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Article

Tidyroom XR: Extended Reality (XR) Based 3D Bedroom Interior Design Game Using Oculus Quest 2

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Abstract: The advancement of Extended Reality (XR) technology, which includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), has created fresh possibilities in multiple areas, such as interior design. This research seeks to create TidyRoom XR, a 3D game for bedroom interior design utilizing XR on the Oculus Quest 2, allowing users to engage directly inside a virtual space. The development process utilizes the Multimedia Development Life Cycle (MDLC) approach, which includes six phases: concept, design, resource gathering, production, evaluation, and distribution. The main goal of this application is to offer a helpful tool for interior designers and general users to visualize and organize bedroom layouts efficiently and precisely. Moreover, the application aims to provide a very engaging experience for creating bedrooms in a virtual setting. The test results reflected favorable results, indicating that the system functioned as intended, featuring an intuitive interface and responsive interactions. The game includes functions for object manipulation like Add, Move, Rotate, Drag, Drop, and Delete, and has two kinds of bedrooms furnished with typical items such as beds, tables, chairs, wardrobes, and drawers. These outcomes indicate that TidyRoom XR can function both as an effective platform for investigating interior design and as an interactive educational resource.

Keywords: Interior Design, Extended Reality, Virtual Reailty, 3D, Game, Oculus Quest 2, MDLC.

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1. Introduction

Technology always advances and changes over time. With the rapid development, various significant changes are starting to be seen in daily activities. Activities that previously required face-to-face meetings can now be done online, making interactions easier. In addition, various technologies have been created to help lighten the human workload. One of the developing technologies with great potential is Extended Reality (XR) [1]. Extended Reality is a combination of three technologies: Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). This technology provides a new experience thru a digital world that can interact with the real world, even fully integrated. With its capabilities, XR has great potential to assist various sectors in the future. This technology can simplify various human activities in different contexts, such as learning, presentations, and even social interactions [2].

The use of Extended Reality is not limited to the entertainment sector, but has also been applied in architecture, surgical medicine, and has great potential in the field of design, particularly interior design [3]. Interior design is a series of stages in room arrangement that prioritize the needs of users, both physically and mentally. In addition to arranging spatial elements, interior design also aims to create an atmosphere and

experience that is engaging when designing a room in a three-dimensional (3D) world [4]. Examples of XR applications that have been developed include XR-Architecture, which assists in building design [5], and XR-Surgery, which is used in simulations and medical procedures [6]. Such concepts are also important to apply in interior design, where XR can help minimize errors in design and support a more focused room arrangement process. Through interactive features such as drag-and-drop, select, deselect, and rotate objects, XR technology can offer a more authentic experience in the process of exploring interior design. The gap analysis between this research and the references is that previous studies emphasized the enhancement of spatial abilities in architectural education in general [3], whereas this research focuses on the application of XR in the more specific concept of bedroom interior design. Moreover, previous research has not extensively developed direct interaction features such as Add, Move, Rotate, Drag, Drop, and Delete, which can assist users and interior designers in visualizing and arranging furniture practically and interactively.

2. Materials and Methods

2.1 MDLC Diagram

This Extended Reality-based interior design game uses the Multimedia Development Life Cycle (MDLC) method in its development. In this research, several stages of design and game system development are required. This method was chosen because it is suitable for the development of interactive multimedia applications, particularly 3D games that require the integration of visual, audio, animation, and user interaction elements [7].

Figure 1. MDLC Diagram.

By using the MDLC method, the development of this game can be carried out systematically and structured, thereby minimizing the risk of errors and ensuring that the final result aligns with the research objectives [7].

2.2 Flowchart

A flowchart is used as a graphical representation of the system's workflow. This representation illustrates the steps of the process sequentially using standard symbols, thereby facilitating the understanding of the ongoing process. The flowchart design in this study is based on the UML (Unified Modeling Language) concept, as shown in Figure 3 [7].

