Augmented Reality Mobile Application: A Feasibility Study in a Local National Museum

B Y Chan, Z I B A Ismail, L P Jack and M F Asli
Faculty of Computing & Informatics, Universiti Malaysia Sabah, 87000 Labuan, Malaysia.

Abstract. In an age of thriving science and technology, the use of advanced technologies in the museum exhibition of museums in Malaysia is still limited, especially in the context of Augmented Reality (AR). Most of the exhibitions in Malaysia’s national museum are still using the passive and conventional information display methods. Hence, this study is intending to promote the usage of AR technology in the national museum exhibition by investigating the feasibility of AR mobile application usage in a local museum. A qualitative approach was used in this study including the interview with domain experts and template analysis. From the template analysis in this study, it shows positive feedback from the respondents. Positive results were shown where AR is considered as an innovative way to preserve and conserve history, enable to the capability to enhance the visitor experience, attract more potential visitors and elevate visitors learning level.

Email: cindy_bychan@hotmail.com

1. Introduction
With the ubiquitous connectivity characteristics, smartphones have become an inevitable device for almost everyone in this modern era. The smartphones also serve as an ideal platform for the development and implementation of Augmented Reality (AR) applications with its pervasive nature [1]. Based on [2], AR has expanded in ubiquity within the extensive educational society and is designated as one of the key developing types of instructional innovation. The usage of AR has been widely adopted to various field, including the tourism sector to enhance the overall visitor experience [3]. AR promotes the study of history through the conveyance of multimedia (e.g. text, image, audio, video, and animation) that is sensitive to the particular displays and artefacts in various historical and heritage sites [4]. Implementation of AR enables the presentation of extra information with the museum as the medium and create integration of the physical world and virtual environment to the user visually [5].

As stated by Department of Museum Malaysia [6], national museum served as an institution to preserve, conserve and propagate value and knowledge of nation's history, cultural and natural heritage. Heritages are a valuable asset to the country, and it needs to be preserved and conserved to prevent its extinction in the future. In a research conducted by Pendit, Zaibon, and Abubakar [7], it stated that AR mobile application has not been implemented at the museum in South-East Asia region including Malaysia in the year 2014. The lack of mobile AR usage in the national museum of South East Asia has gained some improvement throughout the years as Singapore has introduced their AR national museum exhibition in South East Asia, namely “Story of the Forest” in 2016 [8]. Despite the fact that another country has developed mobile AR in their national museum exhibition, Malaysia, however, has yet to adopt this approach. Current approach was using the passive and conventional display methods where the display is mostly description text or image which imply a non-dynamic display method [9]. The
conventional information display method used in the national museum in Malaysia is said to be lack of interaction and not attractive to the visitors [10]. Hence, the objective of this study is to promote the usage of AR technology in the national museum exhibition by investigating the feasibility of AR mobile application usage in a local museum.

2. Literature Review

2.1 Augmented Reality (AR)
Augmented Reality, generally known as AR, is a real-time technology that enables the user to perceive enriched perspective of the physical environment by augmenting computer-generated objects [11]. Different from Virtual Reality (VR), which generates a total artificial condition in the virtual environment, AR is utilizing the existing real-life environment and overlays new virtual data over it. It obscures the line between the reality and the virtual digital data by reinforcing what we observe in reality [12]. AR is an innovation that bridge the gap between the virtual and physical by connecting the computer-generated virtual objects and the real environment scenes [13].

2.2 Usage of AR in Tourism and Museums
The foundations of AR innovation were started during the 1960s by Sutherland [14], who first introduced a head-mounted display idea named “the ultimate display”. Despite the fact that AR has existed as an idea since the 1960s, it is only over the recent two decades that technological advances have made AR feasible in a distinct research field [15]. Ever since then, AR has been widely used in several industry sectors such as medical, education, and stimulating training to intensify the user experience [16]. The tourism sector started to realise the opportunity of AR and utilized it, initiating to provide new ways of interpretation to tourist attractions [17]. From another perspective, AR can help tourist organizations in reaching wider target customers by acting as the conveyance technology of engaging interactive media content and mobile applications, calibrated to different learning levels [15]. Furthermore, AR information systems can assist tourists in gaining valuable information and enhancing their insight with respect to the touristic attraction, improving the tourist experience and providing elevated levels of entertainment throughout the process at the same time [18]. The implementation of AR has turned those museums into unique mediums that offer sophisticated understanding to museum artefacts by augmenting the interaction between visitors and museum, making information turns out to be more expressive and intriguing.

