THE IMPLEMENTATION OF AUGMENTED REALITY (AR) TECHNOLOGY IN PROMOTING SAVING ENERGY AWARENESS AT HOME

ATIRAH NURAIN BINTI AMINUDDIN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE IMPLEMENTATION OF AUGMENTED REALITY (AR) TECHNOLOGY IN PROMOTING SAVING ENERGY AWARENESS AT HOME

ATIRAH NURAIN BINTI AMINUDDIN

This report is submitted in partial fulfillment of the requirements for the Bachelor of [Computer Science (Interactive Media)] with Honours.

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I hereby declare that this project report entitled

[THE IMPLEMENTATION OF AUGMENTED REALITY (AR) TECHNOLOGY IN PROMOTING SAVING ENERGY AWARENESS AT HOME]

is written by me and is my own effort and that no part has been plagiarized without citations.

STUDENT : _____ _____ Date : 24th August 2021

ATIRAH NURAIN BINTI AMINUDDIN

I hereby declare that I have read this project report and found this project report is sufficient in term of the scope and quality for the award of Bachelor of [Computer Science (Software Development)] with Honours.

SUPERVISOR : _____ Date : 7 September 202

ASSOC. PROFESSOR TS. DR. AHMAD NAIM BIN CHE PEE

DEDICATION

For the endless support and guidance of my beloved parents, family, lecturers and my fellow friends. This work is also dedicated to my supervisor, Assoc. Professor Ts. Dr. Ahmad Naim Bin Che Pee whom I am grateful for his teaching and guidance to help me achieve the new knowledge I always wanted to explore, which is AR Technology.

ACKNOWLEDGEMENTS

First of all, Alhamdulillah, I thank Allah S.W.T for giving me convenient to complete my first thesis on time. Alhamdulillah for all the new knowledges I obtained along this development of the project. It is nothing valuable than knowledges.

I would like to thank Assoc. Professor Ts. Dr Ahmad Naim bin Che Pee for assist me in completing the project successfully. His guidance and advice are precious to me as he help me in every task in my project and help me learn a lot of new things.

To the people who always help me a lot, keep supporting me, giving guidance and advice on this project, especially my boyfriend, beloved parents and family for their constant support, in every way possible, to all my friends in all of their cooperation and knowledge.

To my supervisor, Dr Naim, I can't thank enough as he helped me a lot on improvement and problems I faced during the development of this project.

Lastly to all of my lecturers for without whom, I would not be able to work on this project at all. Thank you for always support and motivate me and motivation throughout my project. Your help and support are very precious to me.

ABSTRACT

Nowadays, people tend to spend the energy more luxuriously. It is including the energy we use at home, office, huge building and institution. Sometimes, the excessive energy consumption happened without us noticing it. One of the ways we able to help in order to achieve green earth is by starting to save energy at our own home. In order to create awareness amongst the general population, an awareness application on saving energy at home has been develop. This application uses an interactive Augmented Reality (AR) technology which able to give the user some tips on how to save energy focusing at home. By implementing the AR technology, this app will allow the user to scan the flash card and thus, information regarding electrical appliances energy's usage will revealed. For example, when we scan a refrigerator flash card, a 3D animation model will appear and can be rotated. Then, there are audio to explain the amount home energy used and the details. Other home appliances including in this apps are the television, computer, air-conditioner and many more. Then, there is also a mini quiz to test the user's knowledge by asking the user a few questions and a score will be given at the end of the mini quiz. Some of the additional features include videos with other ways to save energy at home. There are also images slideshow of energy-saving logos found on electrical appliances. This application also have icon to jump on related websites. Hence, a fun and interesting application created to bring awareness to save energy in home among general population.

ABSTRAK

Pada masa kini, ramai orang cenderung menggunakan tenaga dengan sewenang-wenangnya. Ini termasuk tenaga yang kita gunakan di rumah, pejabat, bangunan-bangunan dan institusi. Kadang kala, penggunaan tenaga yang berlebihan berlaku tanpa kita sedari. Salah satu cara yang dapat kita lakukan untuk mendapatkan dunia "bumi hijau" adalah dengan mula menjimatkan tenaga di rumah masing-masing. Demi mewujudkan kesedaran di kalangan masyarakat umum, aplikasi "AR Technolgy for Awareness to save energy at home" telah dicipta. Aplikasi ini menggunakan teknologi Augmented Reality (AR) interaktif yang dapat memberi pengguna beberapa tips tentang langkah penjimatan tenaga di rumah Dengan menerapkan teknologi AR, aplikasi ini akan membolehkan pengguna mengimbas kad flash dan dengan itu, maklumat mengenai penggunaan elektrik tenaga yang digunakan dari peralatan akan dinyatakan. Sebagai contoh, semasa mengimbas kad flash peti sejuk, model animasi 3D akan muncul dan dapat diputar. Kemudian, terdapat audio yang menjelaskan jumlah tenaga rumah yang digunakan dan penerangannya. Peralatan rumah lain adalah termasuk televisyen, komputer, penghawa dingin dan banyak lagi. Kemudian, terdapat juga kuiz mini untuk menguji pengetahuan pengguna dengan mengajukan beberapa soalan kepada pengguna dan skor akan diberikan pada akhir kuiz mini. Beberapa tambahan adalah video berkaitan langkah lain untuk penjimatan tenaga di rumah. Terdapat juga gambar luncur dengan beberapa gambar logo penjimatan tenaga yang terdapat pada peralatan elektrik. Aplikasi ini juga mempunyai ikon untuk membolehkan pengguna pergi ke laman web yang berkaitan. Oleh itu, aplikasi yang menyeronokkan dan menarik dicipta untuk memberi kesedaran untuk penjimatan tenaga di rumah antara kalangan semua masyarakat.

TABLE OF CONTENTS

PAGE

LIST OF TABLES

PAGE

LIST OF FIGURES

PAGE

LIST OF ABBREVIATIONS

FYP	**-**	**Final Year Project**

LIST OF ATTACHMENTS

Chapter 1: INTRODUCTION

1.1 Introduction

Augmented reality (AR) is different with Virtual Reality (VR). It is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information. (Schueffel, 2017). Sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory. Augmented reality is related to two largely synonymous terms, which are mixed reality and computer-mediated reality. In virtual reality (VR), the users' perception of reality is completely based on virtual information. In augmented reality (AR) the user is provided with additional computer generated information that enhances their perception of reality.

Today, AR are merged together with 3D Objects to create such interesting technology enhancing its functionality to give users' experience on their devices, and will be continue to be used in future technology implementation. The use of AR nowadays are mostly for educational and gaming purposes. Since it used widely in global now, AR are the most suitable technology to use for creating awareness to save energy at home for the general populations.

As we know in our modern world now, energy are preference to human activity for cooling and heating homes, preparing food, powering travel, and producing goods, among many other purposes. Total energy used is related to population growth and economic output, but there is much variation in the effectiveness of energy use across societies. The amount of energy used, as well as the quality of energy, drives economic productivity; more efficient and flexible energy sources like liquid fuels and especially electricity are associated with higher productivity.

Hence, we need to create the awareness to general populations to save energy at home. Without realizing, the energy that we used every day are actually influence our environment. If we use them thrifty, we can reduce the amount of toxic and protect the our ecosystems from destruction. With that, we will able to contribute to a healthy and green earth world.

1.2 Problem Statements

The identified problem statements are:

i. Most of the people nowadays does not aware of their amount energy consumption.

- People tend to use more energy at their home in their daily life. Some of them are not aware of the electrical appliances that use a lot of energy consumption at their house.

ii. They also not being exposed to the ways of saving energy even at their own home.