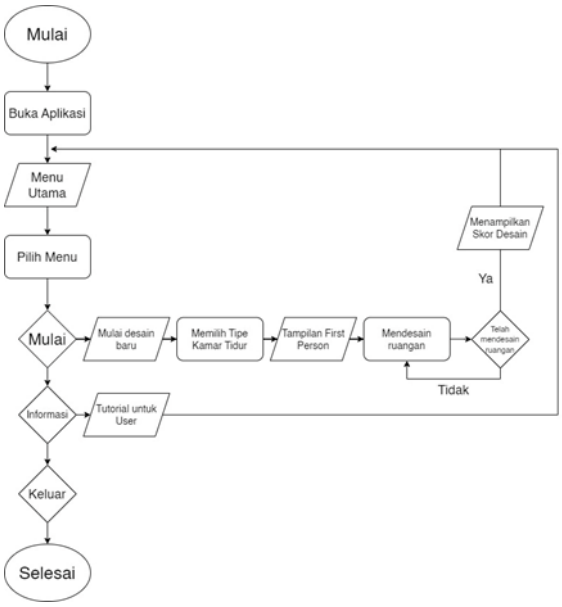

Figure 2. Flowchart Diagram.

2.3 Use Case Diagram

A use case diagram illustrates the interaction between the system and actors. A use case shows the main functions performed by the system and the sequence of actions that occur to achieve a specific goal. Thus, this diagram serves to illustrate the system's activity processes in a structured manner, according to user needs [7].

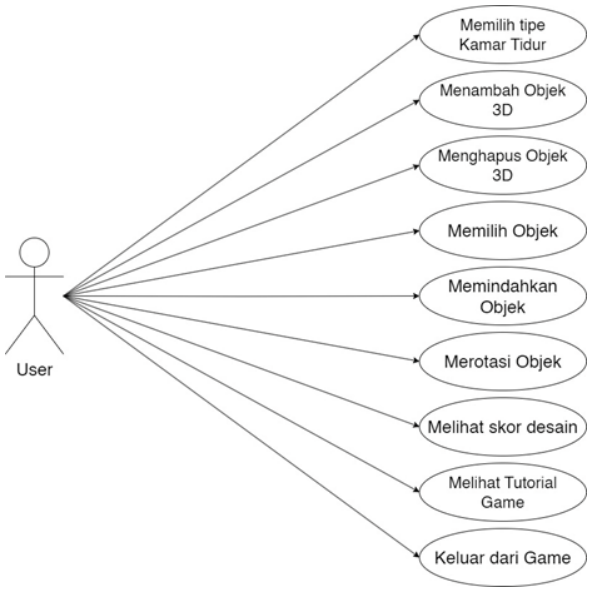

Figure 3. Use case diagram.

3. Results and Discussion

3.1 Concept

The concept stage uses the MDLC method as a framework in the development of multimedia applications. This stage includes needs identification, system planning, and the formulation of the main objectives of the XR-based interior design game. With the MDLC framework, development can be directed to align with user needs and the functional goals of the application.

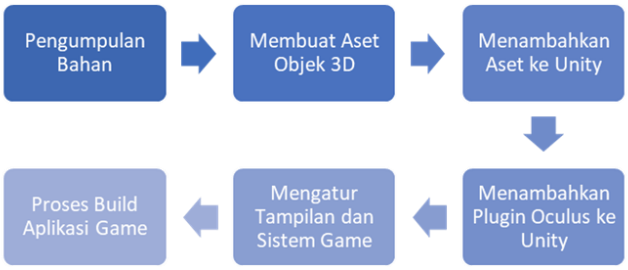

Figure 4. Application Development Concept.

