Journal of Informatics and Web Engineering
Vol. 3 No. 1 (February 2024) eISSN: 2821-370X

Modelling of Virtual Campus Tour in Minecraft

Liyana Tan Lin[1], Han-Foon Neo[2*]
[1, 2] Faculty of Information Science and Technology, Multimedia University, Jalan Ayer Keroh Lama, 75450 Bukit Beruang, Melaka, Malaysia.
**corresponding author: (hfneo@mmu.edu.my; ORCiD: 0000-0001-5054-3351)*

Abstract - Virtual tours have revolutionized the way to explore and experience places from the comfort of our own home. Through advanced technology and immersive digital platforms, virtual tours offer a compelling alternative to tradition face-to-face visits. Whether a famous landmark, museum, real estate or natural wonders, virtual tours offer a unique opportunity to navigate and discover these places form a distance. Meanwhile, creating a virtual tour in Minecraft can provide a unique and immersive experience that sets the users apart from other virtual tour platforms. Minecraft is one of the most popular video games in the world and boasts a large and dedicated community of players. Using Minecraft for a virtual tour allow users to reach a larger audience who are already familiar with the game, increasing the likelihood of engagement and participation. In this paper, the aim is to create a virtual campus tour in Minecraft to give the visitors an immersive and interactive experience with creative freedom. A series of buildings have been built such as Siti Hasmah Digital Library, Common Lecture Complex (CLC) and Smart Lab. Visitors can move around the campus with some gameplay mechanics using mouse and keyboard. Building information was also integrated so visitors can see details about each building during the virtual tour. The virtual tour provides access, comfort and a sense of connection to prospective students, their families and international visitors. Additionally, it serves as a low-cost marketing tool that increases engagement, attracts potential students, researchers and staff and ultimately benefits the University's recruitment efforts.

Keywords—Campus, Virtual Tour, Minecraft, Modelling, Engaging Experience, Interactivity

Received: 20 July 2023; Accepted: 29 August 2023; Published: 16 February 2024

I. INTRODUCTION

A virtual tour is a digital simulation of a physical area or environment that allows people to explore and interact with it from a distance. Through the use of multimedia features such as 360-degree photos or films, interactive maps, audio guides and educational overlays, a virtual tour allows visitors to virtually travel and experience places, venues or events [1, 2, 3]. It strives to provide visitors with a sense of immersion and involvement by simulating the real-world experience as closely as possible. Minecraft offers absolute freedom to build and explore within the game world which allows infinite creativity and imagination. Motivated by this, Minecraft was chosen as the medium for the virtual tour. In this paper, the goals are to create an immersive exploration experience to improve education through useful material, to showcase modernization and to simulate personalized participation. The virtual tour intends to provide an engaging, inclusive and innovative approach for users to connect with the campus environment by exploiting Minecraft's unique features, ultimately changing traditional campus tours for a tech-savvy generation.

To reinvent traditional campus tours, this study aspires to transcend physical boundaries by altering education through immersive experiences that guided by principles of engagement, interaction design and experiential learning from previous studies [4, 5, 6]. This research transforms the Multimedia University Melaka Campus into a virtual world

Journal of Informatics and Web Engineering
https://doi.org/10.33093/jiwe.2023.3.1.2
© Universiti Telekom Sdn Bhd. This work is licensed under the Creative Commons BY-NC-ND 4.0 International License.
Published by MMU Press. URL: https://journals.mmupress.com/jiwe

within Minecraft. It effortlessly merging digital creativity, interactivity and storytelling guided by various aspects of using technology for educational purposes such as virtual tours, smart buildings and cutting-edge learning platforms [1, 7, 8, 9]. This renovation intends to reimagine how people interact with campus spaces by instilling a stronger bond through interactive features. The interdisciplinary approach has anchored in architecture, computer graphics and cognitive science that serves as the foundation for creating an immersive virtual tour. This research guided by educational technology, human-centered design and immersive learning principles in order to reshape traditional campus tours.

There are several types of virtual tours accessible, each tailored to a specific setting and purpose. Potential buyers and renters can explore properties online via real estate virtual tours, which provide a detailed perspective of the interior and outdoor spaces [10]. Visitors can virtually visit museums, landmarks and historical locations, gaining access to art collections, artefacts and instructional information through cultural and heritage virtual tours [1, 11, 12]. On the other hand, travel and destination virtual tours bring visitors to various area across the world, highlighting tourist attractions and picturesque landscapes while educational virtual tours are intended to aid learning by allowing students to virtually visit educational facilities, investigate scientific concepts and participate in historical events. In addition to the diverse range of virtual tours accessible, smart building virtual tours are emerging as an innovative technique in the field of architecture and urban planning. To create immersive experiences of intelligent and sustainable structure, smart building virtual tours use modern technologies such as sensor technologies to track human flow, photogrammetry and remote sensing to create immersive experiences of intelligent and sustainable structures [7, 13]. Visitors can take these tours to learn about the new features and functionalities built into smart buildings such as intelligent security systems, energy consumption and automation systems [8, 14, 15]. These virtual tours provide significant insight into the cutting-edge technology employed in smart buildings, promoting a deeper awareness of their environmental and economic benefits of stakeholders such as architects, engineers and potential tenants [12].

While virtual tours have many advantages, there are also obstacles and limitations to the medium. One of the most serious difficulties is the possibility of a lack of physical presence and sensory impressions [4, 13]. Despite their immersive properties, virtual tours cannot entirely reproduce the tactile feelings, odours or ambient sounds that one would experience in an actual environment. This can reduce the overall sensory experience and have an influence on some visitors' degree of engagement and emotional attachment. There are also some limitations, such as the need for hardware and technological infrastructure to enable the VR experience. Accessibility problems such as the requirement for specialized equipment may limit the popularity of these visit [4]. The construction of high-quality 3D models and immersive experiences can be time-consuming and resource-intensive [12]. Limited resources may prevent these excursions from being widely available, particularly for smaller organisations. Furthermore, technical restrictions and changes in user equipment and internet access mighty result in inconsistent performance, such as slow loading times, buffering or bad image quality, which can degrade the user experience [5]. Another problem is the difficulty in creating and implementing user-friendly navigation systems [16]. Visitors may struggle to properly explore the virtual environment without clear and intuitive navigation, resulting in frustration and disengagement. Addressing these problems and continuously developing virtual tour technology and design will be critical for improving the overall user experience and realising the medium's full potential.

In this paper, the purpose is to create a Multimedia University Melaka Campus model in Minecraft that allows campus virtual tour. Creating a virtual campus tour in Minecraft requires the integration of several technologies, including C++ programming, 3D modelling and user interaction design. It will help to further the study and development of educational solutions that bridge the gap between gaming, virtual environment and educational content delivery. A customized Minecraft Clone was developed using C++ and includes essential gameplay mechanics for seamless navigation and interaction. The campus has been carefully recreated in a Minecraft environment, capturing its architecture and key features. A number of buildings were being built which include the Main Gate, Faculty of Business (FOB) Building, Faculty of Engineering (FET) Building, Faculty of Law (FOL) Building, Faculty of Information Technology and Science (FIST) Building, Smart Lab of FIST, Tennis and Badminton Court, Mosque in the Campus, Common Lecture Complex (CLC), Gym Room, Plaza Siswa, Block B, Siti Hasmah Digital Library, Main Hall and 24-Hours Students' Learning Point. Building information was integrated so visitors can access details about each building during a virtual tour. A user-friendly interface and intuitive controls are implemented to ensure a smooth experience. This evaluation confirmed the project's success in providing an immersive and informative virtual tour.

A virtual MMU campus tour in Minecraft emerges as an innovative tool that perfectly blends technology with experience learning in a quickly expanding digital context. It aims to improve visitors' experience and allows them to gain a better knowledge of how the campus is laid out. Unlike static brochures or movies, this interactive platform allows prospective students, parents and stakeholders to connect with the school environment on their own terms. It also enables accessibility by allowing prospective students, parents and other stakeholders to experience the campus from a distance. This saves time and money on physical visits and making it easier for visitors to see several campuses. Minecraft's immersive nature allows players to traverse, investigate and interact with architectural subtleties, developing a deeper sense of connection and knowledge. This technologically driven approach out not only modernizes the traditional campus tour, but it also coincides with the digital fluency demanded in today's educational scene. By leveraging Minecraft's immense popularity, educational institutions may display their campus, amenities and values in a way that appeals to a tech-savvy age, ultimately altering how individuals explore and connect with educational places.

