VAULT.SPACE: AN EVALUATION OF THE METAVERSE ICONIC LANDMARKS OF SINGAPORE ISLAND ON A HYBRID MAP

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Abstract. This paper presents an early development of a metaverse platform showcasing the Singapore island centred on the premise that; a combination of replicas of abstracted architectural landmarks and fictional imaginary buildings on a hybrid virtual map will enhance the user experience and foster increased levels of user engagement. Adopting an easy-to-use web-based approach and utilising Three.JS as the programming and processing interface, the architectural landmarks and fictional buildings assets are modelled in an abstracted, low-poly style and heavily optimized for achieving high game-play performance. Subsequently, a survey assessed the platform's hybrid model, evaluating the importance of architectural accuracy in digital form. The survey results supported the hybrid environment concept, showing users' preference for recognizable landmarks with detailed architecture, even in a virtual setting. The paper concludes that a metaverse platform blending real and imaginary elements can provide a familiar yet novel digital environment, supporting our notion that even in the digital realm, a faithful representation and adherence to architectural values are appreciated by users, contributing to heightened interest and engagement in this novel virtual environment.

Keywords. Singapore, Metaverse, virtual world, Three.js, mobile device

1. Introduction

1.1. THE DEVELOPMENT OF THE SINGAPORE METAVERSE WITH ICONIC LANDMARKS AND ITS INSPIRATION

Many existing metaverse platforms, such as *Spatial.io*, *Roblox*, and *Decentraland*, offer virtual, game-like environments with fictional buildings and landscapes that create a futuristic setting. However, when they try to represent a real-world city, users may not feel fully immersed in such abstract environments. In this paper, we unveil a thoughtful and deliberate approach toward developing a pioneering and innovative

metaverse platform, combining replicas of real-life architectural landmarks and weaving them amidst semi-fictional buildings, producing a hybrid map environment. Meticulously rooted in architectural principles and thoughtfully designed for practical and commercially viable applications, the platform's initial inspiration comes from the acclaimed Kode Sports Club project (Merci-Michel, 2020). Our platform architecture employs the programming interface Three.js to construct an abstracted, low-poly representation of the Singapore Island within this digital realm without compromising on any aesthetic or historically essential features. We have interwoven iconic landmarks, establishing a central plaza as a social nexus, and crafted stylized galleries—all optimized for seamless user engagement, simultaneously creating an immersive experience easily accessible to a wide demographic of users under the concept of "metaverse for all" and aims to be available on mobile devices.

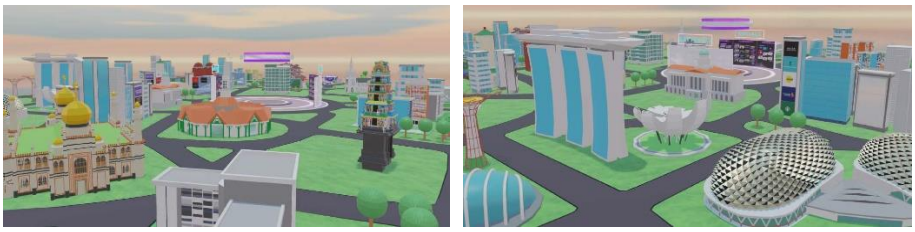

Figure 1: Singapore Metaverse with Iconic Landmarks

In this paper, we focus on the early development of the Singapore Island with its iconic landmarks (cf. figure 1). The process follows a two-fold approach.

Architectural Aspects: First, architectural landmarks were re-constructed using 3D modelling techniques that preserved their real-life values and essence, without compromising on essential details and performance in a metaverse environment. Next, the map was populated with iconic and futuristic buildings and other metaverse features, without following their real-world locations strictly. Last, a balanced and nuanced colour palette was implemented for a harmonious and vibrant colour scheme that appealed to a wide demographic of users. The landmarks were reproduced in their original colours, but also used futuristic hues such as purple and blue to create a playful and imaginative environment.

