Creative Innovation of Augmented Reality for Promote Sustainable Tourism of Chiang Mai Moat

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Abstract. Currently, augmented reality technology has been broadly applied to serve numerous purposes. There is a potential that the application will grow even more rapidly in the future. Augmented reality technology has been raised to assist tourism industry. Thus, this research implemented augmented reality technology to advocate Chiang Mai moat areas by presenting information on nine major temples located around the city’s moat in the form of augmented reality demonstration. The assessment result of system efficiency and application satisfaction was in a very good level. Therefore, it can be concluded that the developed application is considered a technological innovation that benefited Chiang Mai moat area’s tourism. It provided information on the local tourist attractions in an easy to access augmented reality presentation which prompts more tourists by increasing informative channel that can boost tourism value.

1. Introduction
Tourism is a service industry that causes revenue and increases employment rate of the locals. It applies social and cultural assets plentifully cumulated from the past and generates income that stems from ecotourism, heritage tourism, health tourism as well as nature, art and cultural, and folkway tourism. This can be developed into cultural industry by involving local products and cultural activities and allowing other sectors to take part in preserving, conserving, restoring, and integrating cultural heritage. This vision in combination with the Thai government’s Thailand 4.0 Policy drives Ministry of Tourism and Sports to concentrate in enhancing the competitiveness of the Thai tourism sector.

Tourism resources significantly attract tourism customers. These resources include locations, objects, activities, and/or any other dimensions that add value to the tourism sector such as historical values, art and culture, and tourists’ opportunity to be exposed to new experiences. These resources are vital especially for tourist attractions within Chiang Mai moat area where cultural tourism contributes greatly to the sector. However, public relations to promote Chiang Mai moat area’s attractions have not been done thoroughly.

This is where augmented Reality or AR plays an important role the technology can be flexibly applied to serve diverse purposes. AR is an invention that can highly advance tourism promotion. It allows users to learn about tourist attractions in a virtual reality form. For this reason, this research aimed to incorporate AR technology into cultural tourism promotion activities, specifically focused on Chiang Mai moat area. A cultural tourism application was developed to present information on this area. The application was different from other available travel applications as it informed tourists...
about the history and insight of each location. In this manner, it served the purpose to promote tourism and boost both local and national economy. It also functioned as a means for sustainable preservation of art and culture, traditions and religions.

2. Related Work
Nowadays Augmented Reality is well known into many branches like art, commerce, tourism, education, gaming, etc. The widespread of AR came with the use of mobile devices [1]. Mobile and wireless technologies enable the provision of novel applications that support visitors while on the move. Such applications include mobile travel guides and location-based infotainment services [2]-[3]. Augmented Reality as the incorporation of real and virtual objects in real environments, runs interactively in real time, and there is integration between the three dimensions, the virtual object integrated into the real world [4]-[5]. Cultural tourism is defined as “visits by persons from outside the host community motivated wholly or in part by interest in the historical, artistic, and scientific or lifestyle/heritage offerings of a community, region, group or institution [6].

A number of cultural tourism destinations have started to explore possibilities of AR and VR on their sites due to the increasing pressure to stay competitive and attractive to visitors [7]. Innovations such as virtual enhancements to access information through AR overlays in the immediate environment as well as the use of VR to visit remote destinations that would otherwise be impossible or challenging to visit are common. AR information systems can help tourists in accessing valuable information and improving their knowledge regarding a touristic attraction or a destination, while enhancing the tourist experience and offering increased levels of entertainment throughout the process [8].

The constant evolution of technological solutions in the world of cultural sciences has prompted cities to upgrade their cultural tourism promotion, which has always been supported by important international organizations like ICOMOS, UNESCO and the World Tourism Organization. The urban space, associated with informational spaces [9], becomes a place where digital technologies (and often lines of coded algorithms) bring out the complex cultural apparatus of a city through the dense and overlapping layers of representation [10]-[14].

3. Framework of Augmented Reality for Promote Sustainable Tourism of Chiang Mai Moat
In development a augmented reality for promote sustainable tourism of Chiang Mai Moat, to expose Thai people and foreigners, as well as provide travel information. There are 7 steps in development as following in Figure 1:

3.1. Study and Collecting
This process is a researcher studied and gathered data, differences, and took photos from the real sites of the Chiang Mai Moat. The scopes of this research area are in Chiang Mai Moat with 9 temples.

