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Designing Immersive Narratives of Jugra Heritage Site for Cultural Edutainment Using Mixed Reality

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Abstract

Technology integration in the tourism industry has introduced new possibilities for enhancing visitor experiences and promoting cultural edutainment in heritage tourism. Mixed Reality (MxR) is a promising technology for achieving these goals. By leveraging MxR, cultural heritage sites can provide tourists with engaging and educational experiences, allowing them to delve into the rich history and cultural significance of these sites. However, the quality of content in MxR applications can significantly impact the overall experience and educational value. This research proposes best practices for MxR development in smart heritage tourism, ensuring the delivery of high-quality, culturally authentic, and educational experiences to visitors. A qualitative approach has been adopted to achieve this aim, utilizing the Speak Aloud method to collect data from participants who interacted with the MxR prototype. The study focuses on a case study of the Jugra heritage urban landscape, using it as a basis for developing an MxR prototype. The research encompasses two stages: the first is the design for prototype development, and the second is to test the application for user feedback. Through discussions on prototype design development and user experience testing, the research proposes a storyboard framework as a guideline for designing the MxR environment. This framework serves as a comprehensive blueprint, ensuring that each phase, from data analysis to the final Mixed Reality application, is meticulously designed and executed. Respondents tested the prototype to gather feedback on the prototype's outcomes, enabling refinement of the blueprint for subsequent levels of testing with heritage visitors. The results of this study contribute to the field of MxR development in smart heritage tourism. The research enables developers to create high-quality, culturally authentic, educational MxR experiences by offering guidelines and best practices. Therefore, the application of MxR in cultural heritage enhances the level of visitor engagement and facilitates a more profound comprehension of cultural heritage.

Keywords: *Cultural edutainment, smart heritage tourism, immersive, mixed reality, narrative.*

INTRODUCTION

This study addresses research problems related to MxR development in content creation and curation, particularly focusing on challenges within the tourism sector. One challenge is the collaboration of expertise required to develop applications for tourism promotion. Another issue involves realism, where emphasis is often placed on programming rather than on the content and authenticity of tourism destinations. The quality and reliability of MxR content can significantly impact visitor engagement and satisfaction (Bevilacqua et al., 2022; Dehghani et al., 2020; Hammady et al., 2019, 2021; Xu et al., 2022). Poorly designed or low-quality content may lead to a subpar experience and diminish the educational value. Content creators must ensure the content is well-produced, visually appealing, and optimized for the MxR platform. Inaccurate or misleading information can compromise the educational value and authenticity of the experience (Li et al., 2022). Balancing creative storytelling with accurate historical and cultural representation requires extensive research and collaboration with cultural experts (Talgorn et al., 2022). MxR content creators must navigate ethical considerations when representing sensitive cultural practices, sacred sites, or culturally significant artifacts (Gutkowski et al., 2021; Liu et al., 2021). Respecting cultural protocols, obtaining proper permissions, and avoiding cultural appropriation are essential to maintaining ethical standards and cultural sensitivity.

Collaboration among content creators, cultural experts, site managers, and tech developers is essential for addressing these issues, while thorough research, ethical adherence, and quality production are vital in mitigating challenges in MxR development for heritage tourism. This paper combines architecture expertise with 3D digital development and programming to integrate anthropometric dimensions and architectural viewpoints, culminating in a prototype aimed at promoting heritage tourism. The research objective is to evaluate the new design guidelines for developing a mixed reality prototype of the Jugra heritage site for cultural edutainment. The research question is: How do users engage with the new prototype of the digital heritage tourism site using the new MxR design development approach guidelines?

The research aims to propose guidelines and best practices for MxR development that ensure the delivery of high-quality, culturally authentic, and educational experiences in smart heritage tourism, while also identifying user experiences in engaging with the prototype. These guidelines will provide valuable insights for content creators, technology developers, and heritage site managers to ensure the delivery of high-quality, culturally authentic, and educational MxR experiences. In the scope of architecture education, the study of heritage plays a crucial role in providing valuable data on tangible and intangible cultural elements related to heritage sites (Chrysanthakopoulou et al., 2021; Embaby, 2014; Puggioni et al., 2021). Creating an MxR prototype for cultural heritage involves merging expertise in historical element analysis, 3D modeling, and creating captivating interfaces to captivate visitors' interest and elevate their participation, ultimately supporting the realization of smart tourism goals. Simultaneously, shift the focus beyond tourists, aiming to enrich the local community, especially the youth. Mixed reality's immersive experiences not only captivate tourists but also shape a strong local connection, fostering a more inclusive and enriching heritage tourism landscape.

