

# A Framework for Museum Transformation Using AR-VR Technologies to Support Tourism

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**Abstract:** Due to the classical display of artefacts and infrastructure, museums and cultural heritages have several problems. The museums cannot engage the new generation (Gen Z). Similarly, these organisations cannot align themselves with tourism, the world's most popular and fastest-growing service. The classical display also creates problems in reading and understanding the information, and the visitors have no interaction with the artefacts. Therefore, the visitors are getting a boring experience and ultimately fewer visitors and less income. To address all these problems, we have designed and developed an immersive and collaborative framework for the museums using advanced technologies, Augmented Reality (AR) and Virtual Reality (VR). The results show that this system can engage the new generation, promote tourism, and provide an immersive and interactive experience.

**Keywords:** digital transformation; Museums; immersive experience; augmented reality; virtual reality; tourism; cultural artefacts.

## I. Introduction

Museums exist as buildings that keep various collections that aim to preserve and conserve artefacts of the past and document historical evidence (Preziosi & Farago, 2019). Museums are mainly used as a medium of education for the public to gain knowledge of different historical artefacts and pique the public's interest through the short interaction they are in the museum (Kersten, Tschirschwitz, & Deggim, 2017). Therefore, according to Kristianto, Dela and Santoso (2018), museums are no longer a place to preserve history but are becoming a medium for education and cultural space. Interestingly, Walzl (2006) stated that the museum's environment and the visitor's interaction experience are a healthy mix of entertainment and education. Hence entertainment and education play an essential role for museum visitors.

Virtual Reality (VR) presents a three-dimensional virtual world using computer technology. Users of VR experience the virtual environment as if they were in the real world. This immersive experience is provided by replicating as many human senses as possible, such as vision, touch, hearing, and smell, to provide a more immersive experience. People can benefit from virtual reality systems by having memorable and immersive experiences they would not have otherwise. VR allows individuals to tour the museum by doing rather than just reading and looking at infographics. People may attend museums even when not physically, thereby adopting VR for tourism, particularly in museums.

Augmented Reality (AR) technology is one of the leading technologies bringing numerous digital transformations by significantly improving companies' operating processes in various industrial fields. The potential of this technology has increased the demand for its adoption by many businesses. In the beginning, the AR concept was directly related only to games. Now, this technology goes beyond games and entertainment by entering into every industry with multiple perspectives to bring substantial benefits to the well-being of businesses. Currently, AR is playing an essential role in museology, transforming the museum's contents into digital and interactive forms. AR enables a new form of communication among museums and visitors through its power. Many companies support this technology to convey specific messages more innovatively to customers and make this connection more interactive.

The Coronavirus (COVID-19) has swept the world, causing significant disruptions in every economic area, including tourism. When the COVID-19 epidemic arrived, it disrupted certain museums' future, and the only way to stay 'open' was to go digital. The COVID-19 outbreak began in late 2019 and pushed museums into an unexplored field. Museum institutions were forced to remain closed per the government's regulation. Therefore, they must migrate to online platforms to continue their service to stay in business. Considering this abrupt shift has caused museums to reconsider their tactics, confront issues of relevance, and seek new paths that rely on virtual rather than physical interactions. With museums closed for 2020, the economic loss is mirrored in the massive decline in attendance numbers seen by most institutions globally. Almost 70% of participants reported a loss of more than 50% of their yearly attendance. Due to the epidemic, museums' revenue has decreased by 70% (Bernama, 2021). Addressing these concerns necessitated immediate planning for what was rapidly dubbed the "new normal" (Johnson, 2020), as the sole presence became a data version as an alternative to the original version.

Many museums nowadays are exploring the idea of virtual museum (VM) systems to attract more visitors by improving their visitors' experience using various technologies such as virtual reality, augmented reality, and digital technologies. This virtual concept offers the younger generations an interactive experience compared to traditional museums' mundane and non-interactive exhibitions. Since VM can communicate the cultural contents effectively with their entertainment and educational approach, they are considered an effective solution for museums (Barbieri, Bruno, & Muzzupappa, 2017).

The World's First Cat Museum is in Petra Jaya, in the Kuching City North City Hall, and is dedicated to all things feline. Cat fans will find over 4,000 exhibitions, pictures, feline art, and cat souvenirs. The museum is located on the ground floor of the City Hall building and is divided into four galleries spanning a total space of 1,035 square metres. The Cat Museum in Kuching is the world's first museum of its sort. It is operated by Kuching North City Hall and has a collection of Cat artefacts obtained from the National Museum, which showed them in one of its galleries in Kuala Lumpur. The Sarawak Museum purchased these items and showed them for the first time in Kuching City on August 1, 1988, in the Dewan Tun Abdul Razak. The artefacts were officially handed over to Kuching North City Hall at the completion of the DBKU (Dewan Bandaraya Kuching Utara) Headquarters building, which houses the museum, in 1992 (Sarawak Tourism Board, 2022).

