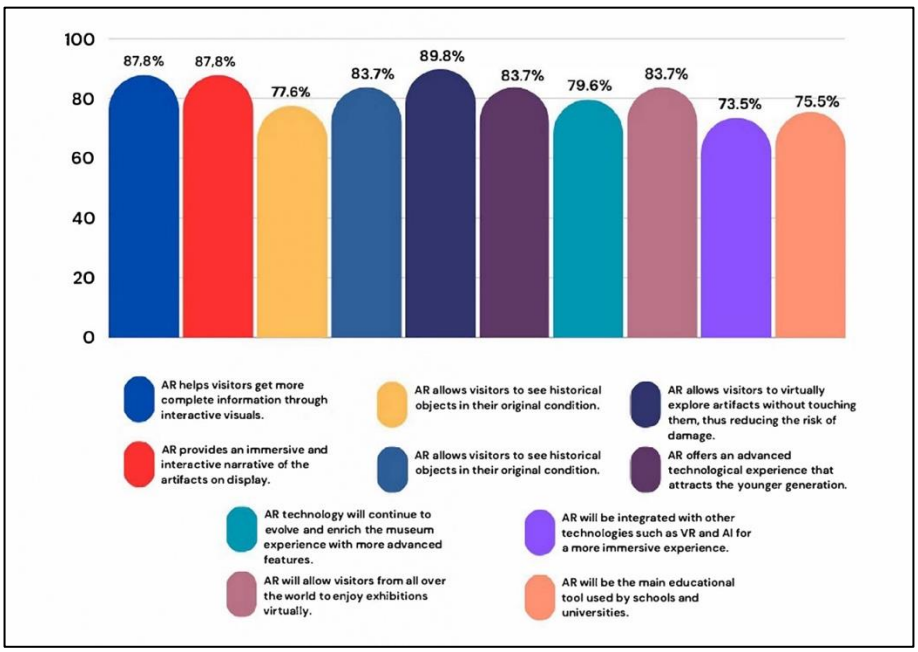


Fig. 8. Bar Chart Analysis of Respondents Answer Percentages

The bar chart shows respondents views on how AR assists them in obtaining information in the museum. The majority, with a percentage of 87.8%, feel that AR helps them access more comprehensive information and enhances education by providing a deep, interactive experience. Visitors also agree that AR allows them to view historical objects in their original condition without needing to touch them, thus reducing the risk of artifact.

4 Final Key Points to Consider

In researching the application of 3D AR for the Kotta Cinna Site Museum, there are several other important points to consider to ensure optimal results and relevance of the technology, including:

1) Usability and User Experience
   3D AR technology should be user-friendly, especially for visitors who may not be familiar with the technology. An intuitive interface and clear guidance are necessary for visitors to enjoy the experience without technical difficulties. Usability testing with the target audience will go a long way in refining this application.
2) Technology Compatibility
   Ensure that this 3D AR app is compatible with the different types of smart devices used by visitors, ranging from Android to iOS-based mobile phones. Visitors who do not have a supporting device should also be provided with a device by the museum to provide equal opportunities to access this technology.
3) Educational Content
   In addition to attractive visuals, historical content and information presented through AR must be supported by valid and credible research. The information delivery must be balanced between entertaining visual elements and in-depth information to provide an educational experience.
4) Level of Interactivity
   3D AR should not only serve as a visualisation tool, but also offer a high level of interactivity. Visitors should be able to interact with objects dynamically, such as zooming in on artefacts, viewing hidden details, or accessing additional information through clicks or taps.
5) User Evaluation and Feedback
   After implementation, it is important to collect feedback from visitors to continuously improve the app. Measurements such as satisfaction level, information comprehension, and duration of interaction with the app can be metrics for evaluation.
6) Integration with Physical Experience
   AR should not replace the physical museum experience, but complement and enrich it. Visitors should still be able to enjoy the artefacts directly while getting additional information through AR.
7) Sustainability and Maintenance
   AR technology requires regular maintenance, both in terms of software and content. Regular updates are needed to maintain relevance and accommodate new technologies that emerge in the future.
8) Social Engagement Aspects
   AR applications can also be developed for group experiences, where multiple users can collaborate or share experiences simultaneously. This aspect can increase social engagement within the museum environment.

5 Conclusion

AR not only changes the way visitors view artefacts, but also increases the accessibility of historical information. This technology allows visitors to interact with history directly and personally, creating an immersive and memorable experience. Going forward, further development can be done by adding other interactive features, such as AR-based educational games, where visitors can solve historical puzzles or follow archaeological trails in game form. Thus, 3D AR is expected not only to be a tool to enhance visual experience, but also as an effective educational medium. It is hoped that AR technology will also continue to evolve and enrich the museum experience with more advanced features by allowing visitors from all over the world to enjoy the exhibits virtually.

Acknowledgments. The researcher would like to thank P3M Politeknik Negeri Media Kreatif for funding this research, as well as the Kotta Cinna Site Museum for providing an open space for the realisation of this research.

References

[1] Alamudi, A. ”Kotta Cinna site, holds a collection of 3,000 historical objects.” IDN Times Sumut, Feb 03, 2024. [Online] Available: https://sumut.idntimes.com/news/sumut/arifin-alamudi/museum-situs-kotta-cinna-simpan-3000-koleksi-benda-sejarah. [Accesses March, 25, 2024]

[2] Zuliana, Z., Siregar, N.R. and Sitepu, E.N.: Tourism problem of Situs Kota China Medan. Santhet: Journal of history, education and humanities, Vol 6, pp. 27–39 (2022)

[3] Boboc, R.G. et al.: Augmented reality in cultural heritage: an overview of the last decade of applications, Applied Sciences, Switzerland, Vol.12. pp 1-25 (2022)

[4] K.Votis., I. Kompatsiaris and D. Tzovaras: A Gamified augmented reality application for digital heritage and tourism. Applied Sciences, Vol. 10, pp. 1-18 (2020)

[5] Zhou, F., Duh, H. B. L., & Billinghurst, M.: Trends in augmented reality research: A review of recent advances. Journal of Augmented and Virtual Reality, Vol. 5, pp. 1-15 (2019)

[6] Younes, B., Ciger, M., & Staubli, P.: AR applications in cultural heritage museums: The case of 3D reconstructions. Heritage Science, Vol 8, pp. 92 (2020).