Virtual Reality Simulation Design for The Use Of Personal Protection Equipment For The Pertamina Refinery Area

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Article Information

ABSTRACT

Occupational safety and health are very important to pay attention to, especially for workers in the field. Personal protective equipment is a tool that can reduce the risk of work accidents. The Pertamina Company requires workers to carry out training on the use of personal protective equipment in Pertamina's demo room. The problem that often occurs is the limited space for conducting simulations if many workers take part in the training simultaneously, they have to queue first to enter the demo room. The final result of this research is to produce a virtual reality demo room application to save training time on the use of personal protective equipment. The stages in making the Virtual Reality demo room application include analysis, methods, design, development, and validation. The process of analyzing the Virtual Reality demo room application includes analyzing system requirements and using the waterfall method. The design of the virtual reality demo room application uses Unity and Blender software for making 3D assets and animation. The Virtual Reality demo room application has passed the material validation test stage with a score of 84 and the media validation test obtained a score of 92, so the application is suitable for use.

1. INTRODUCTION

Along with the times, technology is also developing rapidly. Technological developments make it easier for humans to do work. One of the technologies that humans need is virtual technology that can be used as a simulation medium [1]–[4]. Virtual technology is an effective technology for tools simulating human work. [5].

Virtual reality is made with various game engines, one of which is Unity. Unity is an integrated tool for creating games, building architecture, and simulations [6], [7]. Virtual Reality provides an experience for users to carry out a real simulation using a computer. Currently, various VR headsets have been developed by various companies, one of which is Oculus. Oculus Quest is a virtual reality headset without the need for an intermediary medium such as a PC to run the application program, so that the program can run and be connected to devices based on the Meta Quest version of Android(.apk) [8].

By and large at work always there is a source of danger that can threaten the safety and health of workers. Almost all workplaces have a source of hazards. Potential hazards in the workplace include raw materials, work processes, products, and the resulting waste.

K3 is the basis for every work in the workplace. Every rule in K3 can increase work productivity if properly implemented. Companies must take action for prevention in the event of health problems that occur in workers caused by the work they do in the workplace they are currently working on [9].

Pertamina is a state-owned company engaged in the energy sector and the largest dividend contributor in Indonesia. In the world of work, Pertamina is very vulnerable to danger. Every worker must comply with work safety protocols by K3 that have been determined by Pertamina. One part of K3 at Pertamina is using Personal Protective Equipment (PPE). To make it easier for workers to understand OSH, one of which is using PPE, a special simulation was made in the demo room. The demo room itself is a learning tool to understand and learn related aspects of work safety for workers before starting a job [10].

Virtual Reality Application Simulation Use of Personal Protective Equipment for the Pertamina Refinery Area, making it easier for workers to understand and implement work safety aspects wherever they are. With the Virtual Reality application, the Simulation of Using Personal Protective Equipment for the Pertamina Refinery Area can bring innovative changes to Pertamina companies. And the company will benefit in terms of labor and time [11]–[15].

2. RESEARCH METHOD

Based on the analysis, there are two system requirements, namely functional requirements and non-functional requirements [16]. Functional requirements in the making the Virtual Reality application simulation use of personal protective equipment for the pertamina refinery area, as follows the first is that the system can provide information about the process of using personal protective equipment in the form of a 3-dimensional virtual simulation, and the system is equipped with text, audio, and animation for the user.

Non-Functional requirements consist of a software (software), hardware (hardware), and brainware (human resources). The software used in making the Virtual

Reality Simulation application for the use of Personal Protective Equipment for the Pertamina Refinery Area is microsoft windows 11, unity 3D, blender, adobe illustrator. The hardware used in performing 3D modeling, animation, scripting, rendering and testing processes in application development has high specifications. The brainware in this system includes VR application creators, validators, and users.

For the method used in the software using the waterfall method [17]. In the implementation of the waterfall method using a sequential method, this method must complete stage by stage to produce an application system that is feasible to use. among the stages that will be passed are requirements, design, implementation, verification, and maintenance. Each stage has an important role. In the virtual reality application simulating the use of personal protective equipment for the pertamina refinery area implements all stages of the waterfall method.