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LITERATURE REVIEWS

Mixed Reality Development

Mixed Reality (MR) development refers to the creation and implementation of technologies that blend virtual reality (VR) and augmented reality (AR) to create immersive and interactive experiences that seamlessly merge the digital and physical worlds (Kumawat et al., 2020). MxR is categorized within the scope of Extended Reality (XR), a digital technology that covers Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MxR), as depicted in Figure 1.

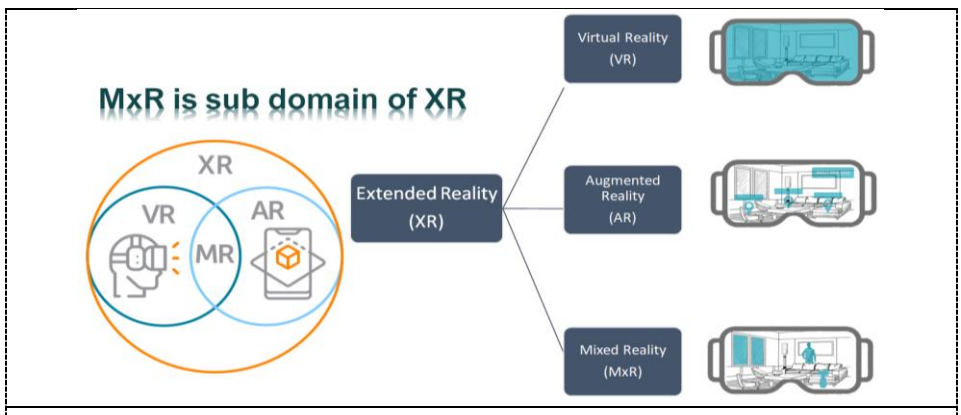

Figure 1: MxR is a subdomain of XR.

VR creates a computer-generated environment that simulates a different location (Flavián et al., 2019; Gaberli, 2019). AR overlays virtual elements onto the real world, enriching it with digital multimedia content (He et al., 2018; Milgram & Kishino, 1994; Trunfio et al., 2020). MxR merges VR and AR, establishing a seamless immersive link between virtual objects and their real-world surroundings (Bekele et al., 2018; Fanani et al., 2021; Flavián et al., 2019; Trunfio et al., 2020), as illustrated in Figure 2. MxR represents an approach in which real and virtual information are blended in various permutations (encompassing VR and AR), utilizing Head Mounted Devices to induce sensations of presence and displacement (Milgram & Kishino, 1994). Examples of MxR head-mounted devices are shown in Figure 3.

(a. MxR more to the physical world) (b. MxR more to virtual world)

Figure 2: Illustration of the MxR spectrum in both the physical and virtual worlds, following the MxR spectrum.

Figure 3: Example of MxR head-mounted device.

Digital Narrative

Digital narrative has been acknowledged as a potential instructional tool for improving information literacy. Leow & Ch'ng, (2021) emphasize that digital narrative methods involve describing historical events from an individual perspective. Each group (such as royals, locals, indigenous people, migrants, and tourists) has its own unique perspective and interpretation of their cultural heritage, contributing to a diverse and varied set of narratives. Establishing an immersive heritage experience for a broader audience, including the local community and tourists, can be achieved by creating and sharing a narrative of the past through an interactive and user-friendly interface (Rashid et al., 2022) in MxR application. The design of digital narratives plays a crucial role in comprehending historical contexts and enhancing learning motivation, which is lacking in traditional museum and heritage site experiences (Zhang et al., 2021). In the domain of edutainment, immersion focuses on narrative and sound effects to enhance the learning experience (Zhang et al., 2021). Eventually, engaging users in edutainment through narrative design about the past enhances the sense of place and personal bonding with the heritage site.

