Adaptation Of Immersive Virtual Reality For Sustaining Tourism Attraction To Preserve History

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Abstract: Due to the pandemic of Covid-19, the tourism sector faces difficulties sustaining the tourism attraction in Melaka, Malaysia's cultural heritage. Tourists could not visit the physical places easily and need to follow a standard operating procedure such as not encourage children to be around in the public area and limit the number of visitors in one time with a limited time duration. Therefore, this paper focuses on the sustainability of the Melaka cultural heritage for Hang Tuah Village (HTV) history through applying the virtual reality (VR) platform. HTV Digital tourism can be an innovative way to preserve historical artifacts and increase the location's popularity. With the development of immersive VR, tourists can explore the HTV and interact with historical objects. The historical background of HTV exploration can be done without traveling and expose to the risk of Covid-19 and damaging the historic site. The functionality of the VR tested using usability testing through the User Experience Questionnaire (UEQ), which eventually has 16 dimensions. The five dimensions applied are attractiveness, perspicuity, dependability, usefulness, and novelty. The evaluation is using a 5-point Likert scale with a total number of 17 questionnaires. As a result, the UEQ acceptance of the system is 'High', with 3.875 average overall of the mean score, and 77.5% of the respondents were overwhelming good feedback based on the experience. Thus, with the high acceptance received, it concluded that the adaptation of immersive VR could help sustain the tourism industry to preserve the history of HTV.

Keywords: Hang Tuah Melaka Village; immersive virtual reality; sustaining tourism

1. INTRODUCTION

History is the study of the human past, as outlined in human beings' written papers [1]. The past is what the general public perceives as the immutable bedrock on which we historians and archaeologists stand, with all their choices finished, their members dead, and their history told. However, as previous suppliers, we acknowledge that the bedrock is quicksand, that there are still untold pieces of the tale, and what has been told is tainted by what we are today. Historical events include physical and occurrences. The word 'History' is from a Greek origin, which means 'inquiry'.

Tourism has become an important sector in Malaysia, and it has a potential area that gives significant earning. Melaka is one of Malaysia's 14 countries and has been recognized by UNESCO's World Heritage List on July 8, 2008, as the best example of a heritage city enriched with its own culture [2]. Melaka situated on Peninsular Malaysia's southwestern
shore. The Melaka region is 1,658km$^2$ and split into three districts: Melaka Tengah, Alor Gajah, and Jasin. Traveling from Kuala Lumpur to Melaka using the highway requires about two hours, and traveling by highway to Singapore takes about three hours. Melaka is a well-known historic country that has been wealthy for decades with different tourist locations. In reality, tourism in the services industry accounted for 46.6% of the Gross Domestic Product (GDP) as the country's most significant financial industry [3].

One of Melaka's famous heroes culture is Hang Tuah, who has been the model for both old and young. He helped Malaysians, Indonesians, Singaporeans, Southern Thais, and Bruneians describe their social and moral values over the decades and pride themselves in their national identity. In the 15th century, Hang Tuah, Hang Jebat, Hang Lekiu, Hang Kasturi, and Hang Lekir, was said to have served Sultan Mansur Shah, king of Malacca. Hang Tuah Village (HTV) is a village situated in Kampung Duyong, Melaka, and it was the place where Hang Tuah was born and raised. Hang Tuah Centre in Kampung Duyong has officially opened to the public about seven kilometers from Melaka's capital.

Nevertheless, there were issues raised on the difficulties of getting support and sustaining the cultural heritage. It was happened not only in Melaka but in other heritage [4]. The study claimed that the destruction of the Portuguese, Dutch, and British historical buildings during the colonization period from the 16th to 18th centuries caused some Malay cultural heritage products in Melaka to vanish. These difficulties include setting a strong product status, continuous availability, tourist interest, place, marketing mode, and competition within the same market sector with other cultural products. Historical locations are one of the difficulties that need to preserve for the next generation. One way to promote cultural heritage products is through the commercialization of this historical location. Hence, this valuable legacy could highlight to people all over the world. However, there are issues related to the conservation and authenticity of these cultural heritage products [5]. The drawbacks and disadvantages of Malacca's tourist attractions include inadequacy and lack of staff, increased operating expenses, demand for visitors, and high competition between tourist hotspots [6].