2.1. Application Flowchart Design

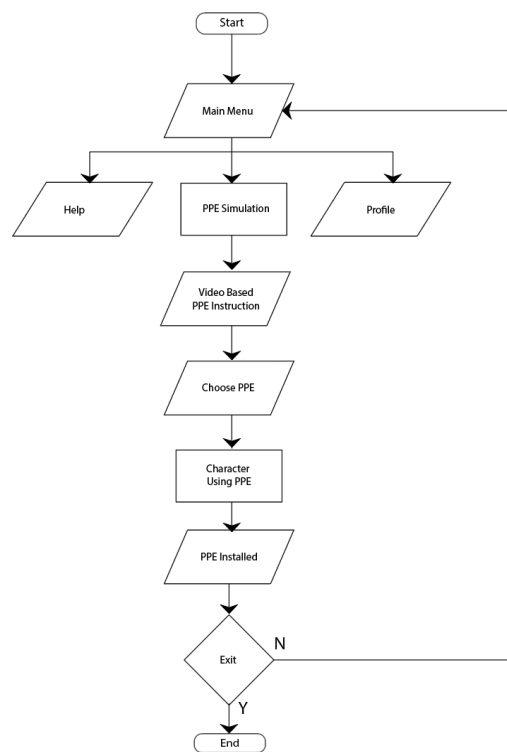At the application design stage, the system flowchart is used as the flow or logic of the application program.

Figure 1. Virtual reality demo room application flowchart design

2.2. 3D modeling

The 3D modeling process will produce an equipment object model that will be used for practice in the Virtual Reality Simulation of Using Personal Protective Equipment for the Pertamina Refinery Area. This object modeling is made using the Blender program and for the game engine using Unity3D [18].
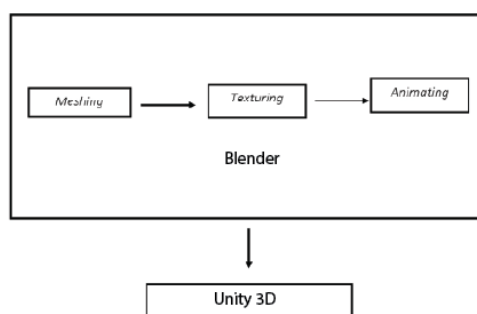

Figure 2. Demo room 3D asset modeling system using blender

Initial stage of 3D modeling is the Meshing stage, where at this stage mesh object modeling is carried out. When the model is finished, then we enter the Texturing stage, also called the stage of giving color and texture to objects that are adjusted to the texture of the personal protective equipment used by Pertamina. The next stage is the character animation stage, namely the stage of making an animation of an object to simulate how to use personal protective equipment. The final stage is moving the finished object to unity [19].
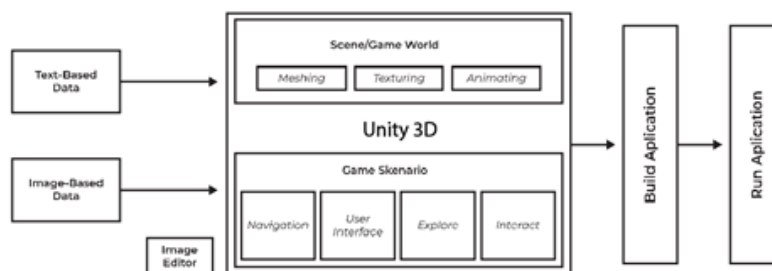

Figure 3. 3D asset modeling system using unity3D blender

Object modeling in Unity3D begins with the stage of creating a Scene or known as a word game, namely the stage of creating or setting a place for Virtual Reality Simulation of Using Personal Protective Equipment for the Pertamina Refinery Area. Setting the place

to create a simulation room to adjust the location of the 3D model and also to adjust the light. The next model is a scenario game that is making the rules used in the Virtual Reality Simulation of Using Personal Protective Equipment for the Pertamina Refinery Area [20].

3. RESULTS AND DISCUSSION (11 pt)

3.1. Application implementation

At the implementation stage, the device will be tested to find out whether the virtual reality design application that simulates the use of personal protective equipment in the Pertamina refinery area can run as needed.

In making the application, it begins with making assets based on real references in the application, such as personal protective equipment used for the Pertamina refinery area and information on the wall to support understanding and convey information related to the use of personal protective equipment. The process of making 3D assets in the virtual reality design application simulation of the use of personal protective equipment in the Pertamina refinery area, namely the creation of 3D object assets for personal protective equipment is carried out using the Blender software application. The following 3D assets were created: work clothes, safety shoes, safety glasses, masks, ear muffs, safety helmets, safety gloves, and characters. Furthermore, 3D assets that have been created using Blender software will be placed in a demo room designed using the Unity application, as seen in the following image:

Figure 4. Asset

There are many textures used in this application, for example, the texture used in coveralls and safety helmets, to resemble the original shape, the textures used are adjusted to their original shape, as well as other 3D object assets.