2.3 Benefit of Implementing AR in Museums
Based on [4], AR promotes learning of history through the conveyance of multimedia that is responsive to the displays and ancient artefacts that are situated in various museums. It enhances the reality instead of substituting it like virtual reality with computerized information designed to be relevant to the visitors that are engaging in with an AR-supported device or AR mobile application. In the research that was done by [12], AR not only beneficial to the tourism industry but the visitors’ experience as well, due to three factors: it is a platform for infinite layers of information, a dynamic tool for engagement and ingenious tool for education. With the usage of AR mobile application in the museum exhibition, museums able to provide visitors a visceral experience tour by exploring the information about artefacts not only from viewing the labelling on the display itself but through a more intense and cultivated way. Visitors can gain more knowledge via the extra layers of information presented by the AR applications and thus create a much stronger engagement with the exhibition. Although the benefits were highlighted, there are some challenges in implementing it with the real-world scenarios such as the level of readiness among current practice and limited resources on understanding the approaches used by current practice.
2.4 Prior Study in Feasibility of AR in Museums

Table 1. Prior Studies in Feasibility of AR in Museums.

| Study                  | Summary of findings                                                                 | Feasibility Factors                                                                 |
|------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| (Dieck and Jung, 2015) | Identifying the dimensions of users’ acceptance of AR in the tourism context.        | External dimensions, Perceptions, Attitude, and Behavioural intention                 |
| (Ding, 2017)           | Several museums have been interviewed and concluded museums must take the factors listed into consideration before adopting AR in their museum. | Museum’s ability, Museum visitors’ needs, Special requirements for the exhibition, effective evaluation process, and create awareness among patrons. |

3. Methodology

This feasibility study is an earlier part of the research project to utilize the AR mobile technology to enhance the current national museum exhibition practice, that later will involve prototype testing and experiments which comprising in the action case research cycles. Action case research is a research method consisting element of action research which reflects the intervention in an organization, and element of case study which embody the understanding gained through analysis and findings [20]. This study is incorporate in the action case research cycle 1 which used the qualitative approach to discover the feasibility of adopting AR technology for the museum exhibition and identifying the user requirement for the prototype. Theoretical research on related works was used as starting point to lay out the preliminary feasibility factors. Relevant factors such as technical and financial capability, technology acceptance and current practice were considered for the feasibility study. In addition, an exploratory study using an interview with the domain experts on the practical usage of AR mobile application in a local museum was conducted to complement the adoption feasibility theory. The local national museum was selected due to logistic convenience for our research, without compromising the representation of national museum practice as it operates with central administration by the Department of Museum Malaysia. The study has been conducted to test how innovative technology like AR can enhance the visitor experience in the museum perspective. Three domain experts from the local museum has participated in the interview, comprised of senior management and museum curators. The participants were selected based on their domain expertise and have an at least 3 years working experience in the domain in order to provide us with an in-depth and fair representation of opinions about the feasibility of adopting AR in the museum. Prior to the interviews, participants were given a brief insight of AR with an explanatory presentation and a short video demonstration. The explanatory presentation was conducted earlier along with the proposition to carry out the research with the organization. After a brief explanatory introduction and permission by the organization, an interview session was conducted. The semi-structured interview covers the topic of technology usage in the museum, domain expert perception, behaviour, and acceptance on AR along with the user requirement for the application.
4. Findings and Discussion
The findings from the interview have been transcribed and analysed by using standard template analysis. Template analysis is a type of thematic analysis where data collected from a research have to be code into a template with a hierarchical theme generated accordingly by the researcher to identify the key ideas. [21]