- Most of the people and kids nowadays had been given a luxury life by their parents. From that, they never know ways to conserve energy even at their home.

iii. The monthly bills are being costly and they do not know the reason.

- At the end of every month, their monthly bills are high and some of the people never know the reason and just paying them out of curiosity. They actually can save more on their monthly bills by practicing the way to to save energy in their home.

1.3 Objectives

To clearly solve the following problems, the objectives are needed to be clearly stated. This project objectives are as following:

1. To investigate the characteristics of AR technology in providing useful information to the general population.

2. To develop an AR application in promoting saving energy awareness at home.

3. To evaluate the functionality and the usability of the developed AR application in promoting saving energy awareness.

1.4 Scope

This app is intended especially for general population such as kids, young adults, teenagers, adult and senior citizen. People with any age who want to know about ways to save energy at home and maintain green earth are recommended to use this app to understand and learn with fun methods.

1.5 Project Significance

The significance of this project is to be useful to the people in any age for their awareness of saving energy at home. This application will give a big impact to anyone who are using it and most importantly it is fun and easy to understand. With the future of AR technology, it will be more people in future to use this application to educate their loves one and family or their kids for further generation. The additional future like fun quizzes need to be added and improve to enhance their knowledge of way to save energy in their home.

1.6 Conclusion

In conclusion, the main objective of this AR application development is to bring awareness to general population to save energy beginning at home. Wasting energy can have significant impact to environment and more importantly to the greenhouse effects. For the next chapter, literature review and project methodology will be explained.

CHAPTER 2: LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

In this chapter, literature review and project methodology will be explained. They will be conducted in order to complete this AR Technology development. Previous studies and researches are very important in the literature review. The purpose of the literature review is to find, gathering, analyses and conclude from every material that we found and studied. For this AR project, the study found that Agile Software Development has been used for this project. The requirements from this project are observed and comparisons were made through the previous projects and then the problems are identified where new contributions could be made. The comparison are including multimedia elements, user control, user experience for design, consistency, system visibility and project assistance documentation. All the software and hardware requirements are stated to apply the requirements for this project.

2.2 Domain

AR can generally be defined as the enhancement of a real-world environment using layers of computer-generated images through a device (Guttentag, 2010; Jung et al., 2015). Guttentag (2010) posited that AR is a type of VR. This echoes Milgram, Takemura, Utsumi, and Kishino (1994)'s view that AR and VR are related and it is valid to consider the two concepts together. Augmented reality is related to two largely familiar terms which are mixed reality and computer-mediated reality. Augmented reality (AR) are vary from virtual reality (VR) in the sense that in AR part of the surrounding environment is actually real and just adding layers of virtual objects to the real environment.

On the other hand, in VR the surrounding environment is completely virtual. A demonstration of how AR layers objects onto the real world can be seen with augmented reality games. For example, WallaMe is an augmented reality game application that allows users to hide messages in real environments, utilizing

geolocation technology in order to enable users to hide messages wherever they may wish in the world. Such applications have many uses in the world, including in activism and artistic expression.

2.2.1 About Green Earth

Green Earth is an ambition that everyone should thrive for as the planet is inhabited by us, hence it is our duty to keep it healthy. Each and everyone should take the declination of this planet seriously by doing their part in Green Planet as a goal. All the projects related will ensure a healthy and pollution free environment around us so that we can continue living in this one giant global ecosystem.

Green Earth will giving the better place to everyone in the world. Nowadays, a lot of new disease news keep arising. The cause of the disease are actually the pollution from the human activity itself. We are not aware of how to conserve the green earth instead keep using the energy wisely. Practicing energy saving can help in achieving the eco-friendly life cycle. Not doing pollution and controlling the illegal activities to ecosystem made by human will be a big help. The natural pollutant filter are the trees. So each time when a tree is cut down, we are destroying something which supports human life balance. If we are avoiding that, lots of lives can be saved, which also include safety of other living organisms existing in this planet. Pollution is the important factor that has made people to worry about the planet. Urban areas are the most affected ones because there are lots of vehicles land which pollutes the surroundings. The carbon dioxide in takers are cut down in order to increase the infrastructure of the cities. Water is also as important as air, without water life on this planet is impossible. Keeping the earth green means we are improving the quality of water and free them from the pollution waste.

The purpose of the application is to develop an Augmented Reality mobile application in promoting saving energy awareness especially regarding home appliances. This application will able to let us scan the flash card with some electrical appliances at home. For example, when we scan a refrigerator card, it will appear in 3D and there are some animation moving in the model. Then, there are audio to explain the amount home energy used and the details. User can choose the menu to see the amount energy used for that appliances and also the way to conserve the energy. It will

repeat the same for air-conditioner, plugs, and lamps. Then, there is also a mini quiz that asks users to answer a few questions and get a score. Some of the additional features are like videos with other ways to save energy at home. This application also have icon to jump on related websites.

2.2.2 The characteristics of Augmented Reality

Augmented Reality is the combination of real-time elements and virtual features that we can see as digital in real world environment. From that, there are also augmented by computer-generated sensory and produce sound, graphics, video and also GPS data. There are a few basic characteristics of Augmented Reality.

Firstly, it can overlay of real and digital world. It makes Augmented Reality different and more attractive platform for learning and games. For this application, 3D model of home appliances appear in digital world inside the smartphone. But we can look at it like it is real. Next, Augmented Reality is a real-time interaction. It is independent of time and space, global, fragmented, direct and immediate communication, simultaneously synchronous and asynchronous. The third characteristic of Augmented Reality are it is registration and alignment in 3D. The 3D form make it look immersive to the users.

2.3 Existing application

This section describes and discusses the existing energy saving application currently available.

2.3.1 WWF Free Rivers App

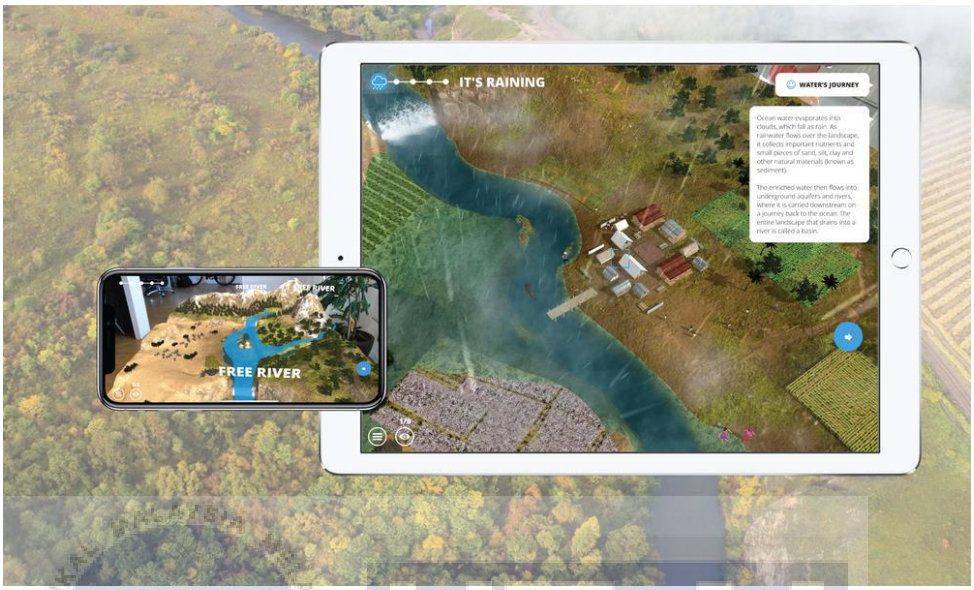


Figure 2-1 WWF Free-Flowing Rivers AR Apps

Figure 2.1 refers to WWF Free Rivers AR application, which basically let you control the world in your palms. It is very immersive as you can interact with almost any living creature in its world. Users can learn from this application by going through series of stories on how an ecosystem can thrive around a river. Users can also try to block the river to see a different outcome and then use alternative method in keeping the river interconnected.