3.2 Design

In this process, the game system is designed as concisely as possible without reducing or adding any other functions within the system. This application is designed as best as possible, taking into account the usability of buttons, button placement, and the neat appearance of the application program on the Oculus device. In the main menu of this Extended Reality game application, there are 5 buttons: "Start," "Tutorial," "Settings," "About," and "Exit." The "Start" button will take the user to the next interface, which is the menu to "Select Bedroom Type" first. The "Tutorial" button will display the Oculus button layout with their respective functions and an initial tutorial video. The "Settings" button will show sound settings and character rotation options. The "About" button will provide a brief explanation of the application. And the "Exit" button for the user to exit the game [8].

After selecting the type of bedroom, the display will be transferred to the next interface, which is the in-game interface in the form of a first-person perspective as the user point of view (POV), where we as users can interact with the environment and objects within this game system. In this in-game scene, there are buttons on the Oculus controller, such as the "Add," "Move," "Rotate," "Drag," "Drop," and "Delete" buttons. Additionally, there are navigation buttons "Pause" and "Furniture" on the Oculus controller. The "Pause" button allows the user to display the Pause Menu, which contains various in-game interface buttons such as "Resume," "Design Score," "Tutorial," and "Exit" buttons. The functions of these buttons are as follows: the "Resume" button to continue the game, the "Design Score" button to display the room design score, the "Tutorial" button to show the in-game tutorial video, and the "Exit" button for the user to exit the game to the Main Menu. The "Furniture" button allows the user to display the Furniture Menu, which will show various buttons to display the furniture they want to add, such as beds, tables, chairs, cabinets, and drawers [8].

3.2.1 Main Menu Display

In the Main Menu display, there are buttons for Start, Tutorial, Settings, About, and Exit. The Start button functions to display the page for selecting room types. The Tutorial button displays the tutorial page, the Settings button displays the settings page, and the Exit button is for exiting the TidyRoom XR application.

Figure 5. Main Menu Display [8].

3.2.2 Room Type Selection Menu Display

In this menu display, there are two button options for selecting room types, namely 4x5 rooms and 5x6 rooms. We can choose a room according to our preference. Then the back button on this menu returns to the main menu.

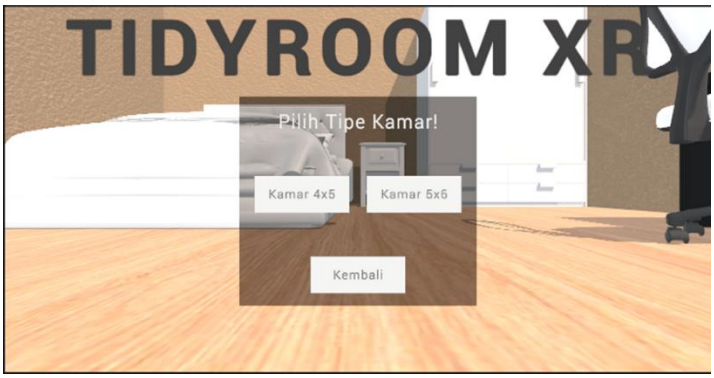

Figure 6. Room Type Selection Menu Display [8].

3.2.3 Tutorial Menu Display

This menu display shows an image of the Oculus Controller with each button and its function. The Video Tutorial button is for displaying the tutorial video. And the back button is for returning to the Main Menu.

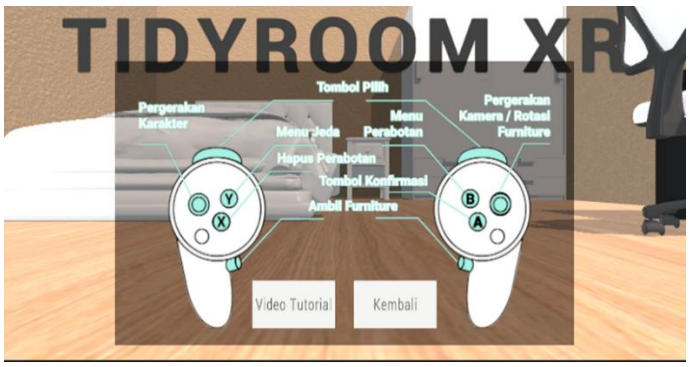

Figure 7. Tutorial Menu Display [8].