Cultural Edutainment

Cultural edutainment combines cultural education and entertainment, aiming to provide visitors with engaging and educational experiences related to cultural heritage (Mazarina et al., 2021). It involves the use of interactive and immersive mediums, such as storytelling, multimedia presentations, hands-on activities, and digital technologies, to convey knowledge and foster a deeper understanding of cultural traditions, history, and heritage (Lee & Hwang, 2022; Okanovic et al., 2022; Saleh et al., 2022;

Zhao et al., 2022). By leveraging the power of MxR, cultural edutainment in digital heritage tourism can provide visitors with engaging, immersive, and educational experiences (Trunfio et al., 2022). MxR enhances the accessibility, interactivity, and personalization of cultural learning, fostering a deeper appreciation and understanding of cultural heritage (Chong et al., 2021; Trichopoulos et al., 2022). Through MxR, digital heritage tourism contributes to achieving smart tourism goals by offering innovative and transformative experiences that preserve, educate, and engage visitors with cultural heritage (Buhalis et al., 2019). In general, smart heritage tourism leverages technology to enhance cultural edutainment experiences for visitors. By incorporating innovative technologies, such as mobile applications, AR, VR, IoT, and gamification, cultural edutainment becomes more immersive, accessible, and engaging. These smart tourism strategies promote a deeper appreciation of cultural heritage while preserving and showcasing the unique cultural identity of the destination in Malaysia (Hamamurad et al., 2022; KPKT, 2021; Lim et al., 2021).

Smart Heritage Tourism

Smart heritage tourism refers to integrating advanced technologies and digital solutions to enhance the visitor experience, improve operational efficiency, and promote sustainable practices at heritage sites (Mazarina et al., 2021). It involves the use of technologies like the Internet of Things (IoT), artificial intelligence (AI), mobile applications, data analytics, and virtual reality (VR) to create intelligent and interactive tourism experiences (Buhalis et al., 2019; Muthanna et al., 2018). MxR (Mixed Reality) significantly impacts smart heritage tourism, bringing numerous benefits and transforming how visitors engage with cultural heritage. MxR has a transformative impact on smart heritage tourism by offering immersive and interactive experiences (Shehade & Stylianou-Lambert, 2020)., preserving cultural heritage digitally (Mekonnen et al., 2022), providing personalized and adaptive content (Katifori et al., 2020), facilitating real-time information and navigation, incorporating gamification, and enabling data-driven insights MxR enhances the visitor experience, promotes cultural edutainment (Ibrahim & Ali, 2018), and contributes to the sustainable management (Errichiello et al., 2019) and preservation of cultural heritage in the smart tourism landscape. Utilizing digital technology can develop a sense of "person-place bonding" among tourists and elevate the emotional connection to the sense of place within the local community, particularly among the younger generation (Tan et al., 2018). This connection helps form relationships with disappearing landscapes, visualized digitally of the heritage elements.

RESEARCH METHODOLOGY

The research study adopts a qualitative approach and is structured into two stages; the development of the MxR application prototype in stage one and the testing of the prototype in stage two. Stage one encompasses four phases for prototype design and development (Figure 4). The focus of the study is on creating an MxR application prototype for the Jugra heritage urban landscape in Selangor, Malaysia,

chosen for its historical significance in the Malay Archipelago. The objective is to showcase the heritage urban landscape to the public to increase its appeal to both local and international tourists.

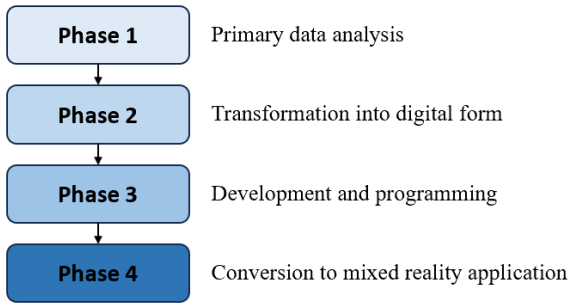

Figure 4: Development phases of the Mixed Reality (MxR) prototype

During the initial stage of primary data analysis, historical information about Jugra's significance was collected from primary data sources. This includes conducting research, interviews, and site visits to collect relevant historical data. Then, the second phase is to transform the data into digital form. In this phase, the process of converting the collected data into digital format using software such as SketchUp and Cinema 4D. This step involves creating digital representations of the heritage site, including architectural models and 3D reconstructions. After that, development and programming were the third phase, utilizing Unity 3D software and Adobe Photoshop to develop and program the gathered information into a digital setting. This includes designing the user interface and integrating the historical data within the digital environment. Finally, the last phase is conversion to a Mixed Reality application. In this phase, the process was to convert the digital setting into a Mixed Reality (MxR) digital environment using the Meta Quest 2 MxR reality device. This step brings the digital heritage environment to life by overlaying virtual elements onto the real-world physical space. A storyboard framework has been designed to complete phases one to four as a guideline for constructing the MxR prototype. The storyboard framework designed in this research study is shown in Figure 5:

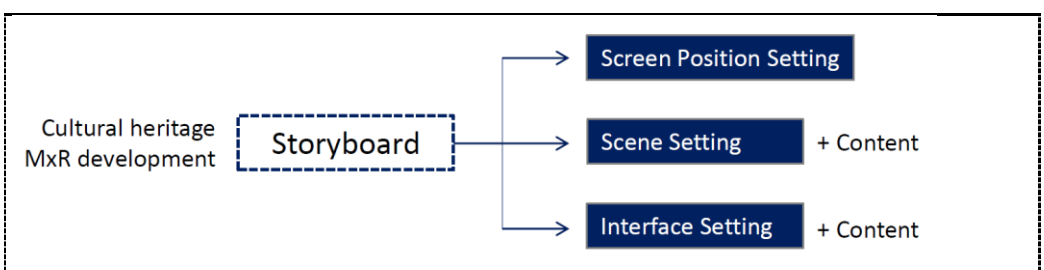

Figure 5: Main storyboard framework.

In Stage 2, testing data were collected from three respondents from the Kulliyyah of Architecture and Environmental Design at the International Islamic University Malaysia (IIUM), who possess average skills in digital technology, primarily using smartphones for websites and mobile apps, though they are not particularly familiar with Extended Reality (XR) technology, specifically using head-mounted devices for Mixed Reality (MxR). Despite their limited experience with Augmented Reality (AR) and Virtual Reality (VR), MxR is considered advanced within the realm of XR technology. The data collection involved respondents experiencing and engaging with the prototype, utilizing the Speak Aloud technique to capture user experiences, which were then transcribed and analyzed using Atlas.ti to extract insights across four main areas: user interface, content, user experience, and familiarity with the head-mounted display (HMD).

FINDINGS & DISCUSSION

Narrative Design Framework

Screen position setting is a crucial aspect of MxR development, as it determines the user's position within the MxR environment and their interaction with the interface. Anthropometry, which refers to studying human body measurements and proportions, plays a significant role in the screen position setting to ensure user comfort and optimal interaction. By considering human body measurements and proportions, developers can position the interface elements to ensure user comfort, facilitate natural interaction, and enhance the overall user experience within the MxR environment (Figure 6).

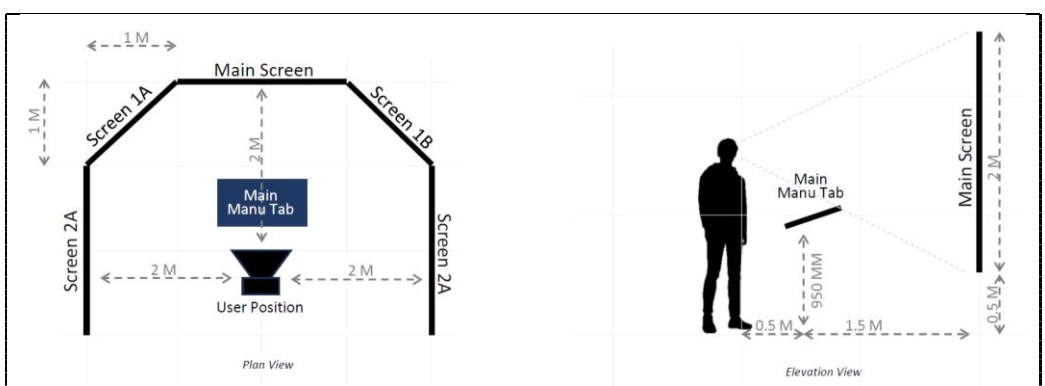

Figure 6: Screen position setting planning.

In this research study, the MxR development for the heritage urban landscape of Jugra utilized five scene settings, as shown in Figure 7, to depict the site's narrative. Each scene represented a specific storyline, contributing to the overall immersive experience of the prototype (Figures 8, 9,10,11, and 12). Using these five distinct scene settings, the MxR prototype offered users a comprehensive and engaging experience of the heritage urban landscape of Jugra. Each scene contributed to the overall narrative, immersing users in the site's rich history and cultural significance.