To use this application is quite easy, as many other AR application, simply enable the AR feature in a device and simply point towards a surface where the ecosystem will be visible. Follow the in-game walkthrough and tutorial to further understand the vitality of rivers related matters and issues.

The application appeals a lot to younger audiences as low as toddlers. The clarity of the visual as well as the information conveyed can help them to better under on what a dam could do to a river and the ecosystem around it. Speaking about any problem seems a bit depressing, but as the application is an eye catcher, it is also packed with calming and friendly narration which helps in making children

understands better and not affected emotionally. Although this app are not about saving energy at home, it is related to green earth which give awareness to audience about saving free- flowing rivers.

2.3.2 Wasteworld!

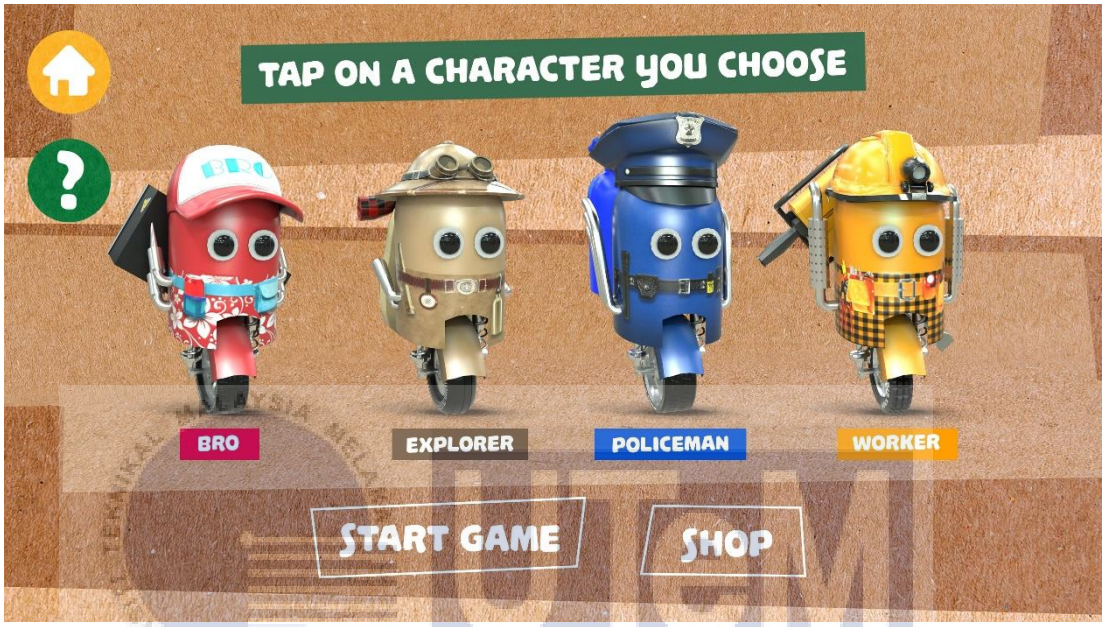


Figure 2-2 Wasteworld Front Interface

Figure 2-3 Wasteworld gameplay

The team at Apptension launched an AR application called Wasteworld (Figure 2-2 & 2-3.). The gameplay of the application covers waste management in an interactive manner. As the previous one, it appeals a lot to children in learning through playing games.

Since AR is the new thing, it comes natural for them to utilize this technology when developing the application. App Scaffold was use in the making of this application and took a time span of 6 weeks to be completed.

2.3.3 Marley the Turtle and the Cube of Recycling

Figure 2-4 Magic cube to scan the cube of recycling

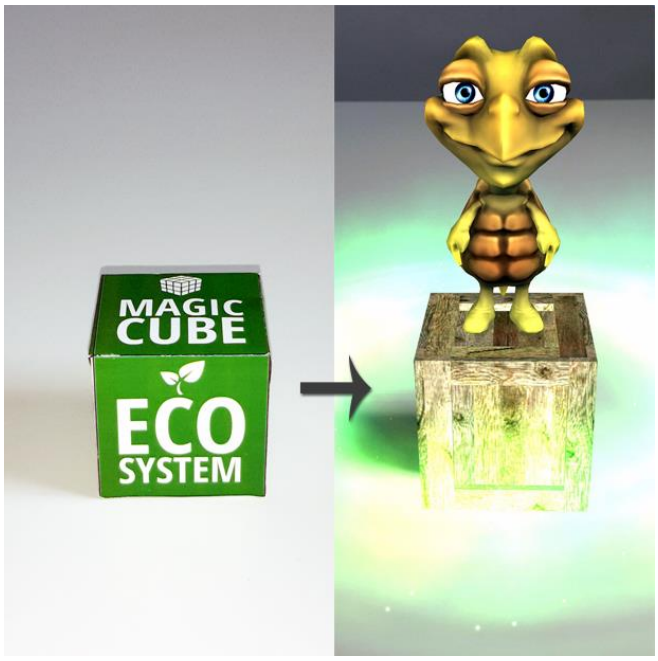


Figure 2-5 Marley the turtle

Marley the Turtle are an Augmented Reality app which talks about recycling as shown in figure 2.3 and figure 2.4. The cube of Recycling is an interactive game where Marley the Turtle, through a portable device, comes alive and plays with kids a funny game related to recycling. Kids learn in a funny way about an important subject. But first, they have to build the cube. So build the cube, launch the app, and enjoy learning.

Play with Marley, we can ask him to tell us something new about recycling. Then, we can also answer to the questions he does and listen to Marley talk like us. More than 100 questions and facts! It is also compatible with Android and Ios. So, it is an education AR apps to teach kids to recycle too.

2.4.3 Summary of the Existing Application

Table 2-1 below shows the comparison of the features towards three existing application:

Table 2-1 Comparison of Existing AR Green Earth Application

	WWF Free Rivers App	**Wasteworld!**	**Marley the Turtle and the Cube of Recycling**
Green Earth Informations	Yes	Yes	Yes
Interactivity and Usability	Yes	Yes	Yes
User Interface	Yes	Yes	Yes
Special Features	Narrative storytelling	Game	Fun Quiz

Based on the analysis with these three current application, it can be conclude that all of three application have their own unique way to attract user's attention. All three of them giving the useful information to maintain green earth and healthy natures. But most of them are focusing to kids as users. They are giving early education using AR technology to protect the natures and environments.

In conclusion, this project are using 3D object and moving animation as attraction. Furthermore, a narrative information are available to give convenient for user to understand the content. Since this current project development are focusing to general population, I hope it will be great benefits to any users who are using this application to maintain green earth with AR technology.

2.4 Project Methodology

The project methodology used in this AR technology to promote awareness to save energy at home application is Agile Software Development. This sub-topic will explain more about the process of this methodology.

In software development, Agile are about discovering requirements and develop the solutions through the efforts together with the target users and possible customers. The requirements, design, development, testing, deployment and review phases need to be undergoes throughout the agile methodology.