Technical Aspects: First, the platform was developed on the Three.js programming interface for hosting 3D animated graphics on a web platform, enabling easy user access and enhanced interface and performance control. Next, Shading and nodal variations were used to colour most 3D models and textures were applied to key locations and objects, such as the Metaverse plaza and Event space, to enhance the realism and visual appeal. Last, a multipronged approach was adopted to improve the platform performance. All 3D models were optimised by removing redundant planes and vertices, reducing file size and refining object complexity. Advanced compression techniques were applied as a post-processing step to further optimise the file size. All 3D objects were combined into a single mesh for optimal performance.

1.2. RESEARCH QUESTION

Some questions arise from our approach taken to build the hybrid version of our metaverse such as: Are the landmarks too abstracted? Can the users recognise them? What level of detail and architectural accuracy is needed or sufficient? Does the relocation of the landmarks to fit the abstracted map make users confused? Can the users easily navigate through them? Does the colour scheme suit the wide demographic of users?

These points can be summarised into one single research question:

Can a newly developed metaverse platform replicating real-life iconic landmarks using a hybrid approach ensure the recognizable expression of architectural and historical characteristics, ergo, providing users with ease of navigation through a sense of familiarity and excitement in a digital hybrid environment?

2. Literature review of the Metaverse Cities

The term "metaverse" was first coined by American writer Neal Stephenson (1992) in his science fiction novel "Snow Crash". The metaverse is enabled by many technologies like VR (Virtual Reality) and AR (Augmented Reality) as entry points, but also blockchain, Web 3.0 and Artificial Intelligence. This term is recently added to the Merriam Webster's dictionary (2023) as "a persistent virtual environment that allows access to and interoperability of multiple individual virtual realities". According to Cathy Hackl, a tech futurist and metaverse expert, the metaverse is a convergence of our physical and digital lives (Hackl & Alaghband, 2022).

This paper explores the development of the metaverse of a city using VR technology. We distinguish between two types of metaverse based on their degree of realism: realistic and fictional. We then examine the characteristics and challenges of each type. Lastly, a hybrid map environment is also observed.

2.1. REALISTIC (DIGITAL TWINS) METAVERSE CITIES

The metaverse cities are online realms created with the innovative technology of metaverse digital twins. However, according to Liu et al. (2020), a digital twin does not need to be an exact replica of a physical building, but a virtual model reflecting its current state and performance. These digital twin cities are created for different purposes, for example, *Metaverse Seoul* is an 'All in one' metaverse integration platform that supports various functions such as administration, tax, education, civil complaints, and cultural tourism (Metaverse insider, 2022). Shanghai, China's largest city and financial capital, has set an ambitious target of constructing 30 metaverse projects focused on culture and tourism by the end of 2025 (Forkast News, 2021). Some digital twins were created to showcase infrastructure and layout such as New York City's *Urban Transportation Twin*, Dubai's *Metaverse Metro Network*, and Tokyo's *Streets Digital Twin*. They have the potential to resolve a variety of real-life issues and provide efficient solutions.

2.2. FICTIONAL METAVERSE CITIES

On the other end of the spectrum, many metaverse cities have been developed in a

fictional way. In the novel "*Invisible Cities*" by Italo Calvino, the traveller Marco Polo makes verbal reports to emperor Kublai Khan, telling fantastical stories about the cities that he's visited. These cities, all bearing women's names, are described with poetic imagery and geometric rigor, and they inspire a reflection that holds good for all cities in general. Chloe Sun (2022) suggests that metaverse planners can be inspired by some of the mentioned qualities of the *Invisible Cities* and should create cities that are not limited by the constraints of the physical world, but rather explore the possibilities of different urban forms, layouts, symbols, and meanings. There are many examples of these imaginary metaverse such as Cryptovoxels, Decentraland and The Sandbox, which are user-owned virtual worlds built on the Ethereum blockchain. The design of the world isn't a realistic 3D model of any particular city, but the urban layout and structure can be reminiscent of real-world cities.