The organisation of the paper is as follows. Section II reviews the related study of virtual campus tour while research methodology is presented in Section III. Campus tour screen design and proposed solution are entailed in Section IV. Section V presented User Acceptance Test to compare pre-test and post-test results that were conducted in different time. Subsequently, it is followed by discussion in Section VI. Finally, conclusion is presented in Section VII along with limitations and future directions.

II. RELATED STUDY

Virtual tours have arisen as a dynamic and immersive approach to explore virtual environment in game-based platforms [17]. Platform such as Roblox and Minecraft offer dynamic environments in which users may create, explore and interact with virtual worlds. These game-based virtual tours provide distinct benefits such as the possibility to include gameplay, narration and social involvement. The ability to create detailed, visually stunning virtual environments improve the whole experience. Furthermore, interactive aspects enable viewers to travel, interact with objects and engage with others, making the tour more interesting and memorable. Virtual tours based on games can also be educational, encouraging learning and critical thinking in disciplines such as history, art and science. Furthermore, the accessibility of game-based platforms makes virtual tours more accessible to a broader audience, allowing for greater inclusivity. As game-based platforms evolve, virtual tours have enormous potential to revolutionise how people explore and interact with virtual environments, creating innovative and transformative experiences [18, 19].

Several studies have delved into the possibilities and potential of virtual tours in a diverse of contexts, highlighting user perceptions, learning experiences and their impact on the tourism industry. Suwarno and Nerru Pranuta Murnaka [16] focused on student perceptions of virtual campus tours as an alternative to physical campus visits. The authors explored the use of virtual environments to provide students with an immersive and interactive experience on campus. They discussed the benefits and limitations of virtual campus tours, considering factors such as visual fidelity, navigation and information availability that contributed to student perception and participation. The review highlighted the positive impact of virtual tours that had on student decision-making processes, as they allowed students to explore campus facilities, infrastructure and amenities remotely. They have highlighted the importance of creating realistic and user-friendly virtual environments that accurately represent the physical campus to improve student perception and belonging. Their findings have helped universities understand the role of virtual campus tours in attracting and engaging prospective students and helped universities improve virtual tours and adapt to the changing needs and preferences of students in the digital age.

At the same time, Rey Luis Arauho` Castillo et al. [11] investigated the use of virtual tours as an educational tool to improve learning experiences and student engagement. This review highlighted the benefits of virtual museum tours that allowed access to cultural and historical artifacts from around the world, regardless of geographic restrictions. The authors emphasised the interactive nature of the virtual tour, which allows students to explore the museum, examine artifacts and access detailed information through multimedia presentations and virtual guides. They discussed integrating virtual tours into social science education and promoting active learning, critical thinking and cultural awareness. The review also addressed challenges and considerations related to virtual museum tours, such as the need for a suitable technological infrastructure, user-strategies to maximize learning outcomes. The findings contributed to

our understanding of the educational potential of virtual museum tours in social science education, highlighting their ability to engage students, broaden their cultural horizons and promote meaningful learning experiences.

Osman El-Said and Heba Aziz [10] explored the impact of travel restrictions and social distancing measure on traditional tourism practiced and explored the potential of virtual tours as an alternative way to experience destinations remotely. They discussed the benefits of virtual tours in terms of accessibility, convenience and security that allow individuals to explore and connect with destinations virtually from the comfort of their own homes. This highlighted the immersive and interactive nature of virtual tours, which provided a realistic and engaging experience through the use of virtual tours, which provided a realistic and engaging experience through the use of technologies such as 360-degree video and augmented reality. This study highlighted the importance of virtual tours as a tool for destination marketing and promotion, allowing tourism organizations to showcase their products and attract potential visitors.

Besides the research on the real-world virtual tours, some articles that related to virtual tour and modelling in video-game engine also being discovered. Cecile Meier et al. [9] discovered the potential of game-based platforms like Roblox to engage and provide an immersive learning environment. The authors discussed the process of designing virtual tours that allow users to explore and learn about their sculptural heritage in an interactive and fun way. This review highlighted the benefits of using gameplay mechanics, storytelling elements and social interaction features in virtual tours. They also addressed educational benefits such as increased motivation, engagement and knowledge retention. This research also highlighted the potential of game engines like Roblox to democratize access to cultural heritage and promote a deeper understanding and appreciation of the sculptural arts. The result contributed to the understanding of how game-based platforms can be used as effective educational tools to explore and learn about cultural heritage and to develop innovative approaches to cultural heritage education and virtual tours.

Correspondingly, Nolan et al. [20] demonstrated a unique approach to modelling a metasmart city on Mars in the Minecraft virtual world. The researchers wanted to use the game's creative capabilities to explore the possibility of using virtual environments to simulate and design future smart cities in extraterrestrial habitats. This paper described the methodology used to build virtual cities and focused on the integration of advanced technologies such as automation, artificial intelligence and sustainable energy systems. The study highlighted the importance of considering various factors such as resource management, environmental sustainability and human-centered design when developing smart cities, even in extreme environments. This research provided valuable insight into the application of virtual platforms like Minecraft as tools for imagining and planning future Smart City infrastructure on Mars.

By exploring the potential of virtual environments in Roblox's extraterrestrial habitat exploration and immersive cultural heritage learning and Minecraft, these studies collectively foster innovation and support in diverse research and educational engagements. It demonstrates the transformative power of game-based platforms. Virtual tours focused in campus or University settings are limited in the literature, and in this paper, the aim is to create a virtual campus tour based on Multimedia University to engage students from everywhere to explore the campus' facilities, buildings and infrastructure.

The authors of previous research by Chang et al. [6] use a network perspective to examine the effect of virtual tours on urban visitors. This study intends to offer information on how virtual tours affect tourists' interactions with and impressions of urban settings. The authors investigate the complex relationships that develop between visitors and their participation in virtual tours using a network analysis methodology. The study emphasizes the value of virtual tours as instruments for improving the exploration and understanding of urban settings, even when the details of the virtual tour platform are not covered in the material that is presented. This article advances knowledge about how technology-mediated experiences, including virtual tours influence the activities and interaction of tourists in urban settings.

Meanwhile, Garcia et al. [21] focuses on the creation and application of a playable 3D virtual tour created for an engaging campus visit experience. In order to draw potential students to the institution, the authors want to highlight the school's facilities. This study highlights the potential of using virtual tours to engage potential students and provide them an in-depth investigation of campus infrastructure and facilities by creating an immersive and interactive virtual environment. The authors offer insights into the process of producing a visually appealing and educational virtual campus tour by integrating technology like 3D modelling and interactive features. The emphasis on the function of virtual tours in campus exploration and higher education marketing makes this work a contribution to the field of virtual reality research.

These articles have jointly contributed to the growing field of virtual tours by demonstrating how they are used in a variety of contexts such as urban environments and educational organisations. While Change et al. [6] explores how virtual tours affect how urban visitors engage with one another from a network perspective, 3D virtual tour was implemented by Garcia et al. [21] to engage and enlighten prospective students about campus amenities in order to draw them as students.

There was a collection of research efforts that are inextricably linked to the current study's objectives of producing a virtual campus tour for Multimedia University. Suwarno and Nerru Pranuta Murnaka [16] investigate student impressions of virtual campus tours, which corresponds to the current research's emphasis on engaging prospective students through immersive experiences. Similarly, Rey Luis Arauho Castillo et al. [11] investigate the pedagogical potential of virtual museum tours, emphasizing interactive learning and interaction inside a virtual setting. Osman El-Said and Heba Aziz [10] emphasise the accessibility and immersive character of virtual tours, which is consistent with the current study's purpose of providing an alternate way to experience campuses. Cecile Meier et al. [9] findings on game-based platforms and interactive learning are consistent with the study's objective to use Minecraft to create an engaging virtual campus tour. Furthermore, Nolan et al. [20] demonstrate the novel application of virtual worlds such as Minecraft, which aligns with the current research's use of the platform to revolutionise campus exploration. These studies provide techniques and inspire future approaches for the current study, all of which contribute to the transformative potential of game-based virtual tours.

Table 1 below shows the comparison table of literature review.