Since entertainment is a factor that attracts museum visitors, therefore, this research study introduces a Framework for Museum Transformation Using AR/VR technologies to overcome the problems of museums redesign in such a way to engage the new generation, promote tourism, and provide an immersive and interactive experience.

## II. Materials and Methods

### 2.1 Conceptual Framework

When using immersive Virtual Reality (iVR), a user is surrounded by an enclosing virtual space (Mills & Noyes, 1999). The user is transported into a virtual environment to interact with or perform tasks using their entire body. Compared to non-immersive VR, immersive VR creates a learning environment free of distractions (Martín-Gutiérrez et al., 2017). Mulders et al. (2020) propose recommendations within the M-iVR-L framework that should be considered when designing iVR learning environments that can be implemented for Virtual Reality development, as shown in Figure 1. In this research, M-iVR-L is used as guidance to develop the system.

#### i. Learning first, immersion second

The main feature of immersion is its benefits for learning. To support the instructional goal of minimising unnecessary extra processing by carefully considering the level of immersion required for the Virtual Reality System. A higher level of immersion in the system is unnecessary if the system can achieve the goal as a learning tool. Less immersion, in some cases, is more beneficial.

#### ii. Provide learning-relevant interactions

The task relevant to the learning process can aid declarative knowledge and is required if learners acquire procedural knowledge such as skills and information. Providing learning relevant interactions Interaction in the virtual reality system can be optimised by avoiding unnecessary and irrelevant interactions.

#### iii. Segment complex tasks into smaller units

The content in iVR learning environments is a highly complex form of multimedia instruction that can overwhelm the learner. Segmenting complex tasks into smaller units can prevent the virtual reality system from overwhelming learners.