2.3. HYBRID METAVERSE CITIES

A hybrid metaverse is a type of virtual environment that combines elements of realistic and fictional categories. It uses abstracted or stylized representations of real-world landmarks or locations, as well as digital or imaginary assets that do not exist in physical reality. An example of a hybrid metaverse is the *Liberland Metaverse* (Dezeen, 2022), crafted by Zaha Hadid Architects, is a virtual city mirroring the self-declared Free Republic of Liberland. It showcases the firm's signature architectural style with gravity-defying structures and serves as a hub for the web 3.0 community. This metaverse aims to foster networking among metaverse developers and the crypto industry. *Metrotopia*, another virtual city by the same architects (Zaha Hadid Architects, 2023), functions as a collaborative space for architects to display and discuss their designs, blending the physical and digital realms.

2.4. RECAPITULATION

This following graphics (figure 2) recaps the metaverse platforms/projects based on (1) the degree of fictional/realistic and (2) the degree of reference of the place/buildings/assets:

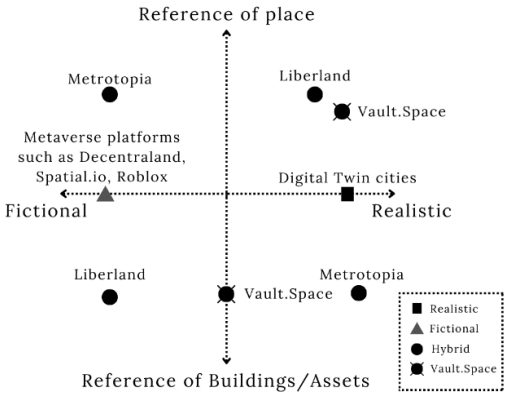

Figure 2: Recapitulating quadrant showing metaverse platforms based on (1) the degree of fictional/realistic and (2) the degree of reference of the place/buildings/assets

Figure 2 shows that similar to *Liberland*, which simulates a real-world micronation with fictional and abstracted architectural elements, our metaverse *Vault.space* also adopts a hybrid approach. It draws inspiration from the island and landmarks of Singapore, but incorporates abstracted and imaginary components (buildings and assets) that enrich the user experience and activity (see Figure 2). For example, our metaverse includes a social plaza and user galleries that do not exist in the physical Singapore, but offer spaces for social interaction, artistic expression and commercial opportunity.

3. Evaluation of the Metaverse and their iconic landmarks

3.1. THE METHODOLOGY

The metaverse evaluation utilizes a mixed-methods approach. Quantitative and qualitative data is gathered via a questionnaire administered to a diverse sample, both Singaporeans and foreigners.

3.2. THE QUESTIONNAIRE

A questionnaire has been designed to evaluate the hybrid approach of Singaporean landmarks on the Metaverse. It collected quantitative and qualitative data. Quantitative data measured the frequency of variables such as age group, nationality, and degree of preference or realism of the Metaverse compared to real life. Qualitative data explored the users' preference through close-ended and yes/no questions such as their opinions on the Metaverse and their familiarity with Singapore and its landmarks. Before the questionnaire, participants accessed and explored the Metaverse Singapore map without any specific tasks, information on navigation controls, basic functionalities, or guidance. Then they answered the questionnaire, which had six sections:

1. *Iconic landmarks recognition*: Show users a series of images of abstracted Singaporean landmarks and ask them to identify them.

2. *Navigation and orientation*: Ask users if they knew their location on the Singapore map and if they minded that the landmarks were not in their exact places on the metaverse map.

3. *Hybrid Model Evaluation*: Ask users to give feedback on how the familiar landmarks in the fictional environment made the platform more interesting and relatable. Assess their preference for a realistic, fictional or hybrid map.

4. *Architectural Accuracy Evaluation*: Ask users to give feedback on how the replication accuracy of the landmarks affected their experience.