As claim by [7], in Malaysia, urban conservation is categorized into three categories: conservation of buildings, conservation of parks, and cultural conservation. Local authorities, Federal and State governments, the Department of Museums and Antiquity, heritage trusts, and other relevant bodies have collectively adopted the policies and guidelines on urban conservation. Nevertheless, some of Malaysia's heritage cities faced exacerbated urban problems causing rapid population growth, fast industrial and economic development, and urbanization. In 1992, research began and uncovered some daunting patterns of troubling developments that threaten historic cities' survival [8]. The five groups of threats were categorized, 1) disruption of the urban pattern, 2) disappearing townscape, 3) changing activity pattern, 4) visual monotony, and 5) obsolescence and gentrification.

Unfortunately, due to the Covid-19 pandemic, the virus spreads rapidly, and Malaysia declared the Movement Control Order (MCO) implemented on March 18, 2020. It was an order restriction of people moving into or out of an area. It started when the first Malaysian that had a travel history to the neighbouring country was tested positive due to the China delegation meeting [9]. The MCO restrictions include social distancing, closure of schools and universities, gathering not allowed, and canceling all the planned events. It also affected the national economies, including the tourism sectors [10] with the impacts of supply and demands [11] such as domestic tourism, airport suspending the flights, accommodation, and
decline of all the activities. Despite the current MCO having reduced the restrictions, people need to be aware of the physical distancing and wearing a face mask. Simultaneously, people need to follow the standard operating procedure that limits the number of people per entrance, and a specific duration given to ensure others have the chance.

Therefore, to overcome these limitations, this paper's main objective was to propose virtual reality (VR) as the marketing strategy with the innovation in tourism, which can add value to the buildings and support the needs of modern lifestyles. We are focusing on exploring HTV using immersive VR technology to enhance learning history from a different perspective. People able to explore the HTV and interact with the historical objects surrounding the environment.

I. RELATED WORKS

In this section, we explore VR's technique, specifically on the technology and its' review of the application. The proposed VR are specifically using Head-Mounted Display (HMD).

A. Virtual Reality

According to [12], VR defined as using a computer-generated 3D environment called a 'virtual environment', where people can explore, navigate, and communicate using one or more five senses in the real-time simulation. VR intends to present an immersive "virtual" experience that makes the user feels the real experience as at the real place using the sensory. In the past, there have been many virtual reality devices used for many different occasions. In the mid-1950s, Sensorama, invented by cinematographer Morton Heilig can stimulate the senses of inclusive sight and sound in an arcade-style theatre cabinet [13]. Followed in 1968, Ivan Sutherland introduces Sword of Damocles; the first VR / AR head ceiling mounted display connected to a computer (not a camera). Later, modern and sophisticated VR devices launched, such as Cardboard VR (wireless smartphones), Google Daydream (fabric-like material), Gear VR (Samsung handphone), Oculus Rift (wired-computer with external cameras), Vive (HTC smartphones panel with wireless controllers), Sony PSVR (video game console with VR HMD), and Microsoft's HoloLens (real-world environment with hologram and wireless connection) [14].

There three different types of VR, such as fully-immersive, semi-immersive, and non-immersive virtual reality [15]. Table 1 shows the difference between VR. This study uses the immersive VR application, so users can interact within the HTV to make the experience more enjoyable in learning history. Users can interact with the historical objects in the environment with HMD.