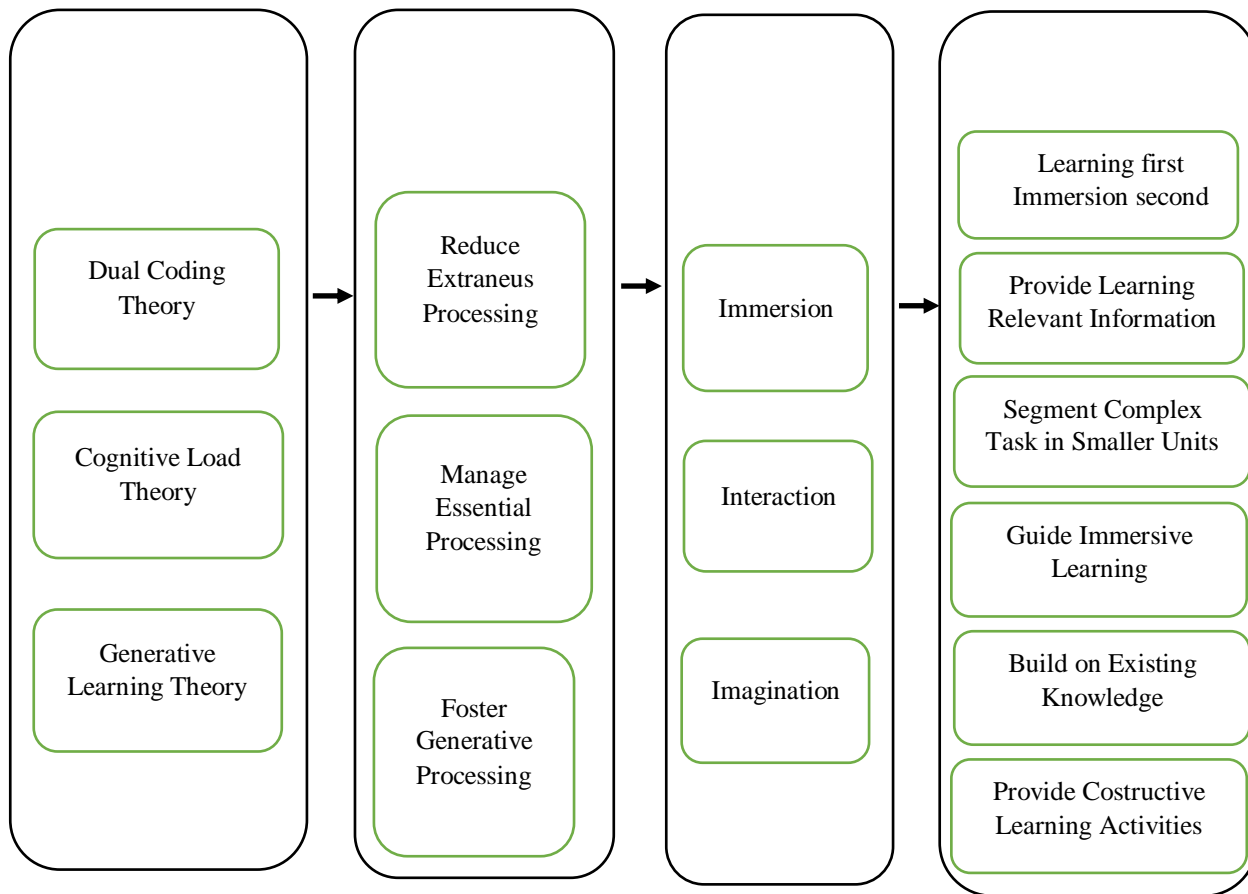


Figure 1. Conceptual framework

### 2.2 Rapid Application Development (RAD) Model

The rapid Application Development (RAD) model is used in this project. It is more focused on development than planning, as shown in Figure 2.

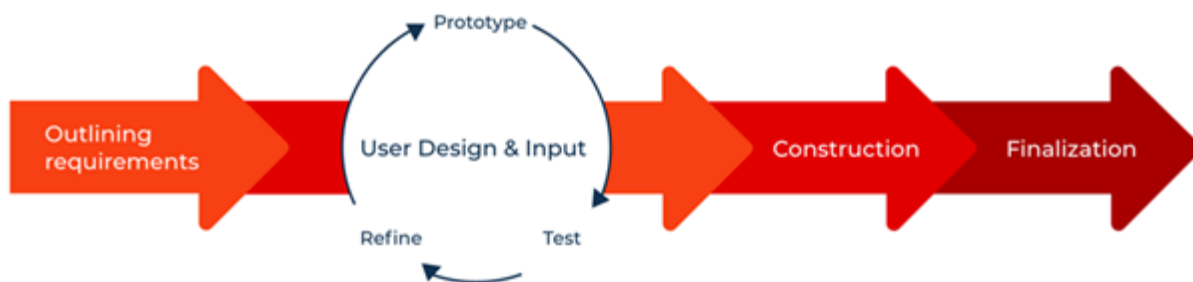


Figure 2. Rapid Application Development Model

RAD performs well in situations where the user interface is more critical than non-GUI programs. The RAD paradigm incorporates the agile technique with the spiral model. We first designed the cat museum's exterior and interior using Unreal Engine 4.27.2, as shown in Figure 3 below.



**Figure 3.** Interior of Cat Museum Kuching Malaysia

After a series of discussions with the museologists of the Cat Museum, the researchers categorised the artefacts according to the type and historical information. The standard categories are interactive displays, 3D models, and storytelling videos inside the immersive virtual environment. Then we accordingly displayed the artefacts on the walls of the walkways in the virtual Cat Museum. Figure 4 shows the interactive information display.

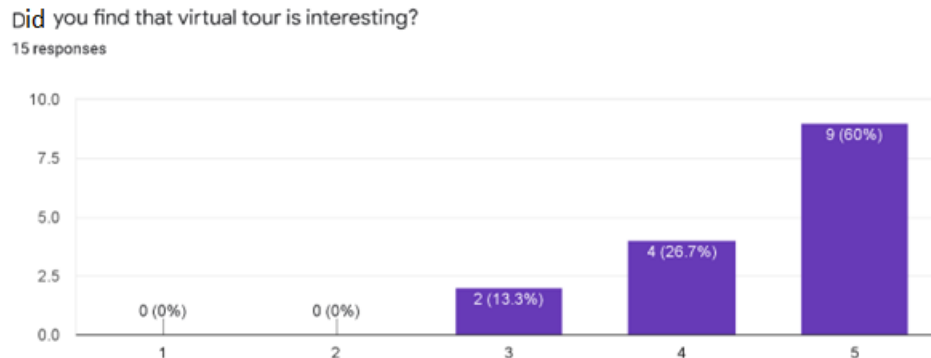


**Figure 4.** The interactive information display

### III. Results and Discussion

Fifteen (15) users tested the system, and a sample size of 8 to 12 is sufficient for evaluating findings with good reliability and validity (Brooke, 2013). Everyone who accepted to participate in the study was briefed and requested to view a two-minute video presentation before answering the three-minute questionnaire. The questionnaire consisted of 2 yes or no questions and 8 Likert-based questions. Likert-based questions are typically used in the system usability scale (SUS) test to evaluate the usability of a

project. There are 15 respondents for the test, primarily young adults ages 17 to 23. One of the responses is shown in Figure 5 below.