3.2.4 Settings Menu Display

In this menu display, there is a slider that functions to adjust the Sound Volume. There is also a button to select the character rotation options in the game. Additionally, there is a confirmation button to confirm all settings.

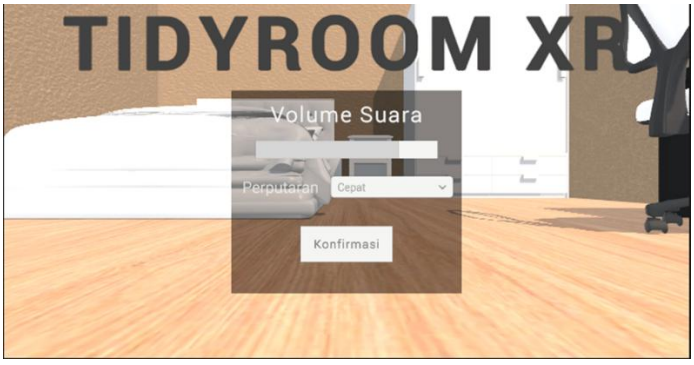

Figure 8. Settings Menu Display [8].

3.2.5 About Menu Display

This display shows a brief credit to the creators of TidyRoom XR: a 3D Interior Design Game based on Extended Reality using Oculus Quest 2. The back button is for returning to the Main Menu.

Figure 9. About Menu Display [8].

3.2.6 4x5 Room Display

Here is the 4x5 room display, which is a space measuring 4x5 m that has not been furnished at all. In this room, we will also be able to interact with various types of furniture.

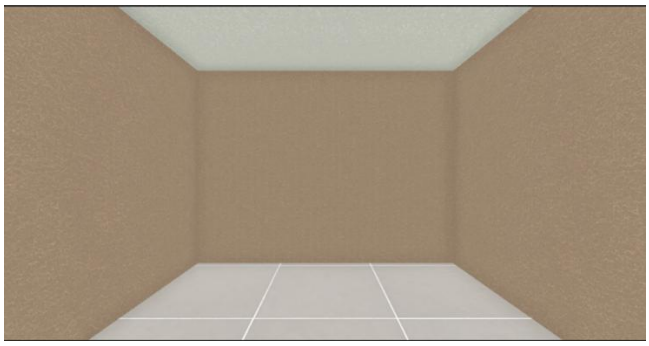

Figure 10. View of the 4x5 Room [8].

3.2.7 5x6 Room Display

Here is the 5x6 room display, which is a space measuring 5x6 m that has not been furnished at all. In this room, we will also be able to interact with various types of furniture.

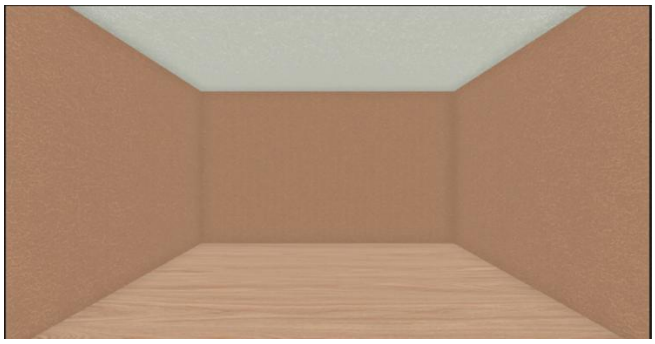

Figure 11. 5x6 Room View [8].

3.2.8 Video Tutorial Display

In this menu display, a tutorial video will be shown. The red "X" button is used to close the video menu display.