| Theme                          | Sub-theme                          | Interview Questions                                                                 |
|-------------------------------|------------------------------------|-------------------------------------------------------------------------------------|
| Technology awareness          | Technology Usage in Museum         | Does the Museum provide any digital tour before?                                    |
|                                | Domain Expert Perception on AR     | Do you know anything about Augmented Reality (AR)? Have you ever experienced AR or using the technology? |
|                                | Domain Expert Behaviour on AR      | What do you think about adopting Augmented Reality in the Museum?                   |
|                                | Domain Expert Acceptance on AR     | Is it feasible to adopt Augmented Reality in the Museum? Why?                       |
| User requirement for the Prototype | Major Information                | Which is the main focus or the highlight of the museum?                             |
|                                | Theme selection                   | Based on the main highlight mentioned, is it possible to conduct the research mainly focusing that particular collection? |
|                                | Content Requirement               | What are the contents required in the prototype?                                    |

4.1 Technology Usage in the Museum
From the interview, current exhibition approach was described to still using the conventional display method complemented with an audio-visual technology. It was a lighting and sound surrounding system corresponding to the exhibition, for an example, gunfire sound could be heard in the World War II exhibition section. However, the system is no longer available due to the budget constraint in maintaining the technology. The local museum used to own two touch-screen kiosks in the ground floor exhibition for information display purpose, but it was removed after the upgrade and renovation in the museum due to high maintenance fees. The museum also consists of some small TV screen panel located in front of the artefacts, displaying slides with image and information regarding on the artefact display. However, the information displayed is the same content with the information text panel and it is a static way of presentation which was claimed to be not attractive for the visitors by Kim and Park [10].
4.2 **Domain Expert Perception towards AR**
In terms of the expert’s perception towards AR, most of them have never encountered with AR prior to the introductory presentation by the research. However, upon exposure towards the technology, the experts later have shown their interest and effort in getting a better understanding of the new approach. The domain experts also stated that AR is capable to attract more visitors to the museum as it is making things real and visitors are able to view the artefacts in a dynamic way. They have observed that the local visitors were easily influenced by the new technologies as the visitors seems to disfavour conventional approaches. They were aware of the importance of interactive in cultural heritage exhibition as the museum is competing against other tourism spot and entertainment arenas, such as theme park and cinema.

4.3 **Domain Expert Behaviour towards AR**
After the early introductory presentation, the organization inquires the possibility of adopting the AR technology from the Department of Museum Malaysia headquarter in Kuala Lumpur. According to them, their headquarters has briefly explained about the application usage as one of the attractions to the museum. Even though the headquarters has acknowledged the AR, they have yet to apply this technology in their exhibition due to budget constraint. Meanwhile, another expert has mentioned that even though she is not an IT savvy person and has limited knowledge on AR, she has to follow up with the trend due to the evolution of time. Another expert expressed his point of view, he perceived that AR is more interactive and accessible, from that AR actually has an attraction for the visitors as people tend to like interactive components.

4.4 **Domain Expert Acceptance towards AR**
In terms of the expert’s acceptance, they have expressed positive acceptance towards AR in order to provide a meaningful experience for visitors. Based on the template analysis results, it is shown that the experts in the local museum agreed that AR is a feasible approach to enhance the visitors experience as the visitors, especially the locals, are easily influenced by the latest technologies and AR could elevate the local museum in the competence with the modern exhibition or other entertainment arenas.

4.5 **User Requirement for the Prototype**
For the user requirement of the prototype, research has gained permission from the museum experts on creating the content based on one theme as there were several themes and collections available in the museum. This is to ensure the content created for the research will be more focus and consistent. After conducting the interview with the domain experts in the museum, 11 topics regarding on the Early History of the state of the selected museum has been highlighted as the content of the prototype. These topics were selected as they exhibit the glorious era of the state under the British administration.

5. **Conclusions**
Based on the findings, the result shows that all the respondents agreed that AR enable to help in elevating the current exhibition approach by increasing the interaction between visitors and hence enhancing the visitor experience. The museum experts also prefer the AR mobile application compared to conventional display method and are thrilled to implement it in the future exhibition. In conclusion, this study has received positive results on the practicality of AR mobile technology, confirming the feasibility of adopting this technology in the current museum exhibition approach.

