

**ADOPTION OF AUGMENTED REALITY MOBILE  
APPLICATION IN LABUAN MUSEUM TO  
ENHANCE THE VISITOR EXPERIENCE**



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**FACULTY OF COMPUTING AND INFORMATICS  
UNIVERSITY OF MALAYSIA SABAH  
2020**

**ADOPTION OF AUGMENTED REALITY MOBILE  
APPLICATION IN LABUAN MUSEUM TO  
ENHANCE THE VISITOR EXPERIENCE**

**CHAN BAO YEE**



**UMS**

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## DECLARATION

"I hereby certify that all the materials in the thesis are original except quotations, excerpts, summaries and references, which have been duly acknowledged."

13 AUGUST 2020

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## ABSTRACT

In an age of thriving science and technology, the uses of cutting-edge technology like Augmented Reality (AR) have revolutionized the way museums present historical information, engage, and educate their visitors. However, the usage of AR in the museum exhibition in Malaysia is still limited. Most of the exhibitions in Malaysia's national museum are still having a passive and conservative exhibition method. Hence, this research intends to study the effectiveness of AR mobile application usage in Labuan Museum in enhancing visitor's expectations and experience. The objectives of this study are to create an AR mobile application that able to promote the learning outcome of visitors, to analyze the significance of AR mobile application in meeting the visitor expectation, and to study the effectiveness of AR mobile in affecting the overall visitor experience in Labuan Museum. The methodology of this thesis follows a mixed-methods approach incorporated with Action Case Research Cycle which includes a semi-structured interview with domain experts in the museum and quantitative data collection using a pretest-posttest questionnaire to obtain feedback from the visitors perspective. A mobile application named AR @ Labuan Museum has been created as an instrument to conduct the study. The results from the interview were analyzed using template analysis while the results of the pre- and post-test were compared and analyzed to investigate the measure and quantify the learning outcome of the participants using paired sample t-test. The null hypotheses of the three variables in visitors' learning outcome, overall experience and expectations met were all rejected. Positive results were shown where AR is considered as an innovative way to preserve and conserve history, the capability to elevate visitor's learning outcome, meeting visitor expectations on the museum exhibition, enhancing the visitor experience, and to attract more potential visitors.

**Keywords:** Augmented reality, Mobile application, Museum tour guide application, National Museum

## **ABSTRAK**

### ***PENGGUNAAN APLIKASI MUDAH ALIH AUGMENTED REALITY DI MUZIUM LABUAN UNTUK MEMPERTINGKATKAN PENGALAMAN PELAWAT***

*Dalam era sains dan teknologi yang berkembang pesat, penggunaan teknologi canggih seperti Augmented Reality (AR) telah merevolusikan cara muzium mempamerkan maklumat sejarah, menarik minat dan mendidik pengunjung mereka. Walau bagaimanapun, penggunaan Augmented Reality dalam pameran muzium di Malaysia masih terhad. Kebanyakan pameran di muzium nasional Malaysia masih menggunakan kaedah pameran yang pasif dan konservatif. Oleh itu, kajian ini bertujuan untuk mengkaji penggunaan aplikasi mudah alih AR di Muzium Labuan untuk mempertingkatkan pengalaman pengunjung. Objektif kajian ini adalah untuk menghasilkan aplikasi mobile AR yang dapat mempromosi hasil pembelajaran pengunjung, menganalisis kepentingan aplikasi mobile AR dalam memenuhi jangkaan pengunjung, dan mengkaji keberkesanan AR mobile dalam mempengaruhi pengalaman pengunjung di Muzium Labuan. Metodologi tesis ini mengikuti pendekatan mixed method yang menggabungkan Action Case Research Cycle yang merangkumi wawancara separa berstruktur dengan pakar domain di muzium dan pengumpulan data kuantitatif menggunakan soal selidik pretest-posttest untuk mendapatkan maklum balas dari perspektif pengunjung. Aplikasi mudah alih bernama AR @ Labuan Museum telah diwujudkan sebagai instrumen untuk menjalankan kajian ini. Hasil wawancara telah dianalisis dengan menggunakan template analysis manakala hasil pretest dan posttest telah dibandingkan dan dianalisis untuk menyiasat hasil pembelajaran peserta menggunakan paired sample t-test. Hasil positif ditunjukkan bahawa AR dianggap sebagai cara inovatif untuk melestarikan dan memelihara sejarah, keupayaan untuk meningkatkan hasil pembelajaran pelawat, memenuhi jangkaan pengunjung di pameran muzium, meningkatkan pengalaman pelawat, dan menarik lebih banyak pelawat berpotensi.*