5. *Colour Palette Evaluation*: Ask users to give feedback on the colour scheme's harmony and effectiveness in portraying Singaporean landmarks (vibrant colours) and futuristic features (purple tone).

6. *Overall Performance and First impression evaluation*: Ask users to evaluate the platform's overall performance. Conclude the test with a brief close-ended question to get their overall impressions, including interface, difficulties, and suggestions. Provide a brief open-ended answer field to collect qualitative insights on their emotional responses.

3.3. DATA ANALYSIS

Analyse of both quantitative data (accuracy in landmark recognition) and qualitative feedback were carried out to draw conclusions about the efficacy and level of user engagement in utilising a hybrid map of replicated Singaporean architecture amidst a fictional environment.

4. Results and analysis

The survey was conducted on a focus group of 50 people, of whom 23 (46%) were Singaporean nationals. Out of the other 54% that are non-Singaporeans, a big majority of them (36%) have visited or lived in Singapore. Genders of the respondents were almost evenly split between male and female, with a wide majority belonging to the platform's target age group (8 years onwards, 46% 13 to 35 years old, 54% 35 and older). The respondents spent an average about 10-15 minutes in the Metaverse. The results are aggregated and represent the views of all age-groups.

4.1. ICONIC LANDMARK RECOGNITION

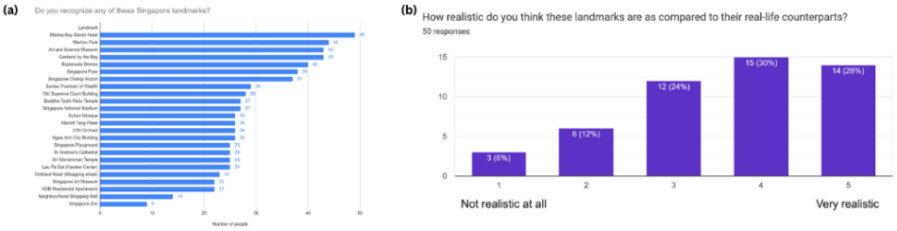

Figure 3: the results of a questionnaire related to Singapore landmarks recognition

Results shown in figure 3 (a) indicate that iconic landmarks, such as Marina Bay Sands Hotel, Merlion Park, and Art and Science Museum, were easily recognised and played a part in creating an engaging environment. On the other hand, landmarks that were not feasible to be presented accurately because of their size and nature and had to be digitally presented in a more abstract manner (e.g.: Singapore Zoo) received low scores for landmark recognition and user engagement. We then combined the above result with the results from figure 3 (b) (Landmark Realism 72.4%) and can infer that users need to easily identify landmarks in a virtual environment and that the level of detail and realism is crucial to the users' overall experience.

4.2. NAVIGATION AND ORIENTATION

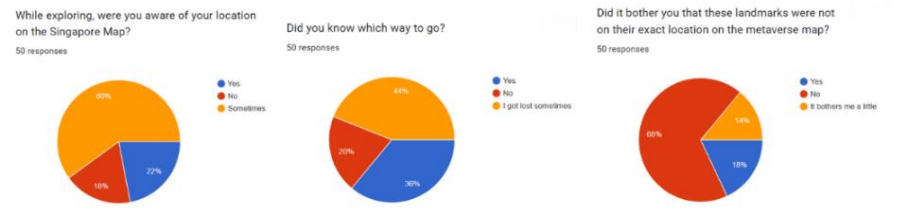

Figure 4: the results of a questionnaire related to navigation and orientation.

Figure 4 shows the results related to navigation and orientation. These results suggest that the layout and position accuracy of these landmarks in a virtual environment was not a significant factor for users of our focus group. This implies that users accept that in a novel digital virtual environment, position layout and accuracy can be altered to create different environments. The above results also suggest that navigation and map location awareness is a relevant factor and can be enhanced in the next iteration and development phase of Vault.space. This means that the map design and layout could be modified to offer more clues and guidance for the users to navigate and orient themselves, such as adding labels, landmarks, or compasses.