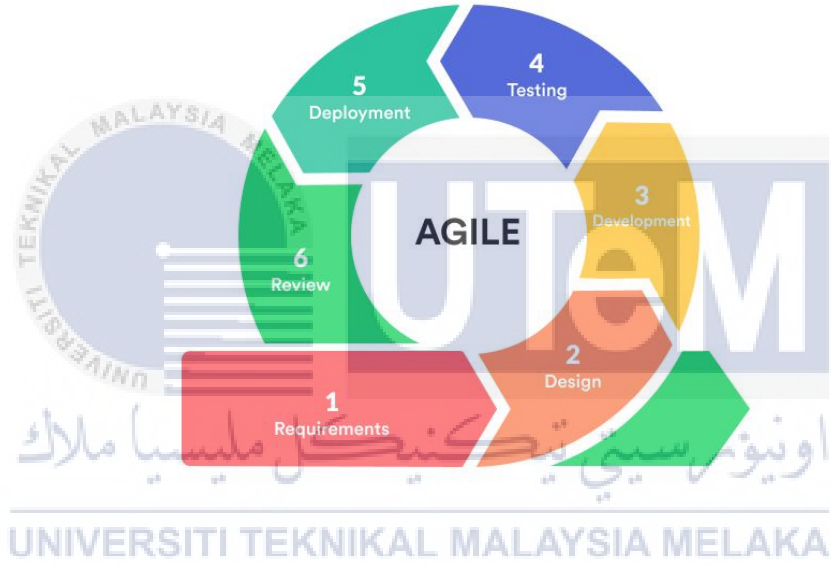


Figure 2-6 Agile Software Development Methodology Chart

1. Requirements phase

The requirements and proper planning are needed in this phase at the beginning of developing this project. A lot of research and the installation of software are occurred during this phase. Most of the time are being spent at this phase to find out the most convenient and better software to use. The planning are created based on the objective and problem statements.

2. Design phase

Some sketches and application flow of each interface are done for this system to see how it looks like and it also being visualize through the diagram to make the developer and user easily understand the flow of this application. It will help in convenient progress of application development. The user interface and user experience of the system are being planned and designed properly for better user-friendly application.

3. Development phase

Development phase is the biggest part in the project lifecycle. In this phase, a lot of time are needed to build a lot of components and elements such as modelling, animation, menu interface, audio implementation, coding, and exporting. This phase are crucial to make sure the application works well without error and bugs in future. It is also a complicated phase which the developer need to connect everything in one application and build it in android or IOS builder for the next step.

4. Testing phase

After the application are build, now the testing process continue to ensure the project are functioning well and have a good performance without error or abnormality from the application. When the application works well, the application now will be given to some of the user to use. The user may experiencing any unrelated or unsuitable elements or they are just having good experience. From those, the feedback will be collected.

5. Deployment phase

In this phase, the deployment will be create from the testing phase based on users' experience. The application will be improved in this phase and then it will be more testing step again until the project are acceptable by the users. Any elements and features will be deployed to make it accessible to users and match all the requirements.

6. Review phase

Review phase is the last phase of this Agile Software Development process. Once all the development above are completed, the review of the progress of the project has made towards complete the requirements. Reviewing the project are crucial to look back the ideas, resolving problems during the previous phase and also comparing the current project with the other project before.

2.5 Project Requirements

Project requirements are includes software requirements, hardware requirements and also other requirements.

2.5.1 Software Requirements

The AR application development requires some of the software. Table 2-2 below shows the software needed to develop this project.

Table 2-2 Software Requirements

Software	Description
Unity 2020	Platform for AR Development
Cinema4D	Platform to create 3D Modelling and animation
Visual Studio and Android Studio	Platform to create programming and project compiling
Adobe Audition	Platform to edit the audio of narrative telling
Adobe Premiere Pro	Platform to edit the video of demonstration
Microsoft Word	Documentation and Report
Microsoft Powerpoint	Platform for Presentation

2.5.2 Hardware Requirements

This AR application development requires the following hardware. Table 2-3 below shows the hardware needed to develop this project.

Table 2-3 Hardware Requirements

Hardware	**Description**
Personal Computer (Laptop)	For all working purposes
External Hard Disk	To keep the data
Android	To build the app together and to use the application

2.5.3 Other Requirements

The other requirements needed to develop this project are in Table 2-4:

Table 2-4 Other Requirements

Other Requirements	**Description**
Vuforia (www.vuforia.com)	Target Market

2.6 Conclusion

For conclusion, literature review and methodology has been explained in this chapter. Agile method has been used as project methodology for this project. This is because Agile Methodology model breaks down products into the details and well-managed phases and performs a quick process to meet user requirements and needs. Furthermore, the previous or existing system had been compared to this current project to identify the features and possible improvements. All the software and hardware requirements are stated to apply the requirements for this project.

CHAPTER 3: ANALYSIS

3.1 Current Scenario Analysis

This chapter analyzes current system problems and details of this AR in promoting energy saving awareness at home project requirements. Current system scenarios will be discussed with this analysis, solutions are found and used to improve previous systems.

This chapter will also describe the problem analysis based on the system scenarios that have been investigated. Analysis is also done on project requirements analysis including sub-topics needs analysis, user analysis, technical analysis and other requirements. Several diagrams are used to illustrate the analysis of the requirements of this project.

3.2 Requirement Analysis

Analysis must focus on content information of the project or application, its functions and the objective we must achieve. Identifying needs are crucial before proceeding to the next phase to prevent the project from break down or problems such as not being able to meet user expectations. An unreliable system is a system that has errors. Details of data requirements, functional requirements, software requirements, hardware requirements and network requirements are also being break down to carefully identified. For this project, the requirements are divided into four sub-conditions. Its sub-requirements are needs analysis, user analysis and technical analysis.

3.2.1 Project Requirement

Augmented Reality (AR) can be simple but interactive in their functionality. Besides, the advances in its technology can make it interesting and beneficial for most importantly in education purpose. AR can allow user to interact with virtual things but in their reality environment. It is not very immersive to user but can make they do things in virtual ways. Since AR can mostly be used in mobile devices like smartphone and tablet, I hope it is convenient to all the target audience since most of people had their own devices these days. To use this application, user need to install additional software or application on their mobile devices.

3.2.2 User Analysis

The aim of developing this project is to convey beneficial information about awareness of saving energy at home. User can interact with the menu, fun facts, ways to conserve energy and mini quiz. AR interface are virtual, hence, users can feel more interested in something new and interactive. Hopefully this AR application is effective for any age of the target users.

3.2.3 Technical Analysis

Technically, the software used to develop this project are Unity to create the AR. Next, Cinema4D are used for 3D modelling and animating purpose.

3.2.4 Requirement Gathering

The preliminary method used for requirement gathering are questionnaire method for survey analysis. The main purpose of this survey is to obtain initial background information from the respondents regarding their current awareness of energy saving knowledge and also their knowledge on the AR technology. The questionnaires was created using Google Form. There are 10 questions in this form with 36 respondents' answers.

- Question 1

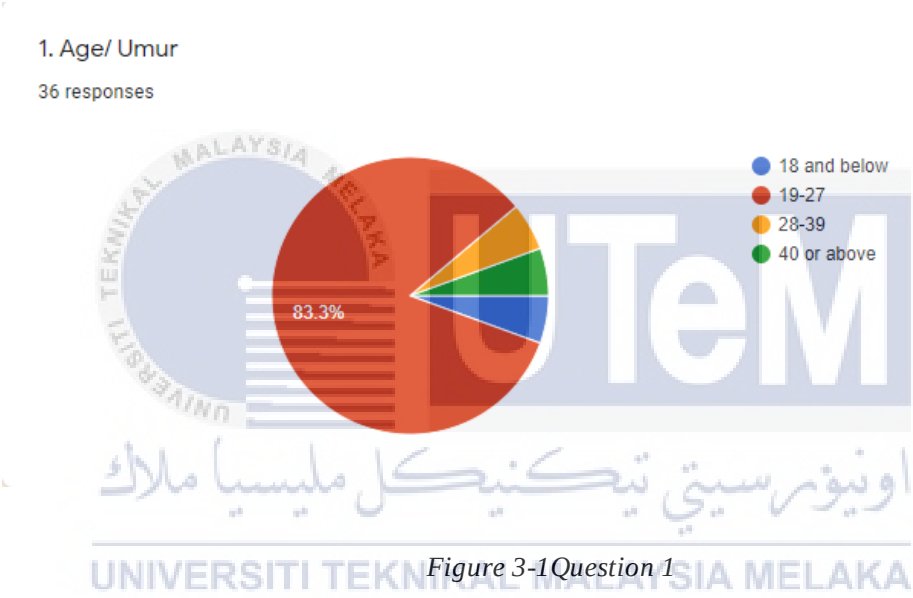


Figure 3-1Question 1

The question asked about respondents' age. As figures 3-1, 83.3% which is majority of respondents are in age 19-27. Others are from 18 and below, 28-39 and 40 or above. From the result, it is not well collected for general population respondents. But, it is still considered as respondent.