6. **Future Work**
After conducting the feasible study with the museum, the positive feedback from the museum experts has shown that it is viable to embrace AR as the museum exhibition approach. However, there were several limitations in the study where the museum is on a shoestring budget and it is lack of IT technician to maintain and support the technology. Regarding on these issues, researcher has discussed with the museum experts and willing to create an application for research and education purpose without involving monetary. Research will provide complimentary technical support to the museum as part of the research contribution complying action case cycle research nature where researcher has to participate
in the organization. Future direction on the study will be focusing on the design and development of the application prototype.

7. References

[1] Casella G and Coelho M 2013 Augmented heritage situating augmented reality mobile apps in cultural heritage communication Proc. of the 2013 Int. Conf. on Information Systems and Design of Communication - ISDOC 13

[2] Martin S, Diaz G, Sancristobal E, Gil R, Castro M and Peire J 2011 New technology trends in education: seven years of forecasts and convergence Computers and Education 57 pp 1893–906

[3] Yu D, Jin J S, Luo S, Lai W and Huang Q 2010 A useful visualization technique: a literature review for augmented reality and its application, limitation and future direction

[4] Azuma R, Baillot Y, Behringer R, Feiner S, Julier S and MacIntyre B 2001 Recent advances in augmented reality

[5] Chang K, Chang C, Hou H, Sung Y, Chao H and Lee C 2014 Development and behavioural pattern analysis of a mobile guide system with augmented reality for painting appreciation instruction in an art museum Computers & Education 71 pp 185-97

[6] Department of Museum Malaysia Website

[7] Pendit U C, Zaibon S B and Abubakar J A 2014 User experience on enjoyable informal learning via mobile AR: development and evaluation Int. Journal of Interactive Digital Media (IJIDM) pp 29-34

[8] Teamlab 2016 Story of the Forest Interactive Digital Installation, Endless

[9] Ambrose T and Paine C 2018 Museum Basics: The Int. Handbook 4th ed

[10] Kim J and Park C 2011 Development of mobile AR tour application for the national palace museum of Korea Virtual and Mixed Reality - New Trends Lecture Notes in Computer Science pp 55-60

[11] Azuma R 1997 A survey of augmented reality Presence: Tele operators and Virtual Environments 4 pp 35- 385

[12] Ding M 2017 Augmented reality in museums

[13] Milgram P and Kishino F 1994 A taxonomy of mixed reality visual displays IEICE Trans. Inf. Syst. E77-D pp 1321–29

[14] Sutherland I E 1965 The Ultimate Display Proc. of the IFIP Congress pp 506-8

[15] Kounavis C D, Kasimati A E and Zamani E D 2012 Enhancing the tourism experience through mobile augmented reality: challenges and prospects Int. Journal of Engineering Business Management 4 p 10

[16] Jung S, Kim S and Kim S 2013 Augmented reality-based exhibit information personalized service architecture through spectator's context analysis Int. Journal of Multimedia and Ubiquitous Engineering 8 pp 313-20

[17] Jung T, Chung N and Leue M C 2015 The determinants of recommendations to use augmented reality technologies: The case of a Korean theme park Tourism Management 49 pp 75-86

[18] Fritz F, Susperregui A and Linaza M 2005 Enhancing tourism experiences with augmented reality technologies 6th Int. Symposium on Virtual Reality, Archaeology and Cultural Heritage (VAST) (Pisa, Italy)

[19] Tom Dieck M C and Jung T 2015 A theoretical model of mobile augmented reality acceptance in urban heritage tourism Current Issues in Tourism 21 pp 154–74

[20] Braa K and Vidgen R 1995 Action case: exploring the middle kingdom in is research methods. Proceedings of Computers in Context: Joining Forces in Design (Aarhus, Denmark)

[21] King N 2012 Doing Template Analysis Qualitative Organizational Research: Core Methods and Current Challenges (London: Sage)