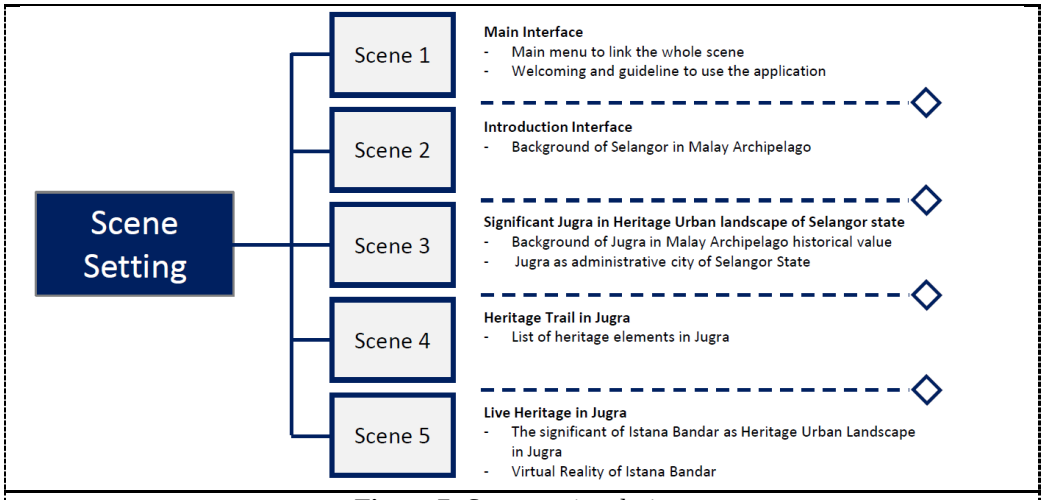

Figure 7: Scene setting design.

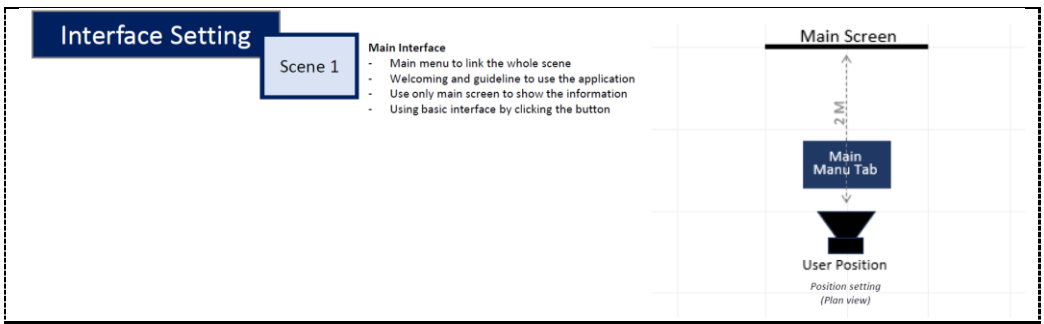

Figure 8: Scene 1 interface setting.

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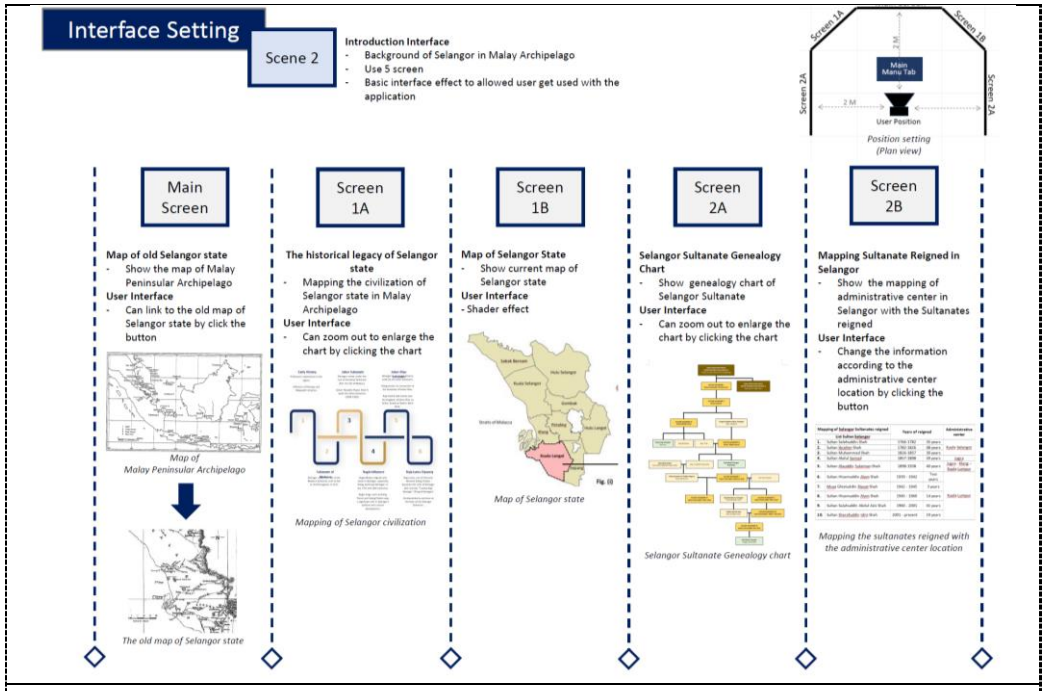

Figure 9: Scene 2 interface setting.