B. Review of Existing Application

There are few existing games available and related to historical environment exploration, such as Titanic VR and CyArk. Titanic VR is a fully immersive VR environment exploration that aims to bring users back when the user becomes one of the passengers of the famous Titanic ship. In this game, the user relives the moments during what happened with the Titanic in approximately 6 hours [16]. There are many projects already done by CyArk. CyArk allowed users to use the mouse to control the camera and rotate and zoom in and out where the user wants to look. The website application also lets users interact with certain multimedia elements such as buttons that provide more information regarding the historical location [17]. Table 2 shows the proposed project's comparison of an existing application for environmental exploration. As presented, despite Titanic VR use the same type of VR, yet HTV VR uses additional multimedia elements, which is text. Also, HTV VR focusing on 3D
environments using Oculus Rift S, which is more advanced with the immersive VR usage. In conclusion, various applications can implement VR in their system. The VR techniques applied in implementing learning the history of HTV, considering the convenience factor for local tourists.

Table 1: Types of Virtual Reality

<table>
<thead>
<tr>
<th>VR Type</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
</table>
| Fully-Immersive Virtual Reality | • Digital technology that allows user to experience the real world through artificial environments  
  • Users experience simulated computer-generated worlds using graphics, auditory and haptics | ![Image](image1.png) |
| Semi-Immersive Virtual Reality | • A special type of VR that allows users to explore three-dimensional virtual worlds while remaining linked to real-world visuals, auditory, smells and haptics, and to retain control over physical objects  
  • Can see and touch, but must rely on a digital picture to be as large as possible | ![Image](image2.png) |
| Non-Immersive Virtual Reality  | • A type of computer-generated VR software, but without a sense of immersion in the virtual world  
  • The key feature is that users can maintain control over the physical world while being mindful of what is happening around them and experience stuff like voices, graphics and haptics | ![Image](image3.png) |

Table 2: Comparison with The Existing Application

<table>
<thead>
<tr>
<th>Applications / Characteristics</th>
<th>Titanic VR</th>
<th>CyArk</th>
<th>Hang Tuah Village VR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimedia</td>
<td>Image, animation, and audio,</td>
<td>Image, audio,</td>
<td>Image, audio,</td>
</tr>
<tr>
<td>Elements</td>
<td>audio</td>
<td>animation, and text</td>
<td>animation, and text</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------</td>
<td>---------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Type of VR</td>
<td>Immersive VR</td>
<td>Non-Immersive VR</td>
<td>Immersive VR</td>
</tr>
<tr>
<td>Content</td>
<td>The historical event that happened with the Titanic</td>
<td>Historical buildings recreated in a 3D environment with relevant information in the text</td>
<td>Historical objects and buildings recreated in a 3D environment in HTV with relevant information in the text</td>
</tr>
<tr>
<td>Platform</td>
<td>Oculus Rift S</td>
<td>PC and mobile based</td>
<td>Oculus Rift S</td>
</tr>
</tbody>
</table>

2. RESEARCH METHOD

For implementing the proposed study, this section explains the methodology used started with the design and development phase, which involved the software and hardware needed, and the overall process diagram. Then, we present the flowchart diagram for the user and, finally, the study evaluation.

A. Design and Development

In this phase, we explained each process's details from the start until the completion of the project. It includes 3D modeling the VR application's assets from scratch, texturing the 3D assets, and designing the virtual environment.

1) Software and Hardware Requirements:

The leading software used to develop this project is Autodesk 3Ds Max, a software designed to construct 3D models, animations, and digital images. It was one of the famous computer graphics tools and is well known for providing durable 3D artists' tools. In this project, 3Ds Max is used to modeling the houses of Hang Tuah and Hang Jebat, inclusive of the props and objects that are inside the homes. Unity is the most popular game engine in the world. The features were packed together and are flexible enough to make almost any game that we can imagine. In this project, we use Unity to create the HTV environment and scenery.

The main hardware used for this project is a personal computer. Almost every process used it; thus, we include it in this project. Due to the high software requirements needed to develop this project, we required a high specification class hardware. The specification such as CPU: Intel Core i7-8700k, GPU: Nvidia GeForce RTX 2070, OS: Windows 10 Pro 64-bit, RAM: 16GB DDR4, and storage: 2.5TB SSD NVMe + 1TB HDD.