4.3. HYBRID MODEL EVALUATION

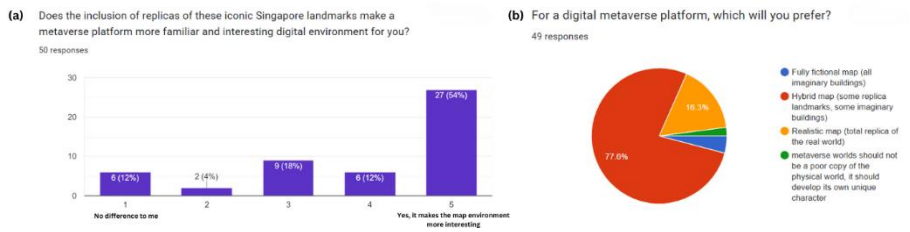

Figure 5: the results of a questionnaire related to hybrid model evaluation

The results shown in Figure 5 (a) has demonstrated that the majority of respondents (54%) has indicated that the inclusion of recreated landmarks has supported our hypothesis of creating a familiar yet interesting and engaging environment.

Figure 5 (b) also strongly supports this with almost 78% of respondents supporting the idea of a hybrid map concept.

4.4. ARCHITECTURAL ACCURACY EVALUATION

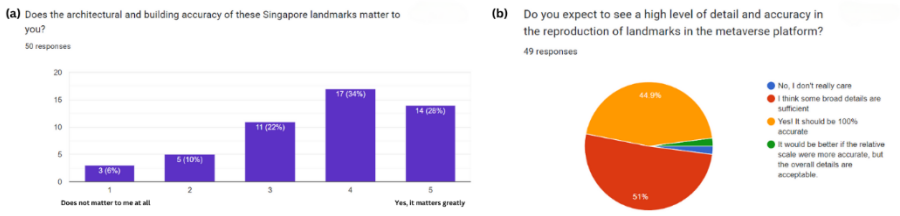

Figure 6: the results of a questionnaire related to architectural accuracy evaluation

The results from Figure 6 (a) and especially from Figure 6 (b) strongly indicate that architectural likeness and accuracy are a matter of significance to users when engaging in a hybrid map concept. Despite understanding that in a virtual imaginative environment where the laws of nature and physics do not need to be applied and buildings can take any form or design, these results further illustrate that users appreciate and expect architectural accuracy even in a virtual environment not bound by design rules or the laws of physics.

4.5. COLOUR PALETTE EVALUATION

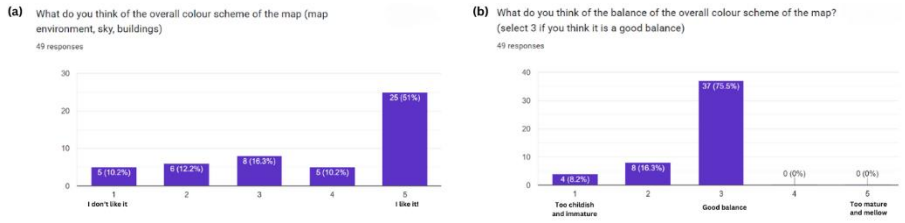

Figure 7: the results of a questionnaire related to colour palette evaluation

When it comes to the colour palette and overall balance, the results shown in Figure 7 (a) shows that a wide majority of respondents (51%) liked the overall colour scheme feel that overall scheme is balanced and neither too appealing towards a younger audience nor mature demographic (Figure 7 (b)). It has been noted that the wide range of age of our focus group users could have contributed to the varied result in Figure 7 (a) concerning the appeal of the colour scheme. But, however, this gives an impetus to make careful adjustments to improve the appeal while still maintaining the desired balance.