3.2. Interface design

The main menu is a page that displays menus from a virtual reality application simulating the use of personal protective equipment in the Pertamina refinery area. In this menu, workers will be presented with several menus, namely play, profile, help, and exit.

The play menu option is chosen when workers want to start a simulation of using personal protective equipment, where workers carry out simulations in the demo room. The profile button is chosen by workers if they want to know the creator of the virtual reality application. Workers will see a help button to learn how to use the app. The exit button is selected by the worker if he wants to exit the application.
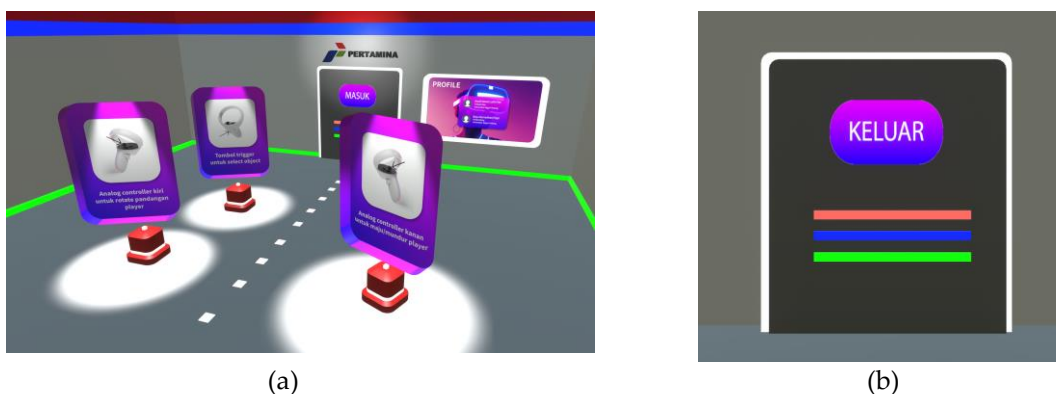

(a)   (b)

Figure 5. 3D model (a) demo room main menu, (b) exit menu

The demo room will display personal protective equipment that will be used for a simulation of wearing PPE. In the demo room, there is equipment to simulate the use of PPE, such as coveralls, safety shoes, safety glasses, masks, ear muffs, safety helmets, and safety gloves. A video base provides information on the sequence of using PPE, and there is a menu that repeats the simulation again and returns to the main menu.

Figure 6. Demo room

3.3. Validation result

The expert validation test is carried out to determine the feasibility level of the application, which includes the development of material experts and media experts. The validation test in this research and development involved four people including two material experts and two media experts. The results of the validation test obtained assessments, comments, and suggestions that were used as improvement materials to improve the virtual reality simulation application for the use of personal protective equipment in the Pertamina refinery area.

Based on the validation test from material experts on Virtual Reality application products which include aspects of learning design, material aspects, and benefit aspects that have been converted into categories. For the number of questions on the learning design aspect, there are 6 questions, 9 questions on the material aspect, and 4 questions on the benefits aspect. So that the total number of questions for material expert validation is 19 questions with a score range of 1 to 4.

Table 1. Material expert

Name	Aspect Score											
	Learning Design				Material				Benefit			
	1	2	3	4	1	2	3	4	1	2	3	4
Janifan Christy, S.ST	0	0	2	4	0	1	5	3	0	0	2	2
Fahri Hartadi Ginanjar, S.E	0	0	3	3	0	3	3	3	0	0	1	3

To produce the aspect score, the formula score * score value is used. then the overall aspect score is summed up, the total score will be obtained. Following are the results of the material expert assessment.

Table 2. Material expert validation test results

Name	Rated Aspect			Total score
	Learning Design	Material	Benefit	
Janifan Christy, S. ST	22	29	14	65
Fahri Hartadi Ginanjar, S.E	21	27	15	63

Based on the results of the material expert assessment of the Virtual Reality application product Simulation of the Use of Personal Protective Equipment for the Pertamina Refinery Area in the aspects of learning design, material aspects, and aspects of the benefits that have been converted into categories. In the table above, it can be explained that the results of the assessment by the material expert get a total score of 65

and 63. After getting the score of the material expert assessment results, calculations will be made using the following formula:

$$P = \frac{\sum R}{N} \times 100\% \tag{1}$$

$$P = \frac{\frac{(65+63)}{2}}{N} \times 100\% \tag{2}$$

$$P = \frac{64}{76} \times 100\% \tag{3}$$

$$P = 0,84 \times 100\% \tag{4}$$

$$P = 84\% \tag{5}$$

The explanation of the formula is as follows, (P) is the percentage of the score being sought (the results are rounded to whole numbers), $\sum R$ is the number of answers given by the validator / option chosen, and N is the maximum score of the number of questions. The N value for the material expert test is the number of questions * maximum score, namely 19 * 4 = 76. Based on the final calculation of the material expert validation test, the percentage result is 84%. This value states that the virtual reality demo room application is feasible and does not need to be revised.