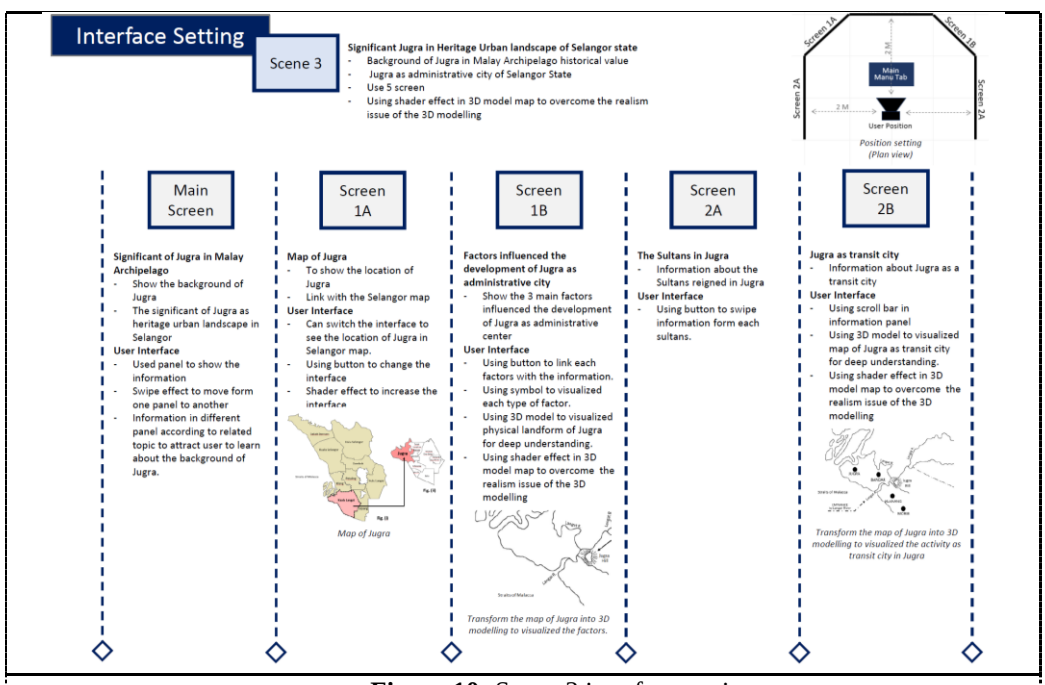

Figure 10: Scene 3 interface setting.