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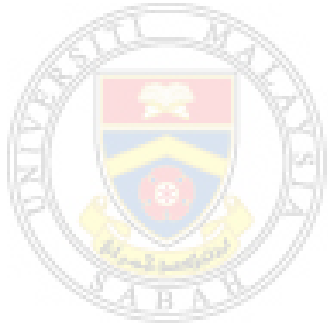
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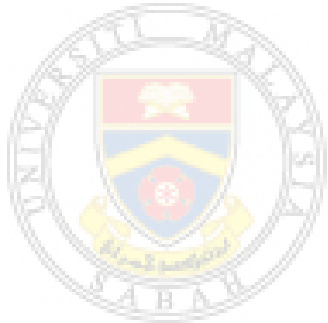
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# CHAPTER 1

## INTRODUCTION

### 1.1 Background of Study

Smartphone has become an inevitable device for almost everyone in this modern era due to its ubiquitous connectivity characteristics. With its pervasive nature, the smartphone also serves as an ideal platform for the development and implementation of Augmented Reality applications. (Casella & Coelho, 2013). Based on Jung, Chung and Leue (2015), Augmented Reality gain its popularity over the years due to its advanced mobile ability. This can be added value by Martin et al. (2011) which stated that Augmented Reality has expanded its pervasiveness within the extensive educational society and is designated as one of the key developing types of instructional innovation. The usage of Augmented Reality has been widely adopted in various sectors, which includes tourism to enhance the overall visitor experience (Wu et al., 2013; Yu et al., 2013). Augmented Reality promotes the study of history by using multimedia which is sensitive to the displays and artifacts in museums as the delivery media (Azuma et al., 2001). Augmented Reality is utilized as a tool to improve the museum visitor's overall experience in virtual heritage adoption (Noh, Sunar, and Pan, 2009). The usage of Augmented Reality empowers the presentation of extra information with the museum as the medium and create an integration of the physical and virtual environment to the user visually (Chang et al., 2014). In this research, the researcher will be conducting a mixed methods research in the Labuan Museum using an Augmented Reality mobile application to determine how innovative technology like Augmented Reality can enhance the visitor experience in the museum and visitor's perspective. Labuan Museum was selected due to logistic convenience for the research, without compromising the representation of national museum practice as it operates with central administration by the Department of Museum Malaysia.

## **1.2 Statement of Problem**

The national museum played an important role in the society as they are responsible to acquire, preserve, conserve, research and presenting tangible and intangible value plus knowledge of nation's history, cultural and natural heritage (Department of Museum Malaysia, 2018). Heritage is a valuable asset to the country which required preservation and conservation to prevent extinction in the future. However, it requires some effort as it is difficult to maintain or recover the real artifact. AR enables us to digitalize the artifact and digitally preserve the heritage value, for example by reconstructing historical objects and archaeological sites. In that way, heritages and artifacts can be preserved and conserved with the immersive experience of AR. Norashikin (2012) pointed out the concerning issue where the total number of visitors in the historical centers in Malaysia is declining on account of the dull display and poor showcase design. The number of total visitors has decreased from 3,143,456 visitors in the year 2011 to 2,782,578 in the year 2019 (Department of Museum Malaysia Annual Report, 2011: 90; Department of Museum Malaysia Annual Report, 2019: 17). Hashim, Taib, and Alias (2014) stated that museums in Malaysia are still using passive and static display methods and incapable to utilize modern equipment or tools to deliver information to visitors. Passive and static displays are displays labeled with description text or image which afford little or no interactivity (Ambrose and Paine, 2018). The static information display method used in the national museum in Malaysia is said to be a lack of interactivity and lack of visual excitement to the visitors. Meanwhile, there is numerous previous research which studies on the contribution and constraints of Augmented Reality on a learning basis, however, the evidence in quantitative is still limited (Sommerauer and Müller, 2014). To fill in this research gap, the researcher will design and conduct a mixed methods research in Labuan Museum to measure the effect of Augmented Reality on enhancing the visitor experience.

## **1.3 Research Questions & Objectives**

This research examines three questions that are crucial to the study in the context of a museum where Augmented Reality is applied. The specific research questions of the study are as below:

- i. How does the Augmented Reality mobile application promote the learning outcome of visitors in Labuan Museum?
- ii. How does the Augmented Reality mobile application meet the visitor expectation in Labuan Museum after the adoption?
- iii. How does the Augmented Reality mobile application affect the overall visitor experience in Labuan Museum after the adoption?