Table 1: Comparison Table of Literature Review

Year	Title	Authors	Focus	Key Findings
2020	The tours in virtual museums a didactic opportunity in social sciences	Rey Luis Araujo Castillo and Xiomara Deysi Linares Zegarra	Educational value of Virtual Museum Tours	Involving pupils and encouraging critical thinking, active learning and cultural sensitivity. Difficulties with learning methods and technology infrastructure.
2020	Students' Perceptions of 360 Degree Virtual Tour-Based Historical Learning About the Cultural Heritage Area of the Kapitan and Al-Munawar Villages in Palembang City	Abidin, R., & Suryani, N.	Learning history on a 360 degrees virtual tour.	Explore students' perception of history learning through 360 degrees virtual tours that highlight their potential for educational engagement.
2020	Virtual tours and informational models for improving territorial attractiveness and the smart management of architectural heritage: The 3d-imp-act project.	De Fino, M., Ceppi, C., & Fatiguso, F.	Virtual tours for architectural heritage management.	Study virtual tours and informative models to improve the management of architectural heritage, contributing to the attractiveness of the territory.

2020	Virtual Campus Tour (Student Perception of University Virtual Environment)	Suwarno and Nerru Pranuta Murnaka	Student's perception on Virtual Campus Tour.	Positive impact on student perspective and decision-making. The significance of developing realistic, user-friendly virtual environments.
2020	Using the Roblox Video Game Engine for Creating Virtual tours and Learning about the Sculptural Heriatge	Cecile Meier, Jose Luis Saorin, Alejandro Bonnet de Leon, ALberto Guerrero Cobos	Game-based platform for engaging learning	Immersive learning environments that use interactive features and gaming dynamics. Improved involvement, motivation and knowledge.
2021	Modelling a Meta Smart City on Mars in Minecraft	Anthony & Emily Nolan, Ryley Nolan, and Flynn Nolan	Future smart city designing in virtual environment using Minecraft.	Use of virtual environment with Minecraft to mimic and create smart Martian cities. Combining cutting-edge technology with human-centered design.
2022	Virtual Tours a Means to an End: An Analysis of Virtual Tours' Role in Tourism Recovery Post COVID-19	Osman El-Said and Heba Aziz	Virtual tourism replaces traditional tourism.	Virtual tours are convenient, secure and easily accessible. Experiences that are immersive and engaging using tools like augmented reality and 360-degree video.
2022	Freshmen Orientation Program Using Minecraft: Designed by Students for Students during the Covid-19 Pandemic	S. Supraja, S. Tan, F. S. Lim, B. Koon Ng, S. Y. Ho and A. W. H. Khong	Minecraft-based freshmen orientation programme	The use of Minecraft to guide freshmen by demonstrating the use of technology to improve engagement in campus activities.
2023	A Playable 3D Virtual Tour for an Interactive Campus Visit Experience: Showcasing School Facilities to Attract Potential Enrollees	M. B. Garcia, D. M. C. Mansul, E. B. Pempina, M. R. L. Perez and R. T. Adao	Virtual Campus Tour in 3D Playable for Interactive Campus Visit	Making an interactive 3D virtual tour to show prospective students the facilities at the school. Put your energy towards enticing potential pupils with an immersive experience.

2023	The influence of virtual tour on urban visitor using a network approach	Chang, M., Lee, G. B., Lee, J. H., Lee, M., & Lee, J. H.	Virtual tour's impact on Urban visitors	Using a network approach to examine how virtual tours affect tourists in urban cities.

III. RESEARCH METHODOLOGY

The research started with the data collection that involving the capture of approximately 20 pictures for each building within the campus. The picture has been taken from all angles and making sure to capture the unique design, architecture marvels and every little details that makes each building stand out. The whole process has taken around three months until the end of the research. Following the extensive data collection phase, the research technique entailed a methodical and technological approach to create the virtual campus tour in Minecraft. The project continued by creating a Minecraft clone by constructing a 3D world populated with various types of blocks using procedural methods. The development of Minecraft clone was established within a C++ framework, further enriched by the integration of C language, OpenGL and HTML. In the Minecraft clone, players can control their character's movement and actions from a first-person perspective using keyboard and mouse. After that, the campus of Multimedia University was carefully recreated in the Minecraft environment, capturing its architecture and key features. The world and blocks chunks will then be saved inside a database and ready to be use inside the virtual tour. With this, visitors can explore the world and discover more information about the buildings inside the virtual world.

The most crucial step was the thorough recreation of the Multimedia University Melaka Campus within the Minecraft. Architectural authenticity was of the utmost importance, ensuring the buildings, landmarks and spatial layout were accurately depicted. There was a total of 15 buildings were built in the virtual campus tour and it takes around five days for each location to be build. To accomplish this, a texture atlas which was an image file comprising several small textures arranged in a grid pattern was used to generate the blocks in the game. There were 24 blocks including Grass, Stone, Cobblestone, StoneBricks, CarvedStone, OakLeaves. SpruceLeaves, OakLog, Cactus, Sand, OakPlanks, AcaciaPlanks, DarkOakPlanks, Bricks, GlassWhite, LampOn, LampOff, WoolRed, WoolGreen, WoolBlue, WoolYellow, Gravel and Clay were generated. Each type of the block had a corresponding texture. The method created a list of block textures and loops through them, retrieving texture coordinates from the texture atlas and saving them in a database. In order to augment the visual quality of these blocks, specific shaders coded in GLSL were incorporated into the fabric of the project and capitalizing on the robust capabilities of OpenGL. Moreover, the project harnessed the potential extension including GLEW for accessing OpenGL functions, GLFW for window management and GLM for mathematics foundation for the virtual world in the Minecraft clone. Figure 1 below shows the types of textures of different blocks in the Minecraft clone. Figure 1 shows the types of Minecraft blocks.



Figure 1: Types of Minecraft Blocks

To achieve seamless user engagement within the virtual campus tour in Minecraft, an intuitive gameplay mechanic was required. The implementation of the gameplay mechanics was executed to enable fluid movement and interaction within the virtual tour. This indicates handling keyboard and mouse input for movement, camera control and actions like placing and destroying the blocks. The snippet of pseudocode below is a collection of conditional statements that react to certain button pushes and activities within the virtual tour. Each IF statement checks to see if a specific button is being pressed and if the condition is met, it performs the related action. From line 1 until line 6 of the pseudocode, visitor will go ahead if the "W" button is pushed. The visitor will travel backward if the "S" button is pressed. Similarly, the "A" and "D" buttons will move the visitor left and right respectively. The visitor can fly if the spacebar is pressed and it can move downhill if the shift key is pressed. Line 7 and 8 of the pseudocode also provides actions dependent on the state of the "action" variable. When the variable is set to "RightKeyPress", it indicates that the user intends to destroy a block. If the "action" variable is set to "LeftKeyPress", the user intends to place a block. Overall, this pseudocode captures button-based interactions as well as the equivalent in-game action for visitor movement and object manipulation. These components came together to create a realistic and engrossing virtual tour by demonstrating the successful fusion of advanced technology. Figure 2 shows the pseudocode for movements and events.

1. **IF** (button W is pressed)
   THEN move forward
   ENDIF

2. **IF** (button S is pressed)
   THEN move back
   ENDIF

3. **IF** (button A is pressed)
   THEN move left
   ENDIF

4. **IF** (button D is pressed)
   THEN move right
   ENDIF

5. **IF** (button space is pressed)
THEN fly
ENDIF

6. **IF** (button shift is pressed)
THEN go down
ENDIF

7. **IF** (action==RigthKeyPress)
THEN destroy the block;
ENDIF

8. **IF** (action==LeftKeyPress)
THEN place the block;
ENDIF

Figure 2: Pseudocode for movements and events

Figure 3 shows the action of placing and destroying the blocks in the Minecraft environment.