- Question 2

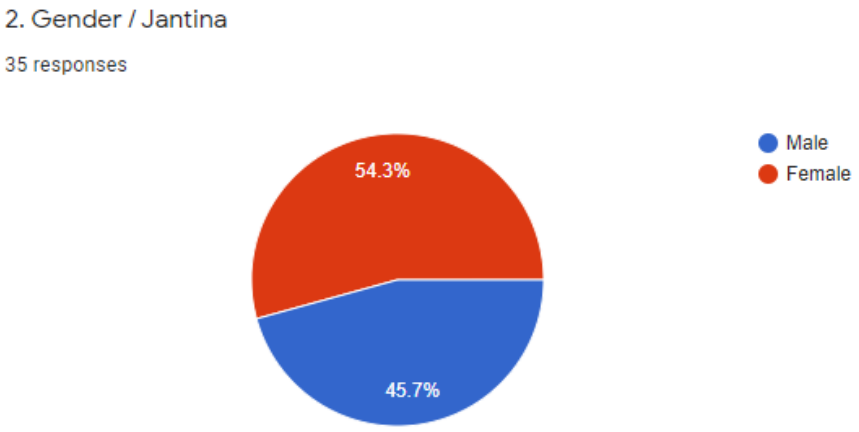


Figure 3-2Question 2

The question asked about gender. As figures 3-2, 54.3% are female and 45.7% are male.

- Question 3

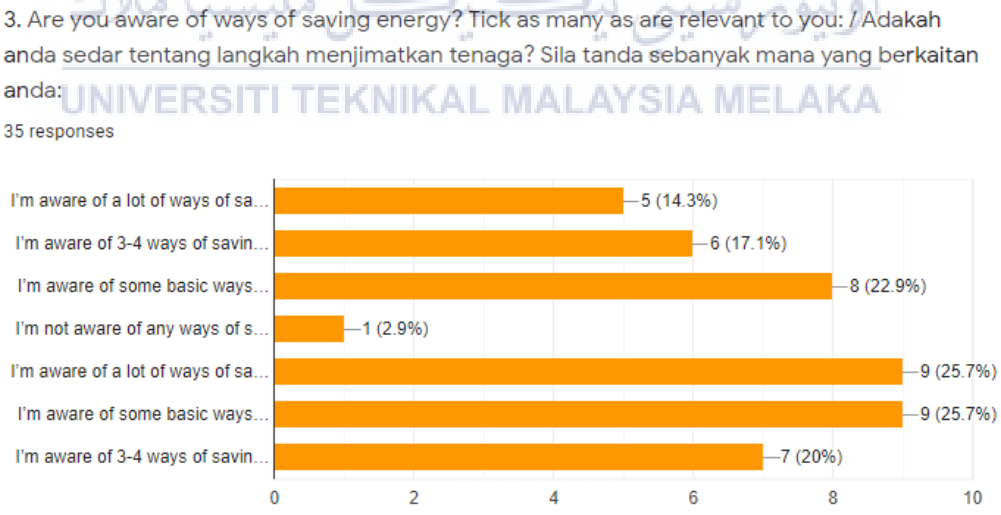


Figure 3-3Question 3

This question asked about the awareness of respondents towards ways of saving energy. Respondent need to tick as many as are relevant to them. From the Figure 3-3

majority of the respondent are aware of a lot ways of saving energy and also they are aware some basic ways of saving energy which is 25.7% for both. The least respondent answer are not aware of any ways of saving energy which is only 2.9%.

- Question 4

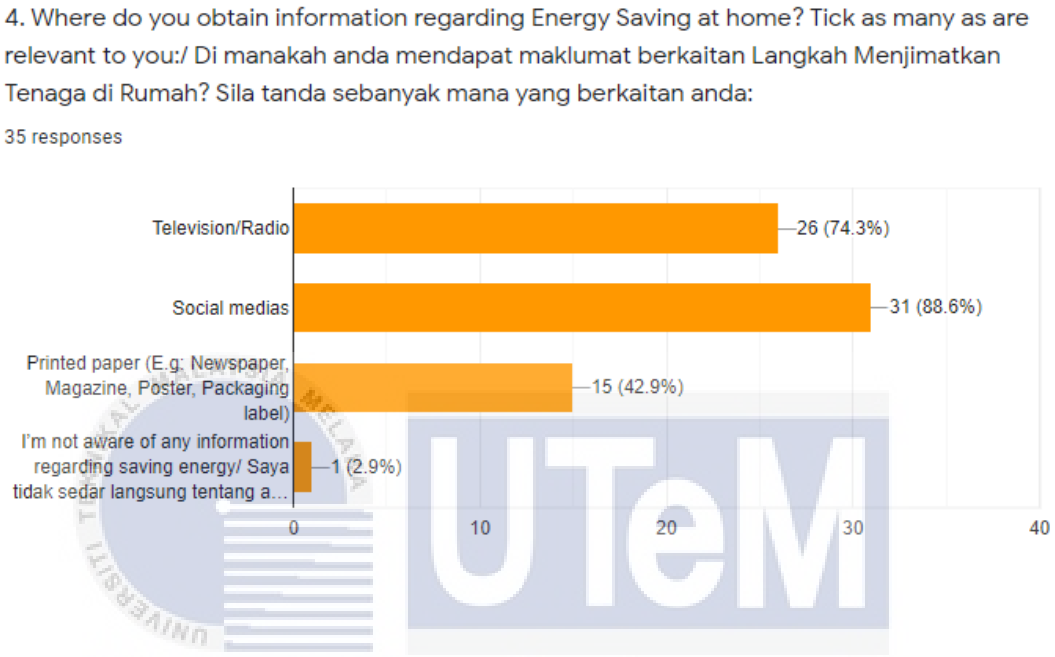


Figure 3-4Question 4

This question asked about where respondent obtain information regarding energy saving at home. Respondent need to tick as many as are relevant to them. Most of them obtain that from social medias with 88.6% and next is from television or radio with 74.3%. It is a good thing since it is only 2.9% of respondent who are not aware of any information regarding saving energy.