4.6. OVERALL PERFORMANCE AND FIRST IMPRESSION EVALUATION

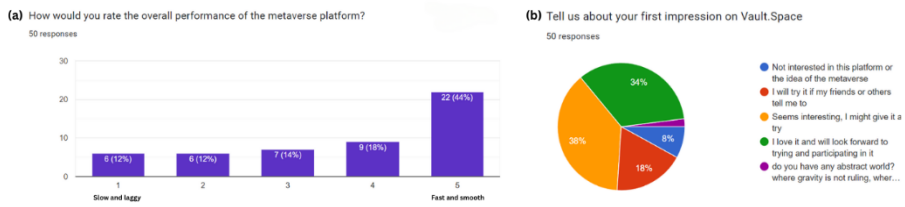

Figure 8: the results related to overall performance and first impression evaluation

Figure 8 (a) describes a proportion of users assessing the demo version of the platform to be lacking in performance and while that can be attributed to a variety of reasons including but not limited to speed of internet connection, processing speed of the device used, type of browser being used and version of browser being used. This provides valuable feedback towards making improvements and bettering the user experience on the platform. Figure 8 (b) finally provides an insightful and yet brutal assessment of the concept. The result is promising and illustrates an appetite by users for a new platform that features a map that amalgamates landmarks that users are familiar woven amidst imaginative fictional buildings. The concept for this common free-roaming hybrid map Metaverse platform enhances user interaction. It also offers a unique opportunity for businesses to promote and engage with their potential customers.

5. Conclusion, Discussion and Future works

This paper has reported an early development of a metaverse platform that showcases the Singapore island with a hybrid approach, combining replicas of abstracted architectural landmarks and fictional imaginary buildings on a virtual map. The paper has conducted a user evaluation to assess the receptivity and engagement of this hybrid concept, as well as the recognition and realism of the landmarks, the navigation and orientation, the colour palette, and the overall performance of the platform. We answered the research question: *Can a newly developed metaverse platform replicating real-life iconic landmarks using a hybrid approach ensure the recognizable expression of architectural and historical characteristics, ergo, providing users with ease of navigation through a sense of familiarity and excitement in a digital hybrid environment?* The results obtained support this hypothesis. Findings consistently indicate a strong preference for a hybrid environment, with users expressing increased interest in virtual spaces when iconic landmarks are included. Additionally, users appreciate and prioritise architectural accuracy and representation, even within a digital domain.

Evaluation of the survey results revealed and supported two key notions. Firstly, the vast majority of respondents were able to recognise the landmarks that were recreated in digital form but also overwhelmingly supported the premise of a hybrid environment. Secondly, even though the landmarks were easily recognisable, users placed an emphasis on the architectural accuracy and level of detail on these landmarks, highlighting and supporting the notion that even in digital form, an accurate depiction and adherence to architectural values is valued by a broad spectrum of users. This demonstrates the potential and feasibility of creating a metaverse platform that bridges the physical and virtual worlds, using architectural design and digital innovation as mentioned on the literature on metaverse cities, by exploring a novel hybrid approach that combines realistic and fictional elements, and by evaluating the user experience and feedback on such a platform.

Looking ahead, the future trajectory of this project will continue to prioritize the amalgamation of architectural values and fundamentals within a hybrid metaverse environment to optimize the future development of user interfaces and enhance user experiences as we progress towards a Web 3.0 ecosystem (Zhang et al. 2022). This iterative process of continued improvement and refinement will be guided by user feedback, aiming to create a digital experience that engages users with UI/UX design (Park, 2023), ensuring the Metaverse offers an inclusive and captivating environment.

As the digital world continues on its march towards evolution and change, designers and developers should always be circumspect about the impact that digital platforms can have on society. Adapting thoughtful architectural design and even the accurate recreation of existing architectural spaces within a virtual space will be an ever-crucial element and inevitable advancement in this digital era. Social platforms in the metaverse and development of virtual worlds therefore play an important role in societal engagement, underscoring the critical and pivotal role of designers in refining the architectural elements and fostering an engaging and accessible Metaverse for all.

Acknowledgements

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