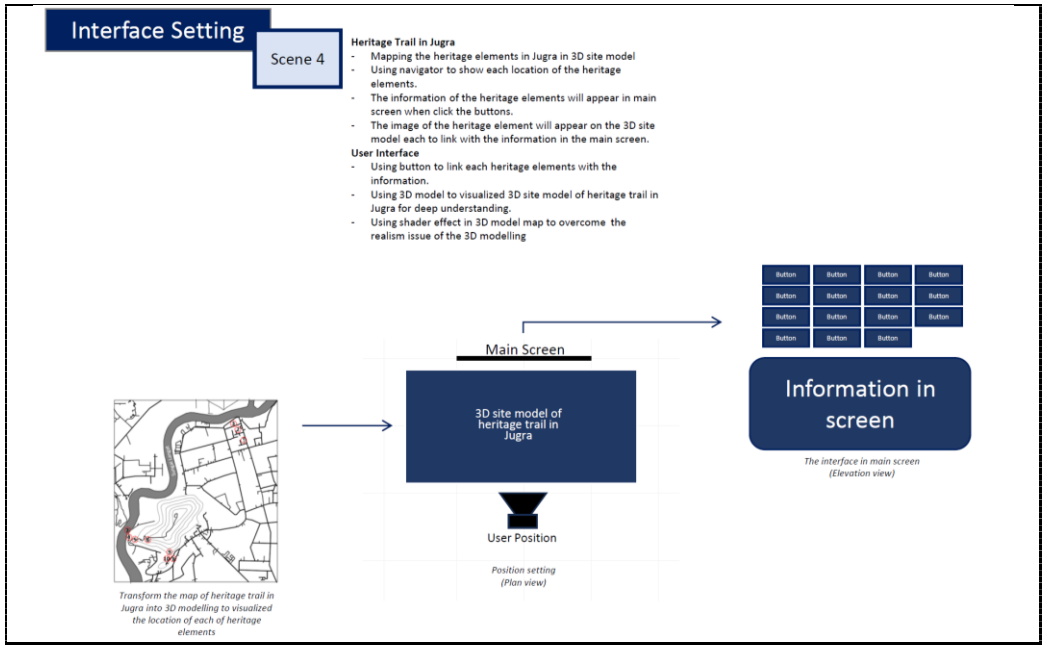

Figure 11: Scene 4 interface setting.

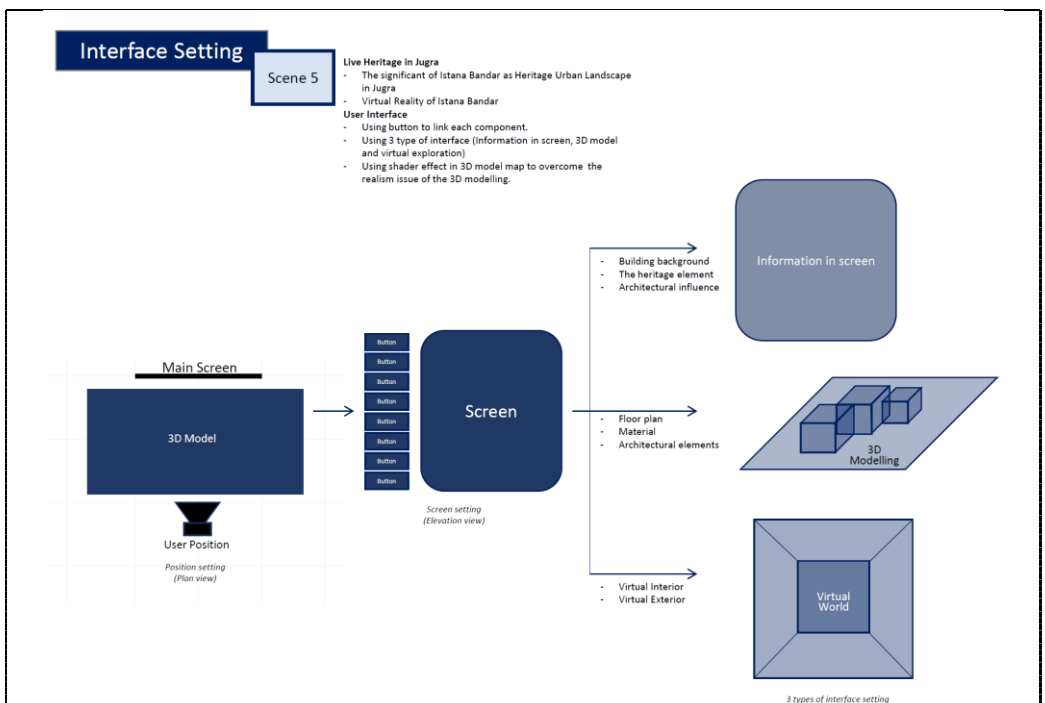

Figure 12: Scene 5 interface setting.

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User Engagement on Jugra Heritage Urban Landscape MxR Prototype

Three respondents from the Kulliyyah of Architecture and Environmental Design at the International Islamic University Malaysia (IIUM) have tested and engaged with the prototypes (Figure 13). The analysis of user engagement is categorized into four aspects: firstly, familiarity with MxR and the Meta Quest Head Mounted Device (HMD); secondly, user interface; thirdly, content; and fourthly, user experience (Figure 14). The user engagement results within each category are presented in Table 1. Based on this analysis, the researcher will refine the prototype's design and development to maximize user engagement for the final product in the future.