- Question 5

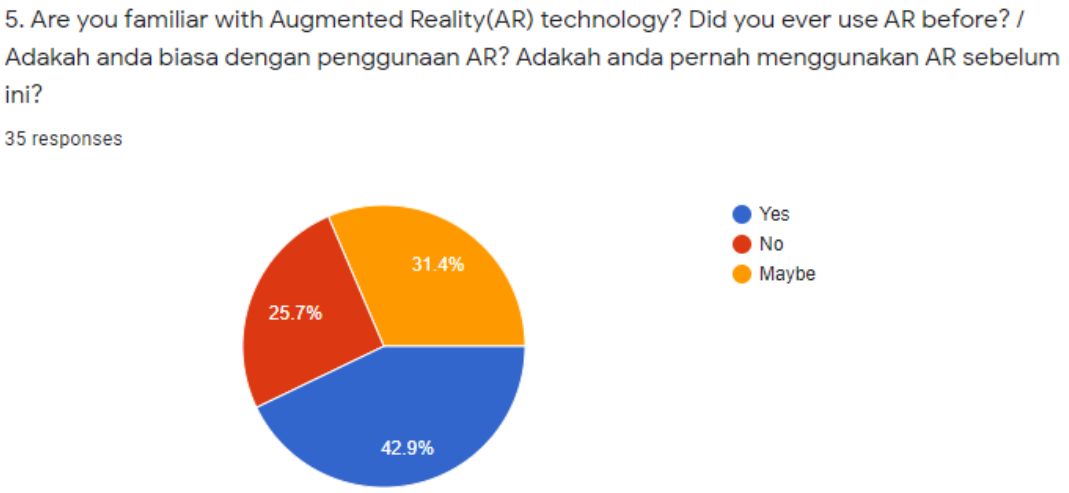


Figure 3-5Question 5

This question asked about is respondent are familiar with Augmented Reality (AR) technology and did they ever use AR before. Majority of respondent answered yes with 42.9% and the least of them said no which is 25.7%.

- Question 6

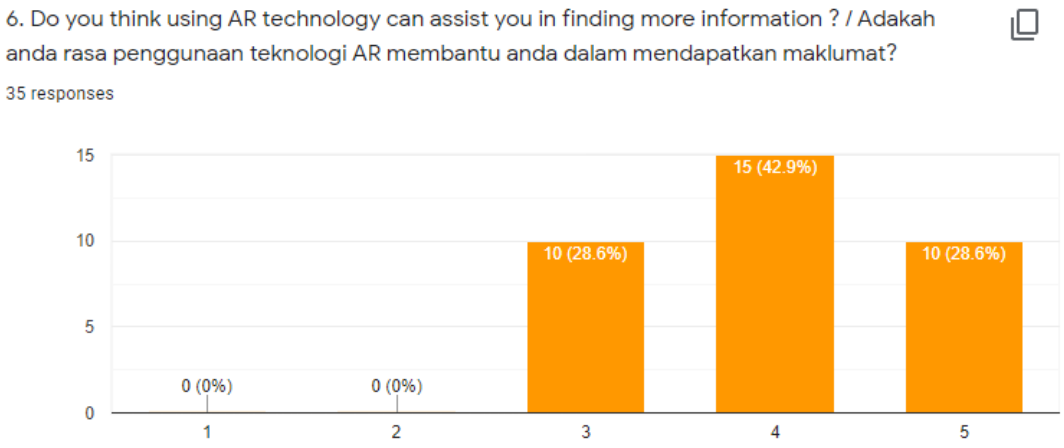


Figure 3-6Question 6

This question asked about is respondent think AR technology can assist them in finding more information. The respondent need to choose based on the scale from 0 not helpful to 5 extremely hopeful. In Figure 3-6, most of the respondents are think it is helpful with the scale of 4 with 42.9%. There are average percentage for scale 3 and 5 which is 28.6%.

- Question 7

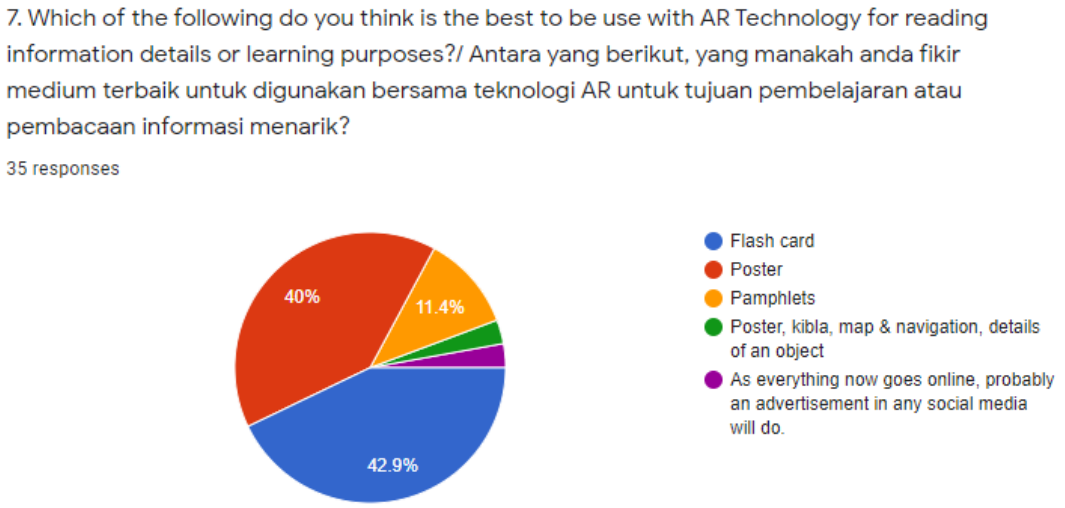


Figure 3-7Question 7

This question asked about which of the following they think the best to use with AR technology for reading information details or learning purposes. Based on Figure 3-7, majority of the respondent think flash card are the best use with AR which is 42.9%. The other opinion are including wanted AR to be used together with anything online or advertisement in any social media. From this, flash card will be implemented together with AR to be used in this project.

- Question 8

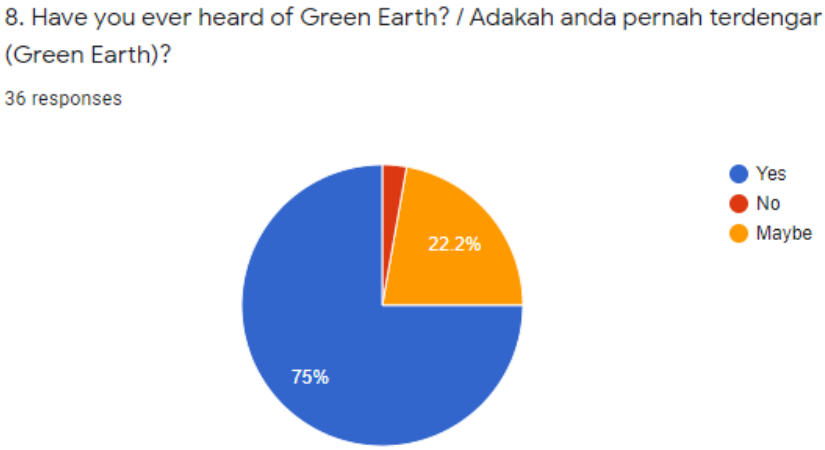


Figure 3-8Question 8

This question asked about is respondent ever heard of green earth. Based on Figure 3-8 most of them knew about that which is major number, 75%. It is a good news as it means they are familiar with saving energy.