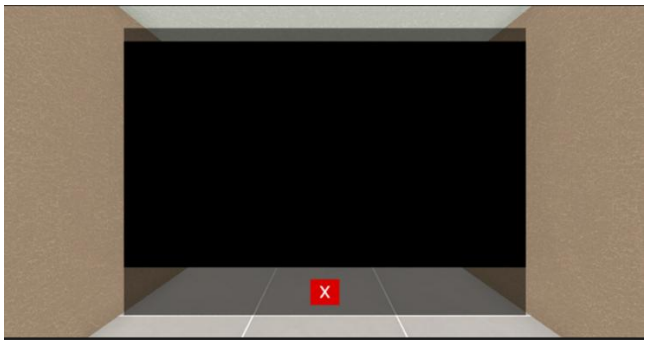

Figure 12. Video Tutorial Display [8].

3.2.9 Pause Menu Display

The Pause Menu Display features various buttons such as the Continue button, Design Score button, Tutorial button, and Exit button. The Continue button is for resuming the game. The Design Score button is for displaying the design score results. The Tutorial button is for displaying the tutorial video. And the Exit button is for exiting the game to the Main Menu.

Figure 13. Pause Menu Display [8].

3.2.10 Furniture Menu Display

This menu displays various buttons to add different furniture to the room. In the 4x5 room, there are only 4 pieces of furniture, whereas in the 5x6 room, there are 5 pieces of furniture. The furniture includes a bed, table, chair, wardrobe, and drawer.

Figure 14. Furniture Menu Display [8].

3.2.11 Design Score Menu Display

This menu display will show the design score of the room that we have designed accordingly. The back button is used to close the Design Score menu display.

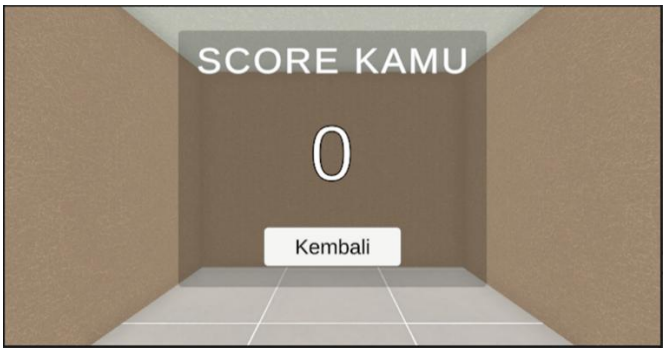

Figure 15. Design Score Menu Display [8].

3.3 Material Collection

Material collection includes the creation of 3D furniture objects and the room environment. The main materials used are furniture models such as beds, tables, chairs, cabinets, and drawers. The development uses Oculus devices, the Unity programming application, and Blender for 3D asset design [8].

Figure 16. Furniture images.

3.4 Manufacturing

At this stage, all the collected materials will be remodeled or modified. The manufacturing stages and remodeling process are outlined as shown in Figure 12 below.

Figure 17. Stages of Game Development.

The next stage is to create the environment within the game, there are two types of rooms that have been conceptualized, namely a 4x5 room and a 5x6 room. Next is to install all the plugins needed for this 3D game development project. Next is testing the connection

of Oculus to Unity. Then, build the game system in Unity. The next process is building the UI and game environment in Unity [9].