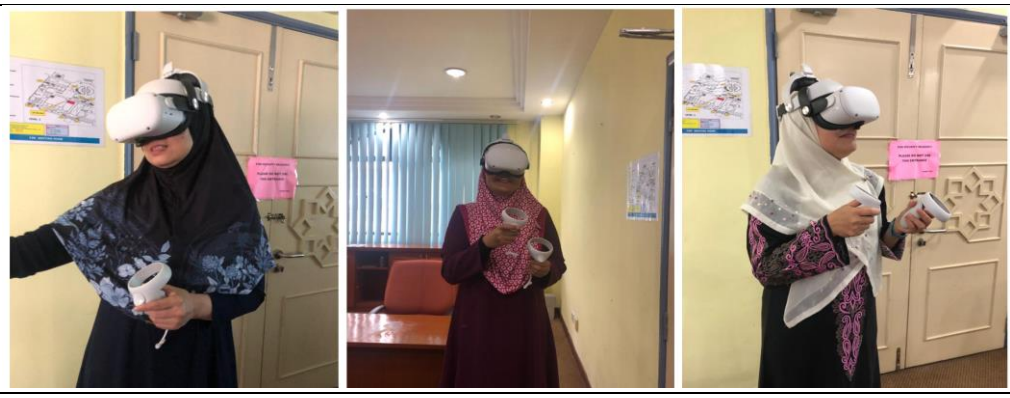

Figure 13: Participants test the prototype.

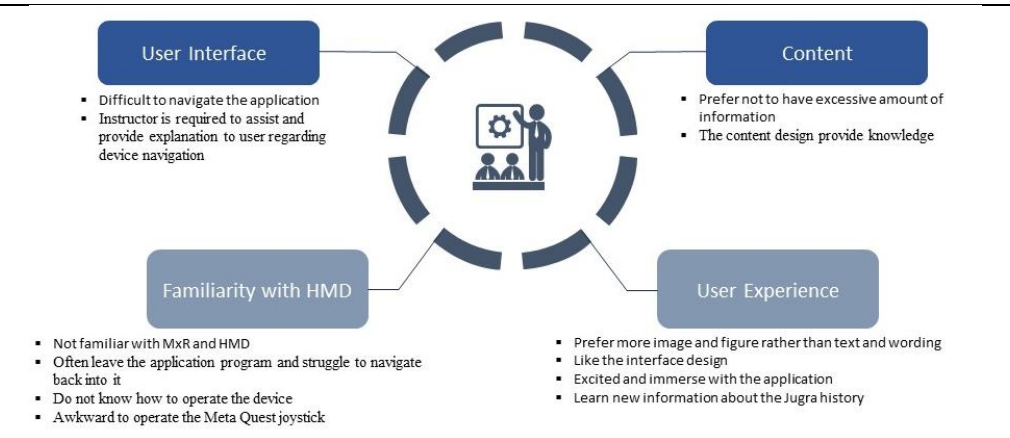

Figure 14: Analyzing user engagement in the MXR prototype for Jugra heritage through networking in Atlas.ti.

Table 1: Analysis category of user engagement.

No	*Analysis Category*	*Findings*
1	Familiarity with HMD	It is awkward to operate the Meta Quest joystick. Do not know how to operate the device. Not familiar with MxR and HMD Often, they leave the application program and struggle to navigate back into it.
2	User Experience	Excited and immersed in the application. Learn new information about the Jugra history. Like the interface design I prefer more images and figures rather than text and wording
3	User Interface	Difficult to navigate the application. The instructor is required to assist and explain device navigation to users.
4	Content	Prefer not to have an excessive amount of information, The content design provides knowledge

CONCLUSION

In this study, the integration of architectural knowledge and skills played a significant role in crafting captivating MxR prototypes. Within the architectural domain, the specialized area of heritage study, which centers on researching and conserving cultural heritage sites, contributes to the design and development of MxR applications for heritage tourism. In stage one research findings, the design of prototype development utilized architectural knowledge and skills in digital presentation settings, highlighting the ergonomic and anthropometric dimensions in a digital environment for presentation. To further strengthen these guidelines, stage 2 research findings show that four elements need to be considered in designing and developing MxR prototypes for digital heritage presentation. Firstly, user skills and background in using HMD, especially for MxR applications, need to be considered as they influence user engagement in experiencing heritage exploration. Secondly, enhancing user experience is crucial to increase immersion in digital exploration. Thirdly, user interface design plays an important role in enhancing user engagement while using the application. Lastly, informative content creation and realistic 3D modeling are essential to illustrate the real content of heritage elements, as they significantly influence user engagement in the exploration.

In conclusion, the prototype storyboard design can serve as guidelines and blueprints for designing and developing heritage applications for MxR. The four elements—user background, user experience design, user interface design, and content creation—play important roles in enhancing user engagement and contribute to the improvement of the sense of place and bonding with the heritage site, enriching their edutainment.

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