3.2. Analysis and design system
Analysis and design system is through analysis of systems and application design, the web structure was designed according to the information technology to present the details in each Temples.

3.3. Augmented Reality development
Augmented Reality development is process for researcher developed Augmented Reality based on analysis and system design. In order to match image inputted from smart phone with object panorama image, exact feature point matching is required by using feature point algorithm.

3.4. Testing system
Testing system is tested regarding analysis and systems designs by experts.
3.5. System adjustment
System adjustment is gathered via feedback from users, and assessment of data. This was utilized to refine the website to maximize efficiency, and minimize errors.

3.6. System assessment
System assessment is to assess the Virtual Museum, the samples of users were selected through questionnaires. Then, the data brought to analyze the hypothesis.

3.7. System in use
In this process is to bring the system into the real use through network.

![Diagram of System Development Process]

**Figure 1.** A Framework for Preliminary Development of Augmented Reality

4. Development and Evaluation system
To develop the system, a researcher took pictures from important parts of Augmented Reality for Promote Sustainable Tourism of Chiang Mai Moat, Figure. 2 to Figure. 4 show an example of development process by used Maya, Visual C#, and Adobe. To assess the systems, a researcher asked 50 system experts including students and other people to volunteer in assessment. The subjects were asked to rate the relevancy of the search results on a five-point scale: Score 1 is the level of satisfaction improvement, Score 2 is minimum level of satisfaction, Score 3 is medium level of satisfaction, Score 4 is good, Score 5 is very good satisfaction.
5. Result and discussion

The result from the assessment in satisfaction in Augmented Reality for promote sustainable tourism of Chiang Mai Moat in Table 1 showed that system reliability and information was 4.22 and reliability was 0.33 which was a good result as shown in following tables:

| Evaluation list                  | Overall Average | Reliability | Criteria   |
|----------------------------------|-----------------|-------------|------------|
| Learn more about Temple          | 4.68            | 0.22        | Very good  |
| Design and Structure             | 3.55            | 0.32        | Good       |
| Fonts                            | 3.78            | 0.27        | Good       |
| Colours                          | 4.3             | 0.51        | Good       |
| Pictures and multimedia          | 4.63            | 0.25        | Very good  |
| Designs are suitable to users    | 4.35            | 0.39        | Good       |
| Total                            | 4.22            | 0.33        | Good       |

The mean difference was applied for assumption that the knowledge of the user about Augmented
Reality between before \((ARBModel)\) and after \((ARAModel)\) use system. Paired sample T-test is employed. It was assumed that the sample comes from populations that are approximately normal with equal variances. Level of significance is set to 0.05 \((\alpha=0.05)\). The results can be summarized as follows:

**Table 2. The result of the assessment.**

| Pair           | Pair differences | Std. Deviation | Std.error | Mean | Sig |
|----------------|------------------|----------------|-----------|------|-----|
| \(ARBModel\)-\(ARAModel\) | .721             | .024           | .001      |      |     |

Statistical testing result from Table 2 indicates that there is a significant difference in the confidence values of the \(ARBModel\) and \(ARAModel\) at \(\alpha=0.05\). In other words, the mean scores of confidence values of \(ARBModel\) and \(ARAModel\) are not the same.

6. Conclusion
This research was aimed to apply augmented reality technology into functional use. The developed AR application combined the reality and the virtual reality by stacking two-dimensional or three-dimensional images in the virtual world to be seen on the real scenarios. It presented information on nine noteworthy temples located around Chiang Mai moat area. The application covered information on history and the details of major buildings of each temple. The researcher paid attention to art elements in creating and presenting the models in an interesting way. The invention was able to promote public relations and educate users in cultural tourism of the selected attractions through augmented reality. Users’ satisfaction in terms of knowledge about the nine target temples before and after using the application as well as the rating on application’s overall usage experience to cover the usage, beauty, language, processing time, and content presentation order were rated very good. For the future development, the attractions’ elements should be presented in a fashion that compares the past and present so that the interested users and tourists can perceive the entire picture of the attractions.

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