2) Overall Process Diagram:

In this phase, we set the process diagram to identify every step involved and completed to achieve this study's objective. Figure 1 depicts the process, which consists of six phases as below.

1) Data Requirements – a collection of requirements was gained from doing on-site research at HTV, as stated in the literature review. It also came from journals, articles, thesis, and trusted websites. The research conducted these methods thoroughly to develop a VR application that will help users learn the history of HTV.

2) Storyboard – to explain the storyline and describe the project flow. It helps developers and designers stay on the right track while developing a product. This project storyboard will show scenes that constructed within the project. For this development, the storyline is the exploration itself.

3) 3D Elements – most of the models used are made from scratch and are modeled according to the real location of HTV using 3Ds Max software. We design the environments and artifacts in HTV.

4) Cinematic Design – scripting the objects for interaction and immersive VR integration.
5) Source Integration – combining all the functions into a complete application.
6) Application Testing – test on target users with identified questionnaires during evaluation.

B. Flowchart Diagram
For this research, the flowchart diagram represents the application process steps to be followed by users to learn about Hang Tuah Village. Based on Figure 2, the system starts by presenting the user with the main menu. The user can then select to start the exploration. On the starting phase, the user positioned is outside of Hang Tuah’s house, where the user can then enter into and interact with objects that display various information regarding Hang Tuah. Afterwards, the user can explore Hang Jebat's house and learn information regarding Hang Jebat. Lastly, the user can then choose to end the exploration by interacting with the buttons or exploring the environment on their own.

C. Evaluation and Acceptance
The population consists of ten public participants who randomly took part in the application testing. Firstly, we briefed the participants on project details and what they need to do with the application. Due to the Covid-19 pandemic, some participants provided with a demo of the application through online video streaming services. At the same time, we lent the rest a VR device and a computer that supports VR to use the application. No time set due to the application not being a game as it is more to exploring the environment.

Evaluation for this study is a quantitative survey on the functionality test based on the function of the menu button available in the system and the User Experience Questionnaire (UEQ). After being exposed to the application, the respondents have to complete the survey form. It was a bi-language questionnaire adopted from the UEQ model. There are 16 dimensions of the UEQ, which is 1) attractiveness, 2) efficiency, 3) perspicuity, 4) dependability, 5) stimulation, 6) novelty, 7) trust, 8) haptics, 9) acoustics, 10) personalization, 11) usefulness, 12) value, 13) visual aesthetics, 14) intuitive use, 15) the trustworthiness of content, and 16) quality of content. However, we choose only five dimensions: attractiveness, perspicuity, dependability, usefulness, and novelty. The selection based on the related items to the project. In total, 17 questions are generated and measured using a Likert 5-point scale started from 'Strongly disagree' to 'Strongly agree', and the min score used to measure the application. As mentioned by [18], the mean score analysis based on 5-score as the highest. There was three range used which is 'Low' for range 1.00 to 2.33. 'Medium' for range 2.34 to 3.67, and 'High' for a range between 3.68 to 5.00.
3. RESULT AND DISCUSSION

This section elaborates the results and discussion from the proposed study through environment exploration using immersive VR HMD technology. We test the functionality testing using the menu button, the VR functionality, and the system's usability using UEQ, which given to a handful of users who were testing the prototype. We carried out an analysis using the data and findings obtained from the evaluation to improve the matter.

A. Functionality Testing
The validation performed by validating the result obtained from each function. A functionality testing checked overall system navigation and examined whether it could produce the expected output or not. Figure 3 shows the snapshot of the HTV main menu, which is to start the exploration. Once selected, the user can walk into Hang Tuah’s house in Figure 4 and view the artifacts, and play an audio description as in Figure 5. Figure 6 shows the screen that enables a user to hold the artifacts in hand and view them. User can read Hang Tuah's background story as in Figure 7 and follow by Figure 8 is menu appear for the user to choose to explore Hang Jebat's house. A similar screen on Hang Jebat will appear as the user walking into Hang Jebat's house.