- Question 9

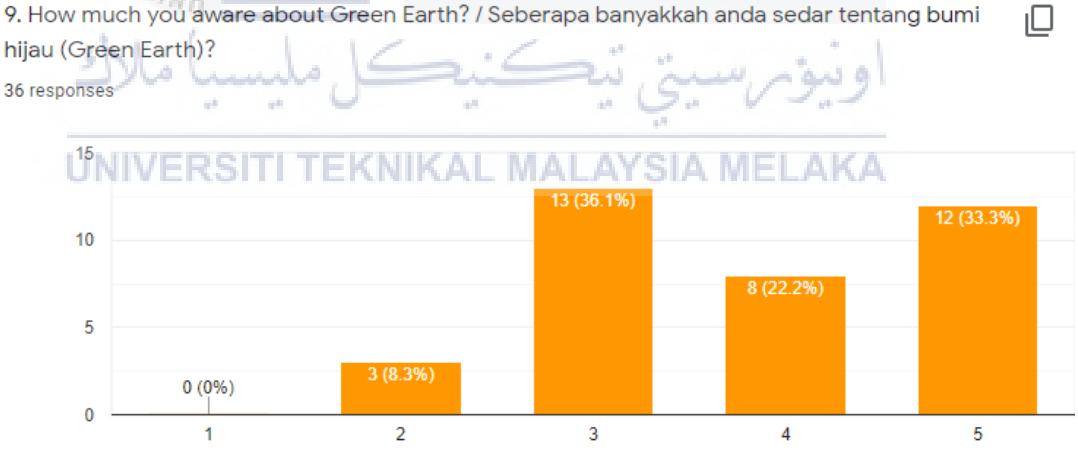


Figure 3-9Question 9

This question asked about how much respondent aware of Green Earth. Most of them are average aware which is half aware and half not with 36.1%. It is a little bit disappointed since they are not too much aware of it.

- Question 10

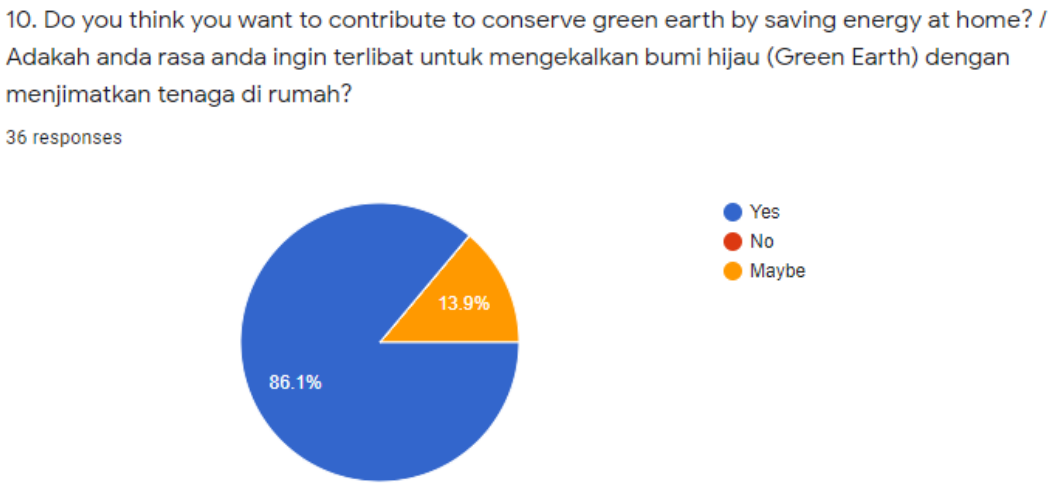


Figure 3-10 Question 10

This question asked about do respondent want to contribute to conserve green earth by saving energy at home. There are a good response from most of them with 86.1% based on Figure . The rest of them are think maybe and there is "No" response from them.

In conclusion, most of the people are not much aware about saving energy at home but in the same time they do want to be part of help to conserve green earth, too. In the other hand, not much of them know about AR Technology which it is a big opportunities to introduce this new technology to them in the same time can convey the awareness of saving energy at home. Next, based on this survey, most of the user prefer to use AR together with flash cards. They are also eager to try this application.

3.2.5 Software Requirement

In the development process of AR Technology for awareness to save energy at home, a few software is required in order to complete every task. The task is including modelling, animating, designing interface, video editing embedding the content into augmented reality application.

In order to develop this AR Technology for awareness to save energy at home application, these are the software needed to develop each of the task. The software needed are as in Table 3-1.

Table 3-1 Software Requirement

Software	**Description**
Unity	Platform for AR development and menu interface
Cinema4D	Platform for modelling and animating
Adobe Illustrator	Platform to design flash card
Adobe Photoshop	Platform to edit the image of image target
Adobe Premiere Pro	Platform for video editing in project
Microsoft Word	Platform for report and logbook writing
Balsamic Mockup	To design project function interface

3.2.6 Hardware Requirement

Table 3-2 shows the hardware needed to develop this project:

Table 3-2 Hardware Requirement

Hardware	**Description**
Laptop	To work with all the softwares
Printer	To print the flash cards
Android Device	To scan the flash card and make AR happens
IPhone 7Plus	Used for audio recording

3.2.7 Additional Requirements

Table below show the other requirement.

Table 3-3 Additional Requirements

Software	**Description**
Vuforia (developer.vuforia.com)	To implement with Unity to make AR possible to use
Quizizz	To create mini quiz
Buttonoptimizer.com	To generate buttons
Youtube	To get video cut content

3.3 Project Schedule and Milestone

Table 3-4 explains the milestones for PSM I and Table 3-5 explains the milestones for PSM 2.

Table 3-4 GANNTT CHART- PROJECT ESTIMATION

Date (week)/ Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Idea Proposal															
Submit Proposal															
Analysis on user requirements															
Modelling &idea content															
Animate &implement -test															
Submit Chapter I & II															
Make survey analysis															
Design draft interface															
Submit Chapter III															
Audio recording															
Produce flash card															
Implementation phase															
Create interaction															

System Testing															

Table 3-5 GANNTT CHART FOR PRODUCT IMPROVEMENT (PSM2)

Date (week)/ Task	1	2	3	4	5	6	7	8
Identify modules to be improved								
Product enhancement development phase								
Full product implementation phase								
Submit Chapter IV								
Testing material and platform preparation								
Alpha Testing								
Beta Testing								
Analysis Testing								
Submit Final Report								
Preparation of final product								
Product Demonstration								

3.4 Conclusion

For conclusion, analysis process are important to properly gathering requirements needed by the target users. A good plan of analysis and design requirements will avoid any untrack task since we are working on the project requirements itself. This phase as a whole is done to analyze the needs and requirements of users to correct, improve and make changes based on the users' needs. The initial questionnaires was carried out in order to obtain information of the respondents on the awareness of energy saving and the respondent's knowledge on AR technology. For the next chapter, the design progress of the project will be explained.

CHAPTER 4: DESIGN

4.1 Introduction

System design are very crucial in any project before it will fully developed. To design a system, we need to properly identify the elements, components, and architecture. It is to identify the requirements of the project to make it a well-developed project. A good planning of system design will assist the developer to work on the project throughout the development properly. It also explain how the system work and function for each of them and the navigation flow.

4.2 System Architecture

The following section covers theoretical model regarding system behavior which provide a foundation on the properties of related objects. The issue on practicality and notions are also an acknowledgement of the system design.