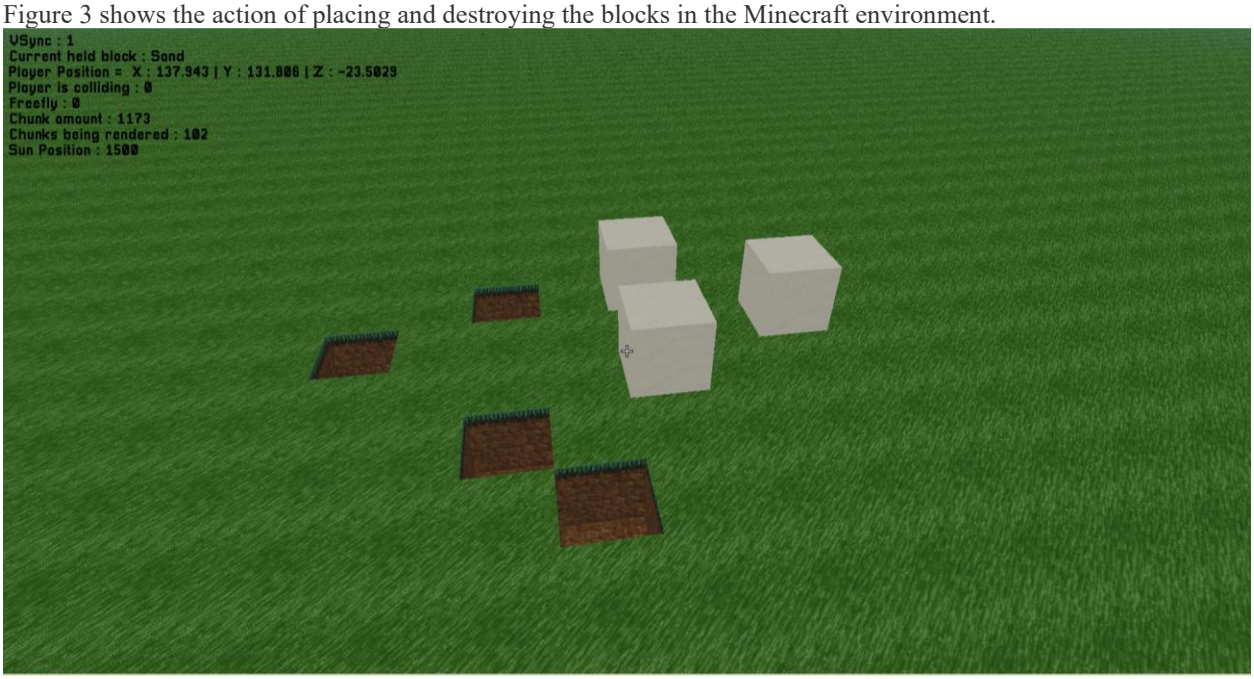


Figure 3: Placing and Destroying The Blocks

Subsequently, data permanence was also handled to provide consistent user experiences. The pseudocode below was responsible for saving the state of the Minecraft world. Line 1 of the pseudocode iterates through each block in the world data collection using a FOR loop. Line 2 will check for changes in either the block states or the light card status within the loop. If modifications are detected in line 3, the block data and worlds data will be saved in "world.bin" and the player data will be saved in "player.bin". The method returns true to indicate that the saving process was successful after processing all of the blocks and successfully saving the data. However, if an exception or problem occurs during the file writing operations in line 4, line 5 will show an error message indicating that the data could not be saved and return false indicating that the saving procedure failed. Overall, the pseudocode demonstrates a simple algorithm for iterating through world data, detecting changes and successfully storing the necessary information in distinct binary files while ensuring data integrity through error handling. Figure 4 shows pseudocode for saving the world

```
1. FOR each block in world data
    2. IF block states OR light card status changed
        3. THEN write block data into "world.bin"
                write player data into "player.bin"
                write world data into "world.bin"
        RETURN true
        END IF
    4. CATCH Exception as e
            5. DISPLAY error message for not saving the data
        RETURN false
END FOR
```

Figure 4: Saving the world

One important goal of the virtual tour was to increase user involvement through interactive building information displays. The pseudocode below displayed a message box with information about library when the visitor is in front of it. Line 1 shows a loop that iterates through each position in the list of positions. Line 2 checks whether the current place in the iteration is labelled as library within the loop. If the condition is true and the position is truly marked as library, line 3 will display a message box with library information. The message box provides the visitors with specific information about the library. This loop will continue to iterate through all positions in the list of positions and anytime it comes across to other buildings in the virtual tour, it will display the message box with the matching building information. Figure 5 shows the pseudocode for displaying the message box.

```
1. FOR (position in list of positions)
    2. IF (list of position == library) THEN
        3. DISPLAY message box with library information;
    END IF
    END FOR
```

Figure 5: Pseudocode for displaying message box

Several limitations occurred during the development process. To ensure a smooth gameplay experience, performance had to be optimized especially while producing large-scale environments. To ensure architectural precision, complex building structures necessitated exact block arrangement. To address these issues, optimization techniques were used and a careful balance of visual accuracy and performance was attained. Furthermore, coordinating interactions and displaying information necessitated an intuitive user interface design that was iteratively updated based on user testing feedback.

IV. CAMPUS TOUR SCREEN DESIGNS



Figure 6: Homepage of The System Prototype

Figure 6 shows the homepage design of the system prototype. There are three buttons in the homepage. Play is to proceed to the next step. Help and about is some guideline for user to refer before start the virtual tour. Exit is to exit the system prototype.



Figure 7: Help and About of The System Prototype

Figure 7 shows the help and about that use to guide the visitor on how to move around the campus during the virtual tour.



Figure 8: Menu Page of The System Prototype

Figure 8 shows the menu page of the system prototype. Visitor can choose the location they want to view or click on the back button to go back to the homepage.

Meanwhile, Figure 9 until Figure 23 will the snapshot of the campus building in the virtual campus tour in Minecraft.



Figure 9: Main Gate of MMU Melaka Campus

Figure 9 shows the main fat of MMU Melaka campus. There is a guardhouse to ensure student and staff's safety.



Figure 10: Faculty of Business (FOB) Building

Figure 10 shows the building of Faculty of Business (FOB) which is a purpose-built building for academic programmes, faculty dean offices, classrooms and administrative offices that connected to business and management disciplines. FOB plays an important role in the education and development of future business executives and professionals. It fosters business education, research and the development of leadership and entrepreneurial skills.



Figure 11: Faculty of Engineering (FET) Building

Figure 11 shows the building of Faculty of Engineering (FET) which is a dedicated facility that designed to accommodate engineering-related academic programmes, faculty dean offices, laboratories and administrative offices. Within the campus, it acts as a hub for engineering instruction and research. It fosters hands-on learning, innovation

and the development of cutting-edge technology while educating students for careers in a variety of engineering specialties.



Figure 12: Faculty of Law (FOL) Building

Figure 12 shows the building of Faculty of Law (FOL) which is dedicated building that houses academic programmes, faculty dean offices, tutorial classrooms, law library, e-moot court and administrative office relating to law and legal education. FOL plays an important role in the teaching and training of future legal practitioners. It offers a comprehensive and specialized environment for legal education, research and community participation, encouraging students and faculty to develop legal knowledge and professional skills.



Figure 13: Faculty of Information Science and Technology (FIST) Building

Figure 13 shows the building of Faculty of Information Science and Technology (FIST). It is a dedicated facility designed to accommodate information science and technology academic programmes, faculty dean offices, research labs, smart lab and administrative offices. FIST building house multiple academic departments relevant to information science and technology. Computer science, information technology, life science and other related subjects may be included.

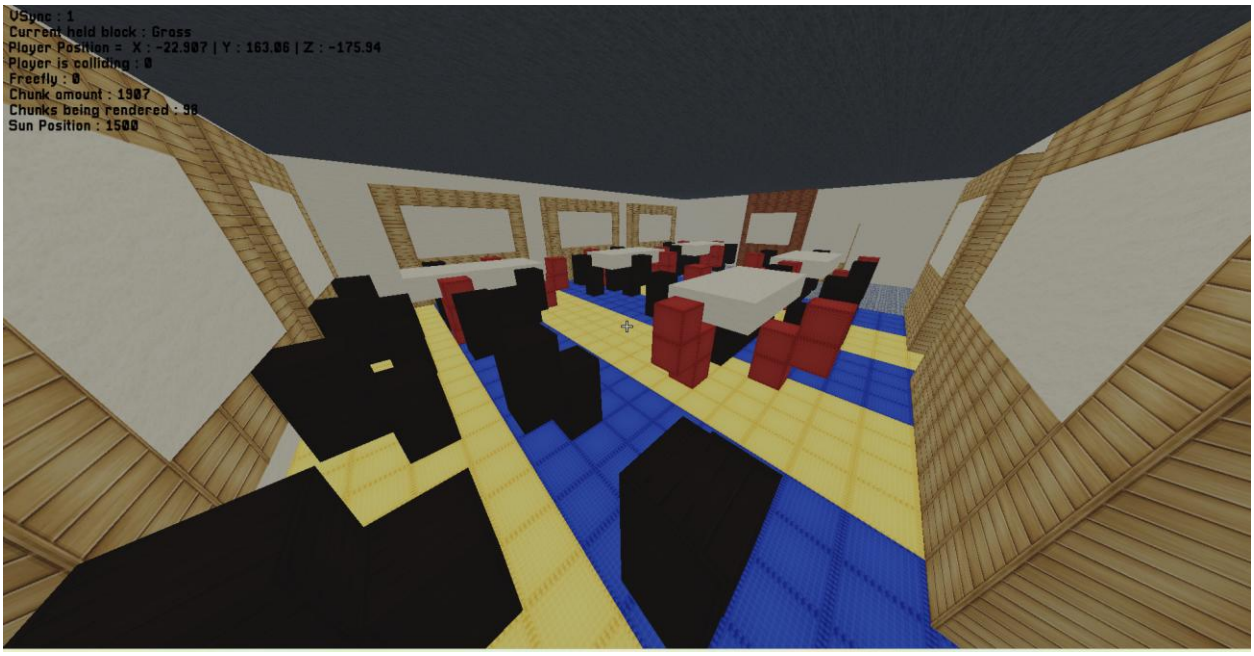


Figure 14: Smart Lab of FIST

Figure 14 shows the Smart Lab of FIST. There are plenty of table and chairs that arranged in groups to make students make discussion more easily. Every group will have one smart board to present and share their ideas during the class.