Based on the validation test from media experts on Virtual Reality application products covering aspects of media design, software aspects, and aspects of the benefits that have been converted into categories. For the number of questions on the media design aspect as many as 16 questions, the software aspect as many as 5 questions, and the benefit aspect as many as 4 questions. So the total number of questions for media expert validation is 25 questions with a score range of 1 to 4.

Table 3. Media expert

Name	Aspect Score											
	Media Design				Software				Benefit			
	1	2	3	4	1	2	3	4	1	2	3	4
M. Zuharmando G, S.Pd	0	0	9	7	0	0	4	1	0	0	1	3
Wahyu Zalfi	0	0	7	9	0	0	1	4	0	0	0	4

The following are the results of the media expert assessment:

Table 4. Media expert validation test results

Name	Rated Aspect			Total score
	Media Design	Software	Benefit	
Muhammad Zuharmando G, S.Pd	55	16	15	86
Wahyu Zalfi	57	19	16	92

Based on the results of the media expert assessment of the Virtual Reality application product Simulation of the Use of Personal Protective Equipment Pertamina Refinery Area on the aspects of media design, software aspects, and aspects of the benefits that have been converted into categories. In the table above, it can be explained that the results of the assessment by media experts get a total score of 86 and 92. After getting the score of the media expert assessment results, calculations will be made using the following formula:

$$P = \frac{\Sigma R}{N} \times 100\% \tag{1}$$

$$P = \frac{\frac{(86+92)}{2}}{N} \times 100\% \tag{2}$$

$$P = \frac{89}{100} \times 100\% \tag{3}$$

$$P = 0{,}89 \times 100\% \tag{4}$$

$$P = 89\% \tag{5}$$

The explanation of the formula is as follows, (P) is the percentage of the score being sought (the results are rounded to whole numbers), ΣR is the number of answers given by the validator/option chosen, and N is the maximum score of the number of questions. The N value for the media expert test is the number of questions * maximum score, which is 25 * 4 = 100. Based on the final calculation of the media expert validation test, the percentage result is 89%. This value states that the virtual reality demo room application is feasible and does not need to be revised.

3.4. Product review

The product produced from this final project is a Virtual Reality application as an interactive learning media using personal protective equipment in the application package file (apk) format. Users of this application are required to install this file with a minimum

API level of 24 on an Oculus virtual reality device and run it according to its use as a learning medium for using personal protective equipment. Virtual Reality applications can be downloaded via the oculus market or directly installed from an existing application package file (apk) device.

The advantages of virtual reality applications simulating the use of personal protective equipment in the Pertamina refinery demo room area, among others, can be a learning medium for Pertamina workers. Virtual Reality technology invites workers to think absolutely without entering the demo room directly by displaying 3d models and animations of personal protective equipment so that workers feel as if they are in the demo room. The Virtual Reality application simulates the use of personal protective equipment for the Pertamina refinery area, making it easier for workers to understand and implement work safety aspects in the use of PPE. In addition to providing benefits for workers, this application also provides benefits for Pertamina in saving work time.

The weaknesses of the virtual reality demo room application for simulating the use of personal protective equipment in the Pertamina refinery area include Running the application still requires Oculus Quest hardware. Some 3D objects, such as safety gloves, do not yet resemble the physical form of the original. The textures used on such objects are not authentic and rigid. Only learn the basics of using personal protective equipment in sequence for Pertamina's refinery area.

4. CONCLUSION

The conclusion that can be drawn based on the discussion data regarding the creation of the Virtual Reality Application Simulation Use of Personal Protective Equipment for the Pertamina Refinery Area is the creation of the Virtual Reality Application Simulation Use of Personal Protective Equipment for the Pertamina Refinery Area with a design according to standards for using personal protective equipment in real life which can be accessed through Oculus headsets with an application score of 86% and users can freely use the Virtual Reality Simulation of Using Personal Protective Equipment for the Pertamina Refinery Area without having to enter the demo room.

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