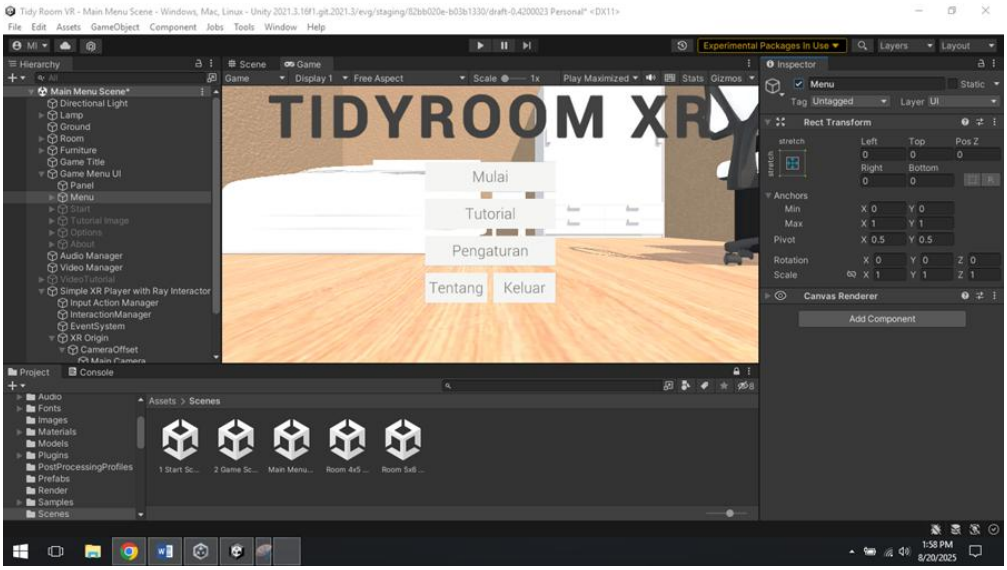

Figure 18. Creation of the Main Menu Display.

The next step is to add furniture object assets into Unity. Then, also add and configure the coding for the system in this game. After everything is done, the next step is the game finishing process. After that, direct game testing with Oculus needs to be conducted. Then the next step is the debugging and maintenance process of the game [9].

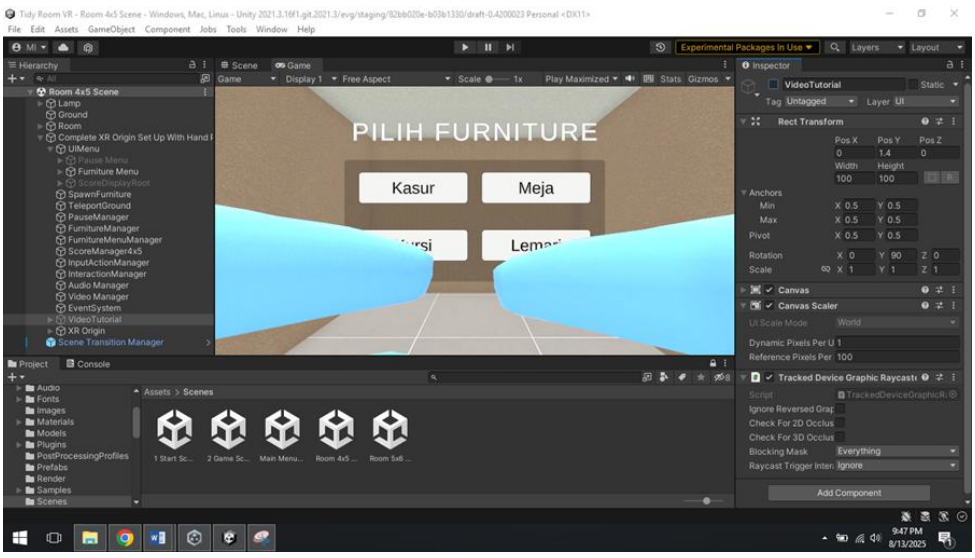

Figure 19. Creation of Game Interface Display.

3.5 Testing

In the testing phase, this application is useful for evaluating the effectiveness of the model that has been created. The target users for testing this application are the Informatics Laboratory Assistants, as this project will later be handed over to the Lab Assistants as a virtual learning application that can be used by all UMSIDA students, especially those in the Informatics Department. The testing method and user questionnaire were used in the testing of this application because the direct user testing method is suitable for ensuring that all application features function without inspecting the application code, making it

appropriate for evaluating user experience. Meanwhile, the user questionnaire was chosen to measure the satisfaction and effectiveness of the application in learning, with data from the Laboratory Assistants collected using a Likert Scale related to the appearance, ease of use, stability, and benefits of the application. Here is Table 1 of the test results.