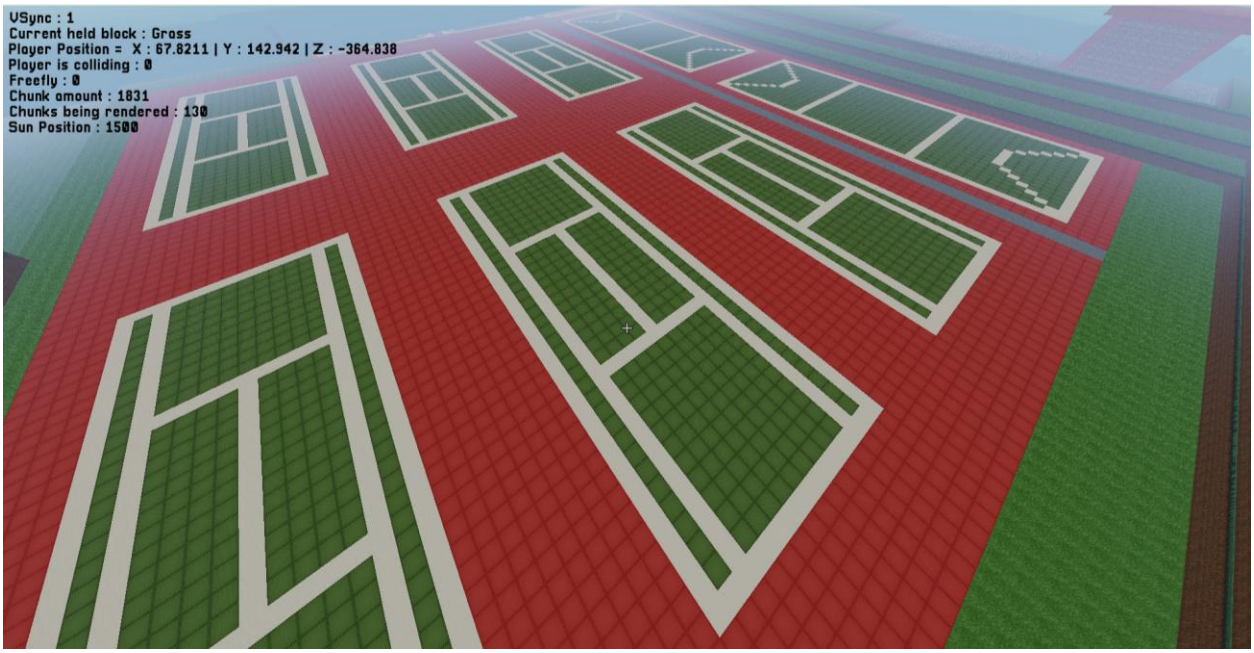


Figure 15: Tennis and Badminton Court

Figure 15 shows the tennis and badminton court of the MMU campus. Both Tennis and Badminton courts give possibilities for physical fitness, skill development and social contact for students. They foster an active and healthy campus lifestyle and contribute to the school community's general well-being. Furthermore, these facilities can serve as a hub for sports organisations, intramural tournaments and leisure leagues in order to help students develop a sense of community and camaraderie.



Figure 16: Mosque in The Campus

Figure 16 show the mosques of MMU campus. The mosque is where all the Muslim students, lecturers and staff can gather for religious worship, prayer and community activities. It is not simply a symbol of religious diversity and inclusion but it is also a valuable resource for Muslims. It offers a place for spiritual reflection and growth while also adding to the cultural diversity of the campus area.



Figure 17: Common Lecture Complex (CLC)

Figure 17 shows the Common Lecture Complex (CLC). It is a building that gather all the lecture hall that allow student to have their daily lecture class. A tiered or slanted seating configuration is used in all the lecture hall to ensure all students have clear sightlines to see the projector screen and whiteboard during the class.



Figure 18: Gym Room

Figure 18 shows the Gym room of the campus. Gym room is one of the facilities inside the campus that dedicated to encouraging physical fitness and well-being among students, lecturer and staff. It is an excellent resource for students who want to be fit and stress-free while pursuing their studies.



Figure 19: Plaza Siswa

Figure 19 shows the building of Plaza Siswa which is a multifunctional facility that is built to meet the needs and convenience of students, lecturers and staff on a daily basis. It houses a variety of amenities and services such as café, convenient store, ATM machines, printing shop and more that improve the quality of life on campus.



Figure 20: Block B

Figure 20 shows the building of Block B where it houses computer laboratories and diploma centres. It acts as an important academic and support hub for students pursuing diploma programmes and needing access to specialized computer resources. Block B plays an important role in creating a friendly and appropriate environment for diploma students. It ensures that they have access to the resources, assistance and services they need in order to excel in their academic endeavours as well as preparing them for future employment or further education.

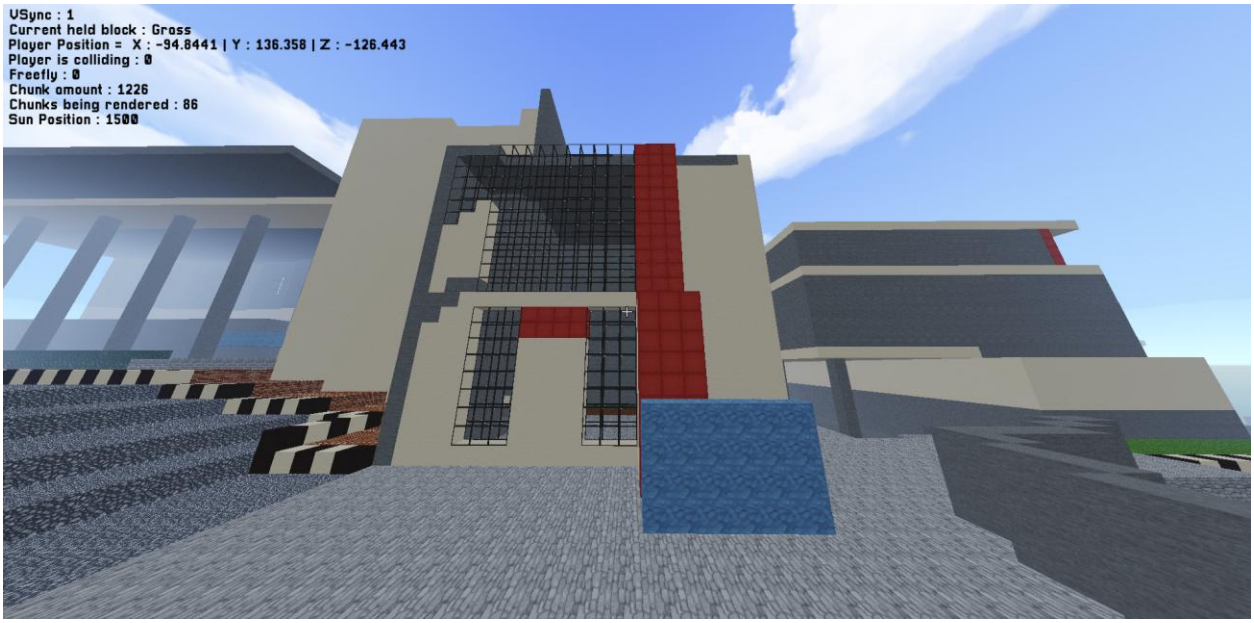


Figure 21: Siti Hasmah Digital Library

Figure 21 shows the building of Siti Hasmah Digital Library. It is a three-floor library that provides digital and physical access to a wide range of academic publications such as books, journals, research papers, multimedia content and other educational tools.