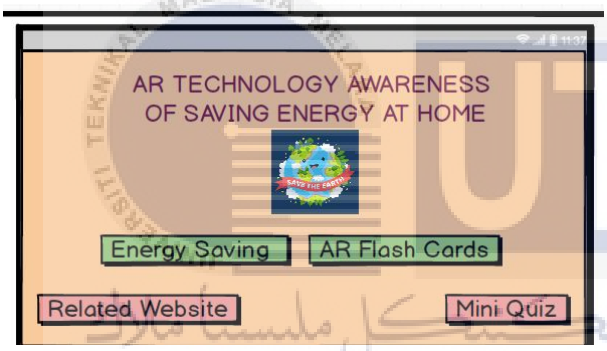
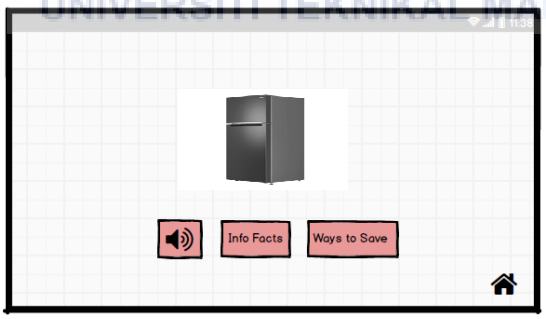
4.3 Preliminary design

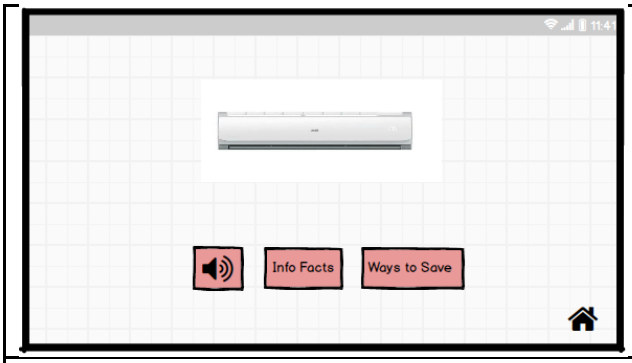
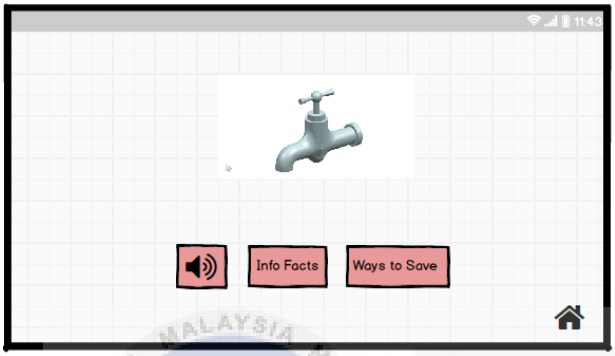
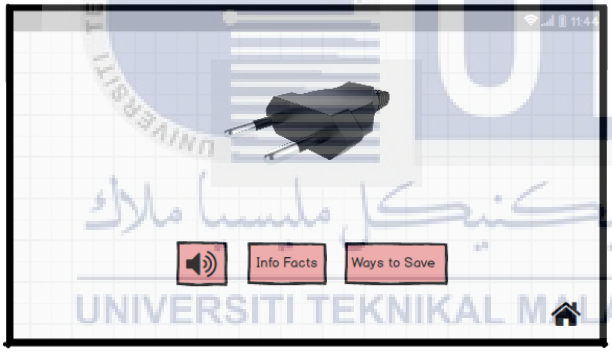
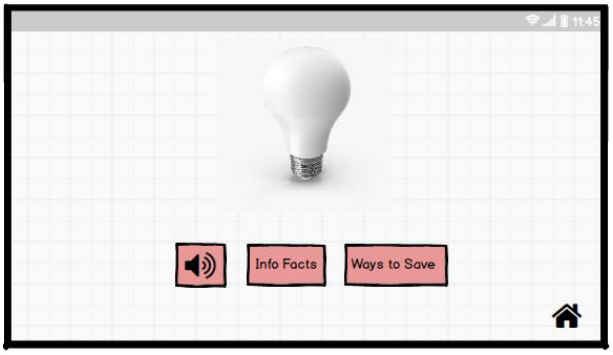
It is the initial stage of design phase. It involve the experiences, processes, interactions and strategies design. The initial design phase are vital to any project development especially AR application. This is because to ensure that developers develop Augmented Reality in the right way and meet the user's requirements. In this phase, there are AR development flow chart and storyboard design explained.

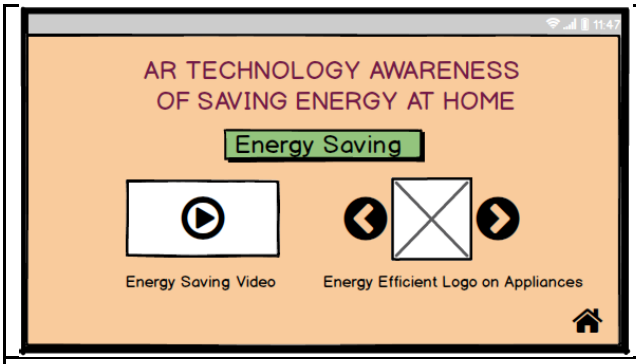
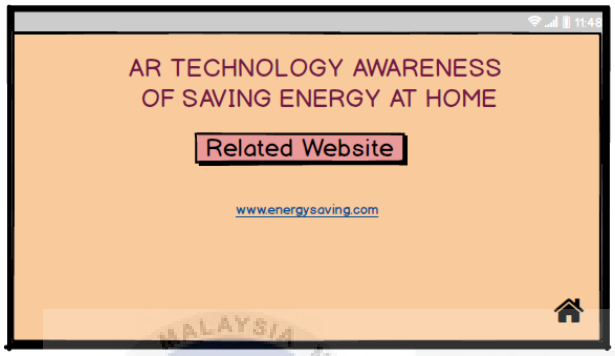
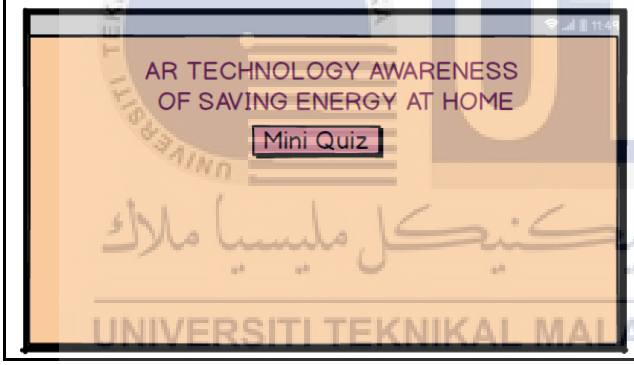
4.3.1 Storyboard Design

For the storyboard of AR project, it is about documenting an immersive experience within a wider field-of-view. Storyboards allow the design and development teams to determine the users' point of view (POV) from scene to scene to accurately detail surroundings, space and interaction. Table 4.1 below depicts the storyboard for the application.

Table 4-1 Storyboard of the application

Scene	Description
	**Scene 1:** Firstly, user click the application and the icon of unity pop out **Action:** User need to wait the application to load up and start
	**Scene 2:** This is the homepage interface to user when the application starts **Action:** User can choose 4 different menus and the "AR Flash Cards" menu is the main goals in this apps
	**Scene 3:** When user choose "AR Flash Cards" menu, the camera will open to the user **Action:** User need to scan the flash cards available and the animation will popup. The option menu also popup. User can choose any of the action.
	Scene 4: When user choose "AR Flash Cards" menu, the camera will open to the user **Action:** User need to scan the flash cards available and the animation will

	popup. The option menu also popup. User can choose any of the action.
	**Scene 5:** When user choose "AR Flash Cards" menu, the camera will open to the user **Action:** User need to scan the flash cards available and the animation will popup. The option menu also popup. User can choose any of the action.
	**Scene 6:** When user choose "AR Flash Cards" menu, the camera will open to the user **Action:** User need to scan the flash cards available and the animation will popup. The option menu also popup. User can choose any of the action.
	**Scene 7:** When user choose "AR Flash Cards" menu, the camera will open to the user **Action:** User need to scan the flash cards available and the animation will popup. The option menu also popup. User can choose any of the action.
	Scene 8: If user choose "Energy Saving" menu, the page of video and

	images related to how to save energy will appear. **Action:** User can click play to play video and also click next or previous for logo images
	**Scene 9:** This is page for "Related Website" menu. **Action:** User will jump to related websites
	**Scene 10:** This is page for "Mini Quiz" menu so user can revise back the things they learn regarding awareness of saving energy **Action:** User can answer the questions to get score and revise.