These three questions are the essential issue of this research and were used to appraise the outcome of the study. Based on the research questions above, the research aims to enhance the visitor experience in Labuan Museum by adopting an Augmented Reality mobile application. The following objectives need to be achieved to adopt the Augmented Reality mobile application to the organization (Labuan Museum):

- i. To create an Augmented Reality mobile application that able to promote the learning outcome of visitors in Labuan Museum.
- ii. To analyze the significance of Augmented Reality mobile application in meeting the visitor expectation in Labuan Museum.
- iii. To study the effectiveness of Augmented Reality mobile in affecting the overall visitor experience in Labuan Museum.

### **1.3.1 Research Questions Interpretations**

In conveying a reasonable idea of the objectives and purpose of the research, interpretation of research questions fundamental to this study have been clarified. This intent to establish the knowledge and ensure that the aim and objectives of the research are unmistakably expressed.

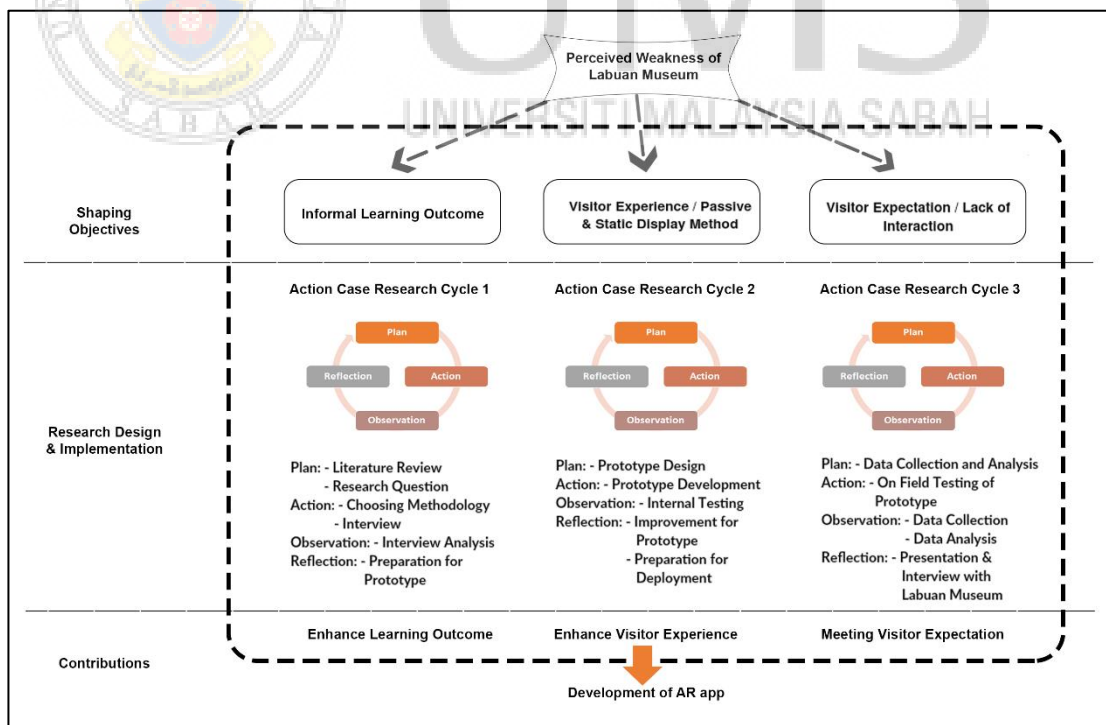
**Table 1.1: Interpretations of Research Questions.**

No.	Research Questions	Interpretation
1.	How does the Augmented Reality mobile application promote the learning outcome of visitors in Labuan Museum?	To introduce the framework used by the researcher to design the Augmented Reality mobile application that promotes the learning outcome of visitors in Labuan Museum.
2.	How does the Augmented Reality mobile application meet the visitor expectation in Labuan Museum after the adoption?	To study the significance of Augmented Reality mobile application in meeting the visitor expectation in Labuan Museum.
3.	How does the Augmented Reality mobile application affect the overall visitor experience in Labuan Museum after the adoption?	To perceive and obtain the user's opinion in the effectiveness of the Augmented Reality mobile application in affecting the overall visitor experience in Labuan Museum.