Figure 22: Main Hall

Figure 22 shows a main hall on the campus where it is versatile and necessary venue for a range of functions such as examination, events, ceremony and meetings.



Figure 23: 24-Hours Students' Learning Point

Figure 23 shows the 24-Hours Students' Learning point with air conditioning on campus. It is a great resource for students where the learning point provides a comfortable and conducive atmosphere for them to study, work on assignments and having group discussion on their group projects even outside the library or lecture hours.



Figure 24: Building Description on The Blue Stone

Figure 24 shows the building description on the blue stone. This is what the user will see when they go nearer to the blue signboard. A message box will come out and display the building name and description.



Figure 25: Pause Page of The System Prototype

Figure 25 shows the pause page of the system prototype. User can click on escape key to pause the system prototype. In this page, user can choose to resume the virtual tour or quit the virtual tour. If user choose the quit the virtual tour, they will be redirect to the homepage of the system prototype.

V. USER ACCEPTANCE TEST

A preliminary survey was conducted to examine the user acceptance of the proposed virtual campus tour. It consisted of pre-test and post-test. The former was administered prior to the creation of the virtual tour and the latter was administered following the completion of the virtual tour. The goal was to learn how participants' impressions and ratings changed after they took the virtual tour. The evaluation criteria included a variety of aspects that contributed to participants' views and degrees of satisfaction with the virtual campus tour in Minecraft. In both the pre-test and post-test questionnaires, these factors were evaluated using five-point Likert-scale ratings. The following metrics were considered:

1. Overall experience: Participants rated their overall experience with the virtual tour, indicating how much it captures and interested them.
2. Simplicity of navigation: Participants evaluated the virtual tour's simplicity and intuitiveness, indicating the platform's user-friendliness.
3. Informativeness of various locations and services: This criterion assessed participants' perceptions of the virtual tour's ability to provide detailed and relevant information about various sites and services on campus.
4. Likelihood of referral: Participants indicated their chance of suggesting the virtual tour to others based on their personal experience.
5. Overall satisfaction: This metric assessed participants' overall satisfaction with the virtual tour, taking into account all areas of their platform interaction.
6. Improvement of user experience: Participants rated whether the virtual tour improved their overall experience when compared to traditional campus tour.

In the pre-test questionnaire, there were a total of 31 participants who have contributed to the user acceptance test. 38.7% of them were male and 61.3% were female. Most of the participants' ages were in the range of 18-21 years old which stands for 58.1% (18 people). The second large group of participants were from the age range of 22-25 years old which stands for 29% (nine people). While the other 12.9% were in the range of below 18 years old (four people). Meanwhile in the post-test questionnaire, there were a total of 30 participants who have contributed, 46.7% of them were male and 53.3% of them were female. Most of the participants' ages were in the range of 22-25 years old which stands for 60% (18 people). The second large group of participants were from the age range of 18-21 years old which stands for 26.7% (eight people). The third large group of participants were from the range of 26-29 years old which stand for 10% (three people). While the other 3.3% was stand by the range of below 18 years old (one people). Figure 26 shows the participant's demographic profile.

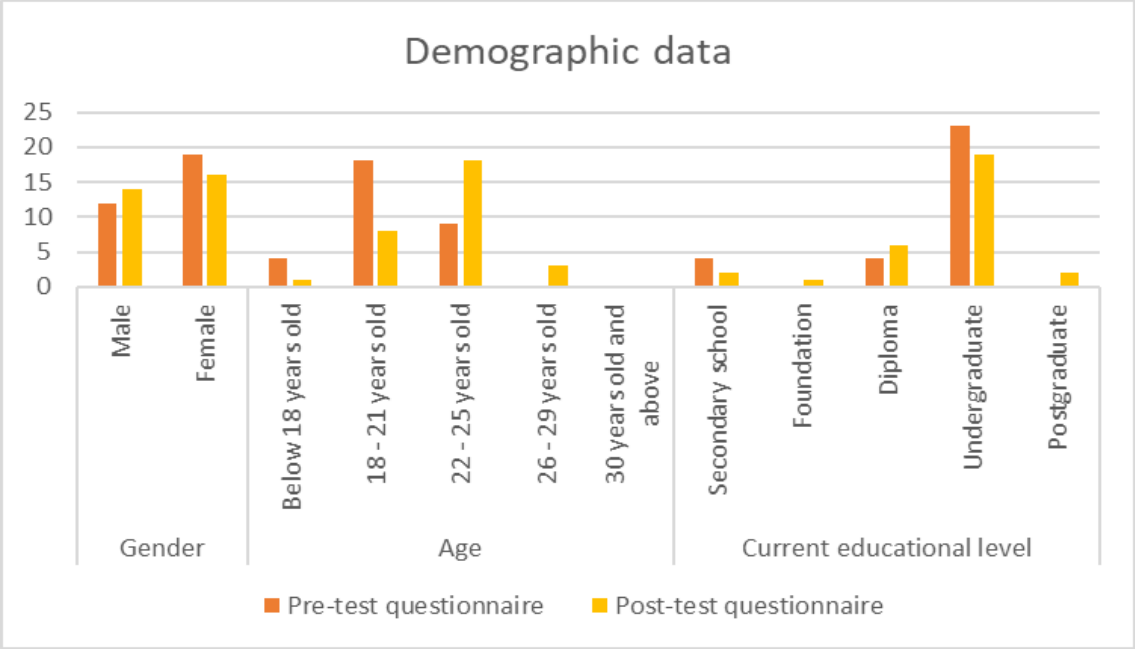


Figure 26: Participants' Demographic Profile

The results, as shown in the table below, highlight the mean values collected from each questionnaire that provide insights into the impact of the virtual tour on participants' impressions and levels of satisfaction. Furthermore, standard deviations show the distribution of replies inside each questionnaire, indicating the extent of agreement or difference among participants' judgements. Table 2 below shows the mean and standard deviation for pre-test and post-test.

Table 2: Mean (μ) and Standard Deviation (σ) for Pre-test and Post-test

Metrics	Pre-test	Post-test	Pre-test	Post-test
	μ		σ	
Overall Experience	4.6129	4.7667	0.7902	0.4230
Ease of navigation	4.4516	4.7667	0.7551	0.5588
Informativeness of Different Areas and Facilities	4.1935	4.6000	1.1478	0.7118
Likelihood of Recommendation	4.4652	4.7667	0.6978	0.4230
Overall Satisfaction	4.2903	4.8000	0.9901	0.4000
Improvement of User Experience	4.5161	4.7667	0.9113	0.4955

In the pre-test questionnaire, participants scored several features of the campus idea. The following were the mean values for each metric: 4.6129 for overall experience, 4.4516 for ease of navigation, 4.1935 for informativeness of different areas and facilities, 4.6452 for likelihood of recommendation, 4.2903 for overall satisfaction and 4.5161 for improvement of user experience. The standard deviations ranged from 0.7551 to .1478, demonstrating some variation on the responses of participants within each metric.

Meanwhile, participants reviewed their experience with the actual execution of the campus virtual tour using Minecraft in the post-test questionnaire. The following were the mean values for each metric: 4.7667 for overall experience, 4.7667 for ease of navigation, 4.6 for the informativeness of various sections and facilities, 4.7667 for likelihood of recommendation, 4.8 for overall satisfaction and 4.7667 for improvement of user experience. The standard deviation varied from 0.4 to 0.7118, showing that response variability was lower than on the pre-test questionnaire.

When the mean values of the two questionnaires were compared, it was discovered that the mean ratings for all metrics increased in the post-test questionnaire, showing an overall improvement in participants' opinions after witnessing the campus virtual tour. Notably, higher mean ratings in the post-test for "overall satisfaction" and "likelihood of recommendation" with mean values of 4.8 and 4.7667 were observed respectively.

When the standard deviations are examined, it is discovered that the post-test questionnaire had less variability than the pre-test questionnaire. This shows that in the post-test, participant responses were more consistent, reflecting a more united perception of the campus virtual tour experience.

The findings show that implementing the campus virtual tour in Minecraft had a beneficial impact on participants' views and levels of satisfaction. The higher mean ratings and lower standard deviation in the post-test questionnaire indicate that the virtual tour improved the overall experience, ease of navigation, informativeness and overall satisfaction with the campus virtual tour idea.