Table 1. Application Testing.

No.	Test Item	System Response			Description
		Good	Poor	No	
1.	Start Button	✓			Opens the room type selection menu display.
2.	Tutorial Button	✓			Opens the tutorial menu display.
3.	Settings Button	✓			Opens the settings menu display.
4.	About Button	✓			Opens the application information menu display.
5.	Exit Button	✓			Closes or exits the application.
6.	4×5 Bedroom Button	✓			Opens the 4×5 bedroom interface display.
7.	5×6 Bedroom Button	✓			Opens the 5×6 bedroom interface display.
8.	Back Button	✓			Returns to the previous menu display.
9.	Tutorial Video Button	✓			Opens the tutorial menu display.
10.	Volume Slider Button	✓			Adjusts the volume level in the application.
11.	Rotation Option Button	✓			Adjusts the camera rotation in the game.
12.	Pause Menu Button	✓			Opens the pause menu display.
13.	Furniture Menu Button	✓			Opens the furniture menu display.
14.	Move Button	✓			Moves furniture objects/items.
15.	Rotate Button	✓			Rotates furniture objects/items.
16.	Drag Button	✓			Picks up furniture objects/items.
17.	Drop Button	✓			Drops furniture objects/items.
18.	Delete Button	✓			Deletes furniture objects/items.
19.	Continue Button	✓			Continues the game and exit the pause menu.
20.	Design Score Button	✓			Opens the design score menu display.
21.	Tutorial Video Button	✓			Opens the tutorial video menu display.
22.	Bed Button	✓			Adds a bed furniture object.
23.	Table Button	✓			Adds a table furniture object.
24.	Chair Button	✓			Adds a chair furniture object.
25.	Wardrobe Button	✓			Adds a wardrobe furniture object.
26.	Drawer Button	✓			Adds a drawer furniture object.

In the "TidyRoom XR" application, the Start button will direct users to a menu screen where they can choose the type of room, consisting of two main options: the 4x5 room type and the 5x6 room type. In both room types, users can design the room according to their preferences, and there will also be an evaluation of the room design results. Each interface for the 4x5 room type and the 5x6 room type has its own specific rules, such as the 4x5

room type allowing only 4 pieces of furniture and the 5x6 room type allowing 5 pieces of furniture. The tutorial button will direct you to the tutorial menu screen. The settings button will display the settings menu, which can adjust the sound and camera rotation in the game. Then, the about button will show a menu containing information about the app's creator. Finally, the exit button is used to exit the application.

Table 2. Score categories on the Likert scale.

Score	Percentage	Description
1.	0%–20%	Very Poor (VP)
2.	21%–40%	Poor (P)
3.	41%–60%	Fairly Good (FG)
4.	61%–80%	Good (G)
5.	81%–100%	Very Good (VG)

The results of the user response questionnaire for the feasibility test of the TidyRoom XR application are calculated using a Likert scale with a maximum score of 5 for each question, so with 10 questions, the maximum score is 50. This score is then multiplied by the number of respondents to obtain the expected score. The frequency value is obtained from the total score given by all respondents, and the feasibility percentage is calculated by comparing the frequency value with the expected score, then multiplying by 100 percent. This percentage indicates the level of satisfaction and feasibility of the application based on user assessments of the application's appearance, functionality, and benefits.

Table 3. Questionnaire Test.