#### **1.4 Research Design**

To deliver the conceptual idea visibly, a research design (Figure 1.1) has been created by conducting an academic investigation of background studies through previous literature to examine the perspective and contribution on the issue of using Augmented Reality in enhancing the museum visitor experience. The perceived weakness of the Labuan Museum is having a passive and static display method, lack of interaction elements fulfilling visitor expectation, and learning outcome. As indicated by Kim and Park (2011), the passive and static display method is the lack of interaction and lack of visual excitement to the visitor. The museum used mostly text panels and some diorama to display the history information of artifacts with some audio-visual display. With only showing the information via image and text, the retention rate will only be 23 percent, which is the ability to remember information (Mayer, 2012). This can be supported by a similar concept from Sandom (as cited in

Vaughan, 2014: 2), who claimed that stimulation with audio can only increase the retention rate by 20 percent, whereas with audio-visual it will increase up to 30 percent and as for interactive multimedia, the retention rate will be high up to 60 percent. This shows that with the usage of interactive multimedia such as Augmented Reality, the user can achieve a higher level of learning outcome. Based on a study by Falk et al. (2004), interaction can support visitor learning by reinforcing the facts and concepts. The study also shown that interactive experience in a museum can change a visitor's perception of the historical institution as "dry and dusty" to "modern and looked forward". According to Milgram & Kishino (1994), AR able to break the boundary between physical and virtual environments by connecting the two to create an interesting and expressive learning environment, and hence improving the visitor experience in the exhibition. As stated by Adam (2014), the role of interactives in the museum experience can be best comprehended by viewing at the visitor learning process. Hence, the best way to assess visitor experience is through their learning outcome. By implying multimedia elements such as AR, 3D model, and play-and-pause-able video into the interactive application, it is much more efficient as those elements will improve the condition.



**Figure 1.1: Research Design**

To tackle the perceived weakness in Labuan Museum, researcher has created a research design and implementation method using the Action Case Research Cycle. The Action Case Research Cycle in the research design consists of three cycles, each cycle has the same process of Plan, Action, Observation, and Reflection. According to Oates (2006), there are many action research frameworks, but they usually follow an identical procedure where it is an iterative cycle of plan-act-reflect. Action case research cycle is used in the research design because the action-orientated research conveyed the solid purpose to accomplish more than observe and record and thus delivered a more grounded analysis and a more useful result than the researcher as a neutral observer (McManners, 2016).

In the first cycle of the action case research, it began with an identifying process in the Planning phase, where the researcher identifies a specific research question (Ryan, 2004). It must be something the researcher can examine. In this case, the researcher requires examining whether AR mobile applications able to enhance the visitor experience in the museum. Next, the researcher conducting a literature review to gain a better understanding of the related research. After that, the research goes on into the Acting process, where the researcher decides on the research methodology, consider the ethical issues, obtain required permissions, set the framework schedule, and create frameworks. This is where the researcher engages in various cycles of experimentation and data gathering. The data gathering incorporated with qualitative data where researcher conduct the first interview with the museum experts. Next, into phase three, the Observation. Researcher began to sort out information from the interview transcript searching for patterns. Researcher has written the result from the first interview into a journal to share the research with the world and reflect on their practice. Finally, the final phase, Reflection. This is where researcher ultimately prompted new inquiries and the cycle will continue again as researcher revised the study to prepare for the prototype development.

Action Case Research Cycle 2 focuses on the development of the AR mobile application prototype. In the Planning phase, the research dived into the prototype design which covers the conceptual design and physical design in both low and high fidelity design concepts. Moving forward into the Action phase, this is where the prototype development took place. The requirements specification is considered to

better reflect the prototype design. System validation, verification, and internal testing were carried out in the Observation phase to ensure the functionality of the prototype. Improvement for the prototype was carried out after the testing to ensure requirements are properly satisfied by the prototype and ready for deployment.

In Action Case Research Cycle 3, data required to construct the questionnaire for the pretest-posttest survey was collected and revised with the museum experts to ensure the validity of the facts and suitability of the questionnaire. On-field testing on prototype incorporated with the pilot testing has been conducted to have a final check on the functionality of the prototype and to determine whether the questionnaire created was appropriate for the participants of the experiment not only in terms of comprehensible. The information collected was then used to improvise the prototype and questionnaire for the survey. The pretest-posttest was carried out afterward to collect the to gather information needed to answer the research questions. After analyzing the data collected, the information was presented to the museum experts in Labuan Museum and the second interview was conducted to have complete findings for the study.

### **1.5 Significance of the research**

The significance of the study is to introduce AR technology to the Labuan Museum in enhancing visitors learning experience and expectation towards a satisfied visiting experience using AR mobile application.

### **1.6 Summary**

Chapter 1 covers the introduction and overview of the research which includes research background, statement of problem, research questions and objectives, research questions interpretations, research design, and the significance of the research.