An empirical study was conducted in order to investigate the influence of using Minecraft as a virtual tour platform on a university campus. This study evaluates the changes in participants' views and satisfaction levels before and after seeing the virtual campus tour in Minecraft using a paired sample t-test analysis. Table 2 shows the calculated mean differences, standard deviation differences, t-statistic and two tailed p-values for the metrics mentioned previously. It illuminating the statistical significance of the observed changes. Table 3 below shows the paired t-test results.

Table 3: Paired T-test Results

Metrics	Mean Difference	Standard Deviation Differences	t-statistic	two tailed p-value
Overall Experience	0.1538	0.6932	1.948	0.062
Ease of Navigation	0.3151	0.6866	2.655	0.013
Informativeness	0.4065	0.8792	2.044	0.050
Likelihood of Recommendation	0.3015	0.5256	3.234	0.003
Overall Satisfaction	0.5097	0.7830	3.969	< 0.001
Improvement of User Experience	0.2506	0.8076	1.722	0.095

The p-values in this table are the two-tailed p-values for a t-distribution with 30 degrees of freedom. These p-values represent the likelihood of encountering a t-statistic, assuming no significant change between the pre-test and post-test averages. Lower p-values indicate greater statistical significance. A p-value of less than 0.05 which are ease of navigation, likelihood of recommendation, overall satisfaction and improvement of user experience are regarded as statistically significant.

Overall, the paired sample t-test empirical research provides useful insights on the effectiveness of using Minecraft as a virtual tour platform for a campus environment. The study found statistically significant increases in numerous important areas, including ease of navigation, referral likelihood and overall satisfaction. These data imply that the virtual tour developed in Minecraft has improved user friendliness, increased the likelihood of participants recommending the tour to others and boosted overall satisfaction. While not all metrics reached statistical significance, the data patterns shows that other criteria such as overall experience, informativeness and user experience enhancement are heading in the right direction.

VI. DISCUSSION

This paper has successfully presented a campus model in Minecraft, enabling an interactive virtual tour of a university campus. The user experience is enhanced by leveraging gaming dynamics and architectural data, allowing for immersive exploration of the campus area. While real-time interactions and dynamic events are currently limited, iterative improvements have been driven by user input. This technique is consistent with the conclusions of comparable research such as Suwarno and Nerru Pranuta Murnaka's [16] study of student views of university virtual environments. Future directions include multiplayer functionality, dynamic elements and expansion of the project to other agencies. This project demonstrated the potential of gamified environments and virtual tours for educational purposes with an emphasis on immersive experiences in campus exploration and participations.

When the visitor enters the system, a homepage with three buttons, "Start", "Help and Options" and "Quit" will be displayed. When visitor click on the "Start" button, it will proceed to the main menu page. But if visitor clicks on the "Help and Options" button, it will show all the instruction for visitor to use in the virtual tour, and "Quit" button is for visitor to quit the system. After visitor choose to click on "Start" button, the main menu page with university name will be displayed on the page. Visitor can choose the university that the visitor wishes to view in the virtual tour. The virtual tour will be displayed.

Visitor can move freely in the virtual tour by using WSAD key to move front, back, right and left. Visitor can also fly up by pressing space key and go down to the floor by pressing shift key. This arrangement promotes freedom of exploration, allowing visitors to easily navigate the campus area. Notably, the incorporation of flying controls in the navigation system of the virtual tour adds a new dimension, allowing users to freely explore the campus layout from various perspectives. This unique feature is similar to the study conducted by Supraja et al. [5], in which Minecraft was used for a freshmen orientation programme. From the main gate of MMU, visitors can move to explore the building for faculty such as Faculty of Business (FOB), Faculty of Engineering (FET), Faculty of Information Science and Technology (FIST) and Faculty of Law (FOL). Visitors also able to explore all the facilities and building such as Administration Office, President Square, Library, Learning Points, Plaza Siswa, Gym Room, Security Building, Tennis Court, Basketball Court, Field and more. This thorough research is consistent with the findings of Radianti et al. [4], who emphasized the instructional benefits of immersive virtual reality applications in higher education. The virtual tour's in-depth exploration parallels the educational opportunities discovered in their research, promoting increased familiarity with campus infrastructure and programmes. Also, visitor can view the interior for one of the signature places of FIST building which is Smart Lab. This level of accessibility is consistent with the findings of Abidin and Suryani [1], who emphasized the effectiveness of 360-degree virtual tours in historical learning and cultural comprehension. Similarly, the virtual tour's comprehensive interior views build a stronger connection with the campus's physical places. Furthermore, the techniques are consistent with recent studies demonstrating the educational potential of immersive virtual environments in higher education [10], [13], [22].

Although the existing literature extensively explores virtual tours in a variety of contexts, including museums, cultural heritage, and urban contexts [1], [11], [12], [23], there is still a marked research gap in the area of university campuses. In particular, the current literature lacks in-depth exploration of campus-specific virtual tours developed on gaming platforms like Minecraft. Although the potential of rich and interactive virtual tours has been acknowledged, little attention has been paid to their application in the higher education sector. There is a notable gap in understanding the educational value of university-specific virtual tours and how they can provide an informative and enriching experience for students. In addition, although studies cite the impact of virtual tours on user engagement and decision-making, gaps remain in understanding how such tours tailored to the university campus and influencing business decisions [24], [25]. It is yet relatively unknown how to incorporate gaming mechanics and dynamics into these virtual tours and there is a knowledge vacuum about how these components can improve engagement and memorability. Finally, research into the uptake and acceptance of game-based virtual tours in higher education, particularly in university recruitment efforts is lacking in the literature. Therefore, this study seeks to fill these research gaps in order to fill the knowledge gap that exists in the field of virtual tours, particularly in the context of university campuses and student participation.

Based on these findings, several studies illustrate the potential of virtual campus tours as effective low-cost marketing tools that increase engagement, attract potential stakeholders and aid in university recruitment efforts. Notably, Osman El-Said and Heba Aziz's [10] study emphasizes the impact of virtual tours in stimulating tourism recovery post-COVID-19 by demonstrating their ability to engage and attract people. Moreover, Suwarno and Nerru Pranuta Murnaka's [16] study on student views of university virtual settings emphasizes the importance of virtual campus tours in increasing engagement and delivering immersive experiences. In addition, Supraja et al. [5] demonstrate the successful use of gamified virtual environments to engage and assist students during the COVID-19 pandemic, highlighting the potential of such tools to attract and support new students. Also, the research on smart campus development [13], [15] and the integration of Internet of Things (IoT) technology [14] demonstrate the favourable influence of technological advancements on campus engagement and efficiency, implying that similar methods to virtual tours have a broader relevance. Furthermore, research on the usage of video game engines to create virtual tours [9] and interactive campus visit experiences [21] suggest that such tools can effectively engage and attract visitors and potential students. While not all references specifically address the use of virtual campus tours as low-cost marketing tools, the collective findings from these studies support the premise that immersive and interactive virtual experiences can effectively engage, attract and ultimately contribute to university recruitment efforts.

VII. CONCLUSION

This research has achieved the goal of developing a campus model in Minecraft and creating an interactive virtual tour of a university campus. Using a customized Minecraft clone, a virtual tour has been created with an engaging and immersive user experience that precisely replicates the campus architecture and allows for seamless exploration. The

integration of building information provided valuable insight into each structure and enhanced the informative nature of the virtual tour. User feedback and ratings confirmed the effectiveness and usability, engagement and accessibility while highlighting the potential of gamified environments and virtual tours in education. Overall, this research has created a valuable resource for prospective students, educators and visitors and has revolutionized the way education campuses are experienced and presented.

There exist some limits that should be addressed in this paper. For starters, the development of real-time interactions and dynamic events within the Minecraft clone was not viable due to time constraints and technical challenges. Due to this, the research was unable to simulate a more realistic and dynamic campus environment. Second, despite efforts to assure accuracy, the Minecraft reproduction of the campus may have found difficulties in duplicating every detail of the buildings and their environments. This could have results in small inaccuracies or discrepancies in the virtual tour. Furthermore, the project's scope was constrained to a single campus, limiting its applicability to other educational institutions. Finally, the project's evaluation was mostly based on visitor feedback and testing, which may not represent all possible consumers' opinions. Despite these limitations, the research serves as a solid platform for future improvements and a great starting point for further advances in campus modelling and virtual tours.