No.	Question	Score 1	Score 2	Score 3	Score 4	Score 5
1	Does the overall game interface look good?	0	0	0	2	8
2	Can the button functions be operated?	0	0	0	0	10
3	Is this game easy to play interactively?	0	0	1	2	7
4	Are the application usage instructions clear?	0	0	0	1	9
5	Can this virtual game help users implement an appropriate bedroom design in the real world?	0	0	0	2	8
6	Do the room, objects, and other details look realistic?	0	0	0	1	9
7	Is the equipment medium (Oculus) easy to access and use?	0	0	1	5	4
8	After using this application, are you interested in designing a room in the real world?	0	0	2	1	7
9	If you are an interior designer, can this application help your work?	0	0	1	1	8
10	Does this application have the potential to be developed further?	0	0	0	1	9

Based on Table 3, the results of the questionnaire collected from the Informatics Laboratory Assistants thru an online survey show that there are 10 respondents who gave

a score of 5 with a total value of 79, a score of 4 with a total of 16, and a score of 3 with a total of 5. Meanwhile, there were no respondents who gave a score of 2 or 1. The assessment of the augmented reality application to test the feasibility of this application on a Likert scale. The maximum score is denoted by X, where the "very good" category has a value of 5. This maximum value is calculated by multiplying the highest score by the number of questions, which is $X = 5 \times 10 = 50$. Meanwhile, the ideal score or expected score is denoted by Y, which is calculated by multiplying the maximum score by the number of respondents: $Y = 50 \times 10 = 500$.

The results of these calculations can be seen in detail in Table 3, which shows the level of user satisfaction with the application.

f = Total frequency value for each question

T = total respondents

Pn = Likert score

P = Feasibility Presentation

Y = Expectation Score. Therefore,

The user satisfaction calculation results are:

f = T x Pn (1)

f = (79 x 5) + (16 x 4) + (5 x 3)

f = (395 + 64 + 15)

p = 474 (2)

p = (474/500 x 100% = 94.8%)

So, the total feasibility percentage = 94.8%

Based on the evaluation results, the TidyRoom XR application received a frequency score of 474 with a feasibility percentage of 94.8%, indicating that this application falls into the very good category and is suitable for use as an interior design aid. The application of Extended Reality (XR) technology in this application has proven to be superior compared to conventional design methods, as it is capable of presenting bedroom models in the form of interactive 3D, making it easier for users to arrange furniture realistically. This immersive experience not only enhances user engagement but also helps accelerate the design exploration process, minimize spatial arrangement errors, and provide a more concrete visualization before implementation in the real world. Thus, this application can be used as an innovative and effective alternative interactive medium to support the interior design process in the digital era [10].

3.6 Distribution

In the distribution phase, this 3D bedroom interior design game will be published and used as a support medium for interior designers or someone who wants to conceptualize their own bedroom. This game can serve as an aid in conceptualizing and designing the interior of a bedroom in 3D [11]. However, there is a challenge that not everyone has access to using the Oculus. The reasons include the high cost of the device (Oculus) and the slight difficulty in adapting to its use [12]. Therefore, another option is to hand over this project to the Informatics Laboratory, which can later be used as a virtual learning medium for all UMSIDA students, especially Informatics students. The next step is the feasibility test, which will be conducted based on the assessment categories that have been previously determined.

Documentation Photo

Figure 20. Application Testing.

4. Conclusion

This research successfully developed TidyRoom XR, a 3D bedroom interior design game based on Extended Reality (XR) using the Oculus Quest 2 with the MDLC method, which consists of the stages of concept, design, material collection, creation, testing, and distribution [7]. This application is equipped with interactive features such as add, move, rotate, drag, drop, and delete objects, allowing users to arrange furniture more realistically in a virtual space. The test results show that all functions operate as designed, with a feasibility percentage reaching 94.8% (very good), confirming that this application is intuitive, efficient, and provides real benefits to users in visualizing bedroom layouts [13]. In addition to serving as a medium of entertainment, TidyRoom XR also has the potential to be a tool for learning and interior design planning, both for novice designers and general users [14]. Nevertheless, limitations still exist in the relatively high cost of Oculus devices and the limited variety of furniture, so future research can be focused on expanding the asset catalog, improving graphic quality, and developing cross-device compatibility to enhance accessibility. Thus, TidyRoom XR has proven to be usable and has the potential to become an interactive innovation that supports the development of digitalization in the field of XR-based interior design [15].

Acknowledgements

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