**Figure 5.** Does VR tour interesting enough

Based on Figure 4, most of the respondents find that virtual tour is fascinating, with nine (9) out of 15 respondents answering fascinating (60%), 4 out of 15 respondents answered interesting (26.7%), and 2 of them responded not sure (13.3%). Ten (10) out of the 15 respondents (66.7%) were curious to know more about the VR tour. Eleven (11) out of 15 respondents (73.3%) agree that this project’s design is very appealing. Five (5) out of 15 respondents (33.3%) responded that the text was clear to read, and 10 out of 15 respondents (66.7%) responded that it was noticeably clear to read. Ten (10) of 15 respondents (66.7%) were very satisfied with the project, 2 of them (13.3%) satisfied with what they saw, and 3 of them (20%) were not sure about their satisfaction level.

### 3.1 Novelty

This innovation has the following new contributions in context of Malaysia.

- i. The existing systems have no virtual collaboration among visitors, while using this innovation, visitors can virtually collaborate, such as talking to each other and sharing information.
- ii. Using the existing systems, visitors cannot interact with the artefacts, while using this innovation, visitors can interact with the 3D models, listen to the storytelling, and play mini-games related to culture and history.
- iii. Using the existing systems, visitors feel no sense of presence, while this innovation is fully immersive and provides a sense of presence.
- iv. Using the existing systems, visitors get a boring experience, while this innovation provides an engaging experience.
- v. The existing systems provide text-based information, while this innovation delivers an immersive 3D virtual environment.

## IV. Conclusions

The design and development of this virtual museum framework provide a space for curators to store their precious artefacts and valuable objects in digital form. The world is getting to a point where everything is digitalised and accessible to everyone without any limitations. Therefore, with the advancement of technology, the ever-expanding digital world thrives as the actual and virtual worlds combine. The most typical applications of VR development are constructing 3D scenes, video games, and virtual social worlds in the entertainment industry. It may also be utilised in various educational settings, including military training software, medical training, and early childhood education.

## References

1. Barbieri, L., Bruno, F., & Muzzupappa, M. (2017). Virtual museum system evaluation through user studies. *Journal of Cultural Heritage*, 26, 101-108.
2. Bernama. (2021). *Museums see 70% drop in revenue due to pandemic*. FMT. <https://www.freemalaysiatoday.com/category/nation/2021/12/07/museums-sees-70-drop-in-revenue-due-to-pandemic/>
3. Brooke, J. (2013). SUS: A Retrospective. *Journal of Usability Studies*, 8(2), 29-40.
4. Johnson, H. (2020). Arts and Culture in a'New Normal'. *The Psychologist*, 33, 98-99.
5. Kersten, T. P., Tschirschwitz, F., & Deggim, S. (2017). Development of a virtual museum including a 4D presentation of building history in virtual reality. *The International Archives of Photogrammetry, Remote Sensing Spatial Information Sciences*, 42, 361.

6. Kristianto, K., Dela, K., Santoso, H., Thamrin, J. M., & Panungangan, K. (2018). Implementation of gamification to improve learning in museum. *Journal of Engineering Science Research*, 2(1), 71-76.
7. Martín-Gutiérrez, J., Mora, C. E., Añorbe-Díaz, B., & González-Marrero, A. (2017). Virtual technologies trends in education. *Eurasia Journal of Mathematics, Science Technology Education*, 13(2), 469-486.
8. Mills, S., & Noyes, J. (1999). Virtual reality: an overview of user-related design issues. *Interacting with computers*, 11(4), 375-386.
9. Mulders, M., Buchner, J., & Kerres, M. (2020). A framework for the use of immersive virtual reality in learning environments. *International Journal of Emerging Technologies in Learning*, 15(24), 208-224.
10. Preziosi, D., & Farago, C. (2019). *Grasping the world: The idea of the museum*. Routledge.
11. Sarawak Tourism Board. (2022). *Cat Museum*. Online. <https://sarawaktourism.com/attraction/cat-museum/>
12. Watl, C. (2006). Museums for visitors: Audience development-A crucial role for successful museum management strategies. *Intercom*, 2006, 1-7.