There are various potential future enhancements that can be implemented in this project to improve the campus modelling in Minecraft. Integration of online multiplayer features, which would allow users to cooperate and explore the virtual campus together, is one path for improvement. This would build a sense of community and allow students, staff and prospective visitors to interact in a virtual environment. Another area for enhancement is the introduction of dynamic components within the Minecraft clone, such as real-time events and interactive activities. These enhancements would increase visitor engagement and provide a more immersive and realistic experience. Additionally, broadening the project's scope to include other campuses or educational institutions will broaden its reach and influence. By developing a flexible framework or template that can be easily customised and adapted to weird situations. Other institutions will be able to adopt and profit from the smart campus concept. These future additions would elevate the virtual tour's educational value and visitor experience, making it even more beneficial and effective in the context of campus exploration and interaction.

Moving in advance, the virtual campus tour in Minecraft reveals a number of potential research possibilities. Addressing technical constraints with better graphics techniques and optimized efficiency is still a top concern. Scalability to include many campuses while allowing for customization necessitates modular system designs. Gamification, augmented/virtual reality and personalized learning experiences can all improve user engagement and knowledge retention. Exploring joint exploration and social interaction aspects could encourage people to share their experiences. Additionally, integrating the virtual tour with campus management systems improves administrative efficiency. These future directions promise an enhanced, immersive and personalized virtual tour, taking educational technology to new heights.

While the virtual campus tour in Minecraft provided in this study is a unique and interesting way to explore university campuses, its limitation necessitate caution in interpreting the findings. The project's scope may obstruct a comprehensive picture of campus life, potentially limiting its usefulness in communicating the full range of academic and extracurricular opportunities. Furthermore, the study's demographic uniqueness and dependence on self-reported feedback cast doubt on the study's good findings' generalizability. Also, the distinctive characteristics of each institution, as well as cultural diversity among potential students, may affect the tour's efficacy in diverse circumstances. Recognising these limitations highlights the importance of additional study to produce more inclusive and adaptive virtual campus tour solutions.

ACKNOWLEDGEMENT

The authors would like to thank the two anonymous reviewers who have provided valuable suggestions to improve the article.

REFERENCES

[1] R. Abidin & N. Suryani, "Students' Perceptions of 360 Degree Virtual Tour-Based Historical Learning About the Cultural Heritage Area of the Kapitan and Al-Munawar Villages in Palembang City", *International Journal of Social Sciences and Management*, vol. 7, no. 3, pp. 105-112, 2020.

[2] M. A. K. Anshary, C. M. S. Ramdani, E. N. F. Dewi, A. N. Rahman & R. Syahriszani, "Application of Point Tracking Technology in 360 Degree Panorama Virtual Tour Applications for Introduction to Siliwangi University Campus", *CESS (Journal of Computer Engineering, System and Science)*, vol. 8, no. 1, pp. 12-21, 2023.

[3] J. Radianti, T. A. Majchrzak, J. Fromm & I. Wohlgenannt, "A Systematic Review of Immersive Virtual Reality Applications for Higher Education: Design Elements, Lessons Learned, And Research Agenda", *Computers & Education*, vol. 147, 103778, 2020.

[4] S. Supraja, S. Tan, F. S. Lim, B. K. Ng, S. Y. Ho & A. W. H. Khong, "Freshmen Orientation Program Using Minecraft: Designed by Students for Students during the COVID-19 Pandemic", *IEEE Frontiers in Education Conference (FIE)*, 2022, pp. 1-9.

[5] M. Chang, G. B. Lee, J. H. Lee, M. Lee, & J. H. Lee, "The Influence of Virtual Tour on Urban Visitor Using a Network Approach", *Advanced Engineering Informatics*, vol. 56, 102025, 2023.

[6] R. Tse, S. Mirri, S.-K. Tang, G. Pau & P. Salomoni, "Modelling and Visualizing People Flow in Smart Buildings: A Case Study in a University Campus", *Proceedings of the Conference on Information Technology for Social Good (GoodIT'21)*, 2021, pp. 309-312.

[7] A. Latifah, S. H. Supangkat & A. Ramelan, "Smart Building: A Literature Review", *International Conference on ICT for Smart Society (ICISS)*, 2020, pp. 1-6.

[8] C. Meier, J. L. Saorin, A. B. d. Leon, A. G. Cobos, "Using the Roblox Video Game Engine for Creating Virtual Tours and Learning About the Sculptural Heritage", *International Journal of Emerging Technologies (iJET)*, vol. 15, no. 20, pp. 268-280, 2020.

[9] O. El-Said and H. Aziz, "Virtual Tours a Means to an End: An Analysis of Virtual Tours' Role in Tourism Recovery Post COVID-19", *Journal of Travel Research*, vol. 61, no. 3, pp. 528-548, 2022.

[10] R. L. A. Castillo & X. D. L. Zegarra, "The Tours in Virtual Museums a Didactic Opportunity in Social Sciences", *International Conference on Virtual Campus (JICV)*, 2020, pp. 1-4.

[11] M. D. Fino, C. Ceppi, & F. Fatiguso, "Virtual Tours and Informational Models for Improving Territorial Attractiveness and The Smart Management of Architectural Heritage: The 3D-Impact Project", *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol. 44, pp. 473-480, 2020.

[12] Y. Huang, S. Ali, X. Bi, X. Zhai, R. Liu, F. Guo & P. Yu, "Research on Smart Campus Based on the Internet of Things and Virtual Reality", *International Journal of Smart Home*, vol. 10, no. 12, pp. 213-220, 2016.

[13] T. Sutjarittham, H. H. Gharakheili, S. S. Kanhere & V. Sivaranam, "Experiences with IoT and AI in a Smart Campus for Optimizing Classroom Usage", *IEEE Internet of Things Journal*, vol. 6, no. 5, pp. 7595-7607, 2019.

[14] M. W. Sari, P. W. Ciptadi & R. H. Hardyanto, "Study of Smart Campus Development Using Internet of Things Technology", *IOP Conference Series: Materials Science and Engineering*, vol. 190, 2017, pp. 012032.

[15] Suwarno & N. P. Murnaka, "Virtual Campus Tour (Student Perception of University Virtual Environment", *Journal of Critical Reviews*, vol. 7, no. 19, pp. 4964-4969, 2020.

[16] M. Muhhin, D. Nael, R. -H. Tunnel & U. Norbisrath, "Adventure and Quiz Learning Game Based On a Virtual Tour of a Video Game Museum", *International Journal of Software Engineering & Applications*, vol. 14, no. 1, pp. 23-37, 2023.

[17] W. H. Tan, "Student-led Gamification in the Undergraduate Design History Course", *International Journal of Creative Multimedia*, vol. 1, no. 2, pp. 1–17, 2020.

[18] F. J. Agbo, S. S. Oyelere, J. Suhonen & M. Tukiainen, "Design, Development, and Evaluation of a Virtual Reality Game-Based Application to Support Computational Thinking", *Educational Technology Research and Development*, vol. 71, no. 2, pp. 505-537, 2023.

[19] A. Nolan, E. Nolan, R. Nolan & F. Nolan, "Modelling a Meta Smart City on Mars in Minecraft", *World Automation Congress (WAC)*, 2021, pp. 222-227.

[20] M. B. Garcia, D. M. C. Mansul, E. B. Pempina, M. R. L. Perez & R. T. Adao, "A Playable 3D Virtual Tour for an Interactive Campus Visit Experience: Showcasing School Facilities to Attract Potential Enrollees", *9th International Conference on Virtual Reality (ICVR)*, 2023, pp. 461-466.

[21] G. Mak & L. Zhao, "A Systematic Review: The Application of Virtual Reality on The Skill-Specific Performance in People With ASD", *Interactive Learning Environments*, vol. 31, no. 2, pp. 804-817, 2023.

[22] M. A. M. bin Saedon, "Tourists' Perception on Virtual Reality Application of Traditional Malay House*", International Journal of Creative Multimedia*, vol. 3, no. 1, pp. 57–67, 2022.

[23] H. N. Yuwono, W. R. Fitriani, A. N. Hidayanto & S. A. Kurnia, "Response to the Educational Roadblock due to the Pandemic: How Can a University Virtual Tour Experience Affect Enrolment Intentions?", *International Journal of Innovation and Learning*, vol. 34, no. 3, pp. 290-312, 2023.

[24] A. Pal, A. Tiwari, A.Singh, M. Tanganiya, R. Bhat & V. B. Lobo, "A Tour of a Technical and Educational Campus Using Virtual Reality", In *2023 3rd International Conference on Pervasive Computing and Social Networking (ICPCSN)*, 2023, pp. 1578-1583.