B. Evaluating User Experience
Table 3 depicts the result of UEQ with the total average for each aspect and overall average value.
Table 3: Total Average for Each Dimension and The Overall Average Value

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Item</th>
<th>Question</th>
<th>Mean</th>
<th>Average Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attractiveness</td>
<td>A1</td>
<td>In your opinion, the application is enjoyable</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A2</td>
<td>In your opinion, the application is good</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A3</td>
<td>In your opinion, the application is pleasant to use</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A4</td>
<td>In your opinion, the application is user friendly</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Perspicuity</td>
<td>P1</td>
<td>In your opinion, the application is easy to understand</td>
<td>4.0</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>P2</td>
<td>In your opinion, the application is easy to learn</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P3</td>
<td>In your opinion, using the application is easy</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>Dependability</td>
<td>D1</td>
<td>In your opinion, the reactions of the application to your input and command is predictable</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>D2</td>
<td>In your opinion, the reactions of the application to your input and command meets expectations</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>U1</td>
<td>You consider using the application as useful</td>
<td>3.9</td>
<td>4.125</td>
</tr>
<tr>
<td></td>
<td>U2</td>
<td>You consider using the application as helpful</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U3</td>
<td>You consider using the application as beneficial</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U4</td>
<td>You consider using the application as rewarding</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Novelty</td>
<td>N1</td>
<td>In your opinion, the idea behind the application and the designs are creative</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N2</td>
<td>In your opinion, the idea behind the application and the designs are inventive</td>
<td>3.4</td>
<td>3.775</td>
</tr>
<tr>
<td></td>
<td>N3</td>
<td>In your opinion, the idea behind the application and the designs are leading edge</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N4</td>
<td>In your opinion, the idea behind the application and the designs are innovative</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Average Overall Mean Score</td>
<td>3.875</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Percentage of Mean Score</td>
<td>77.5%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The result concluded that for attractiveness dimension shows the highest average mean with 4.175 despite the A4 answer shows the medium range, which is 3.5. Most respondents choose 'Neutral' with 40% votes and compare to 35% 'Agree' and 12.5% 'Strongly Agree'. It could determined that the participants feel that the application has an attractiveness factor. For perspicuity, the average mean shows an accepted value, which is 3.8. We consider with those results; the participants feel that the application conforms to the perspicuity dimension of the UEQ. For the dependability dimension, the 'Neutral' side's feedback is the same as 'Agree', which is 35%. While the other 10% is on the 'Strongly Agree' side. 20% of participants choose 'Disagree' on the dependability factor. It shows that the application conforms to the dependability dimension of the UEQ. Furthermore, for the usefulness and novelty dimension, with the average mean of 4.125 and 3.775, we can confidently conclude that the application conforms to the usefulness and novelty dimension of the UEQ. Finally, with the average overall mean score being 3.875 with 77.5%, the system was considered at the 'High' level of usability acceptance.

4. CONCLUSION

In this research, the main objective overcomes the constraints in tourism activities during the Covid-19 pandemic. We are implementing VR HMD; thus, local tourists can visit HTV without ever needing to leave their residences while providing an almost accurate presentation of the village itself in a 3D environment. An adapted UEQ used for this study as the instrument to measure the participants' experience towards the application. The test was explicitly in testing the functionality and usability of the system. Respondents test the system and answer the survey questionnaires that measure the user's experience better than the subjective topic. In total, 17 questions were generated based on the selected five dimensions in UEQ, which are 1) attractiveness, 2) perspicuity, 3) dependability, 4) usefulness, and 5) novelty as the technical terms related to the experiences. For future research, we suggested creating a complete environment of HTV so that the users can feel like they are at the actual location and add more artifacts in the application for more knowledge and experience.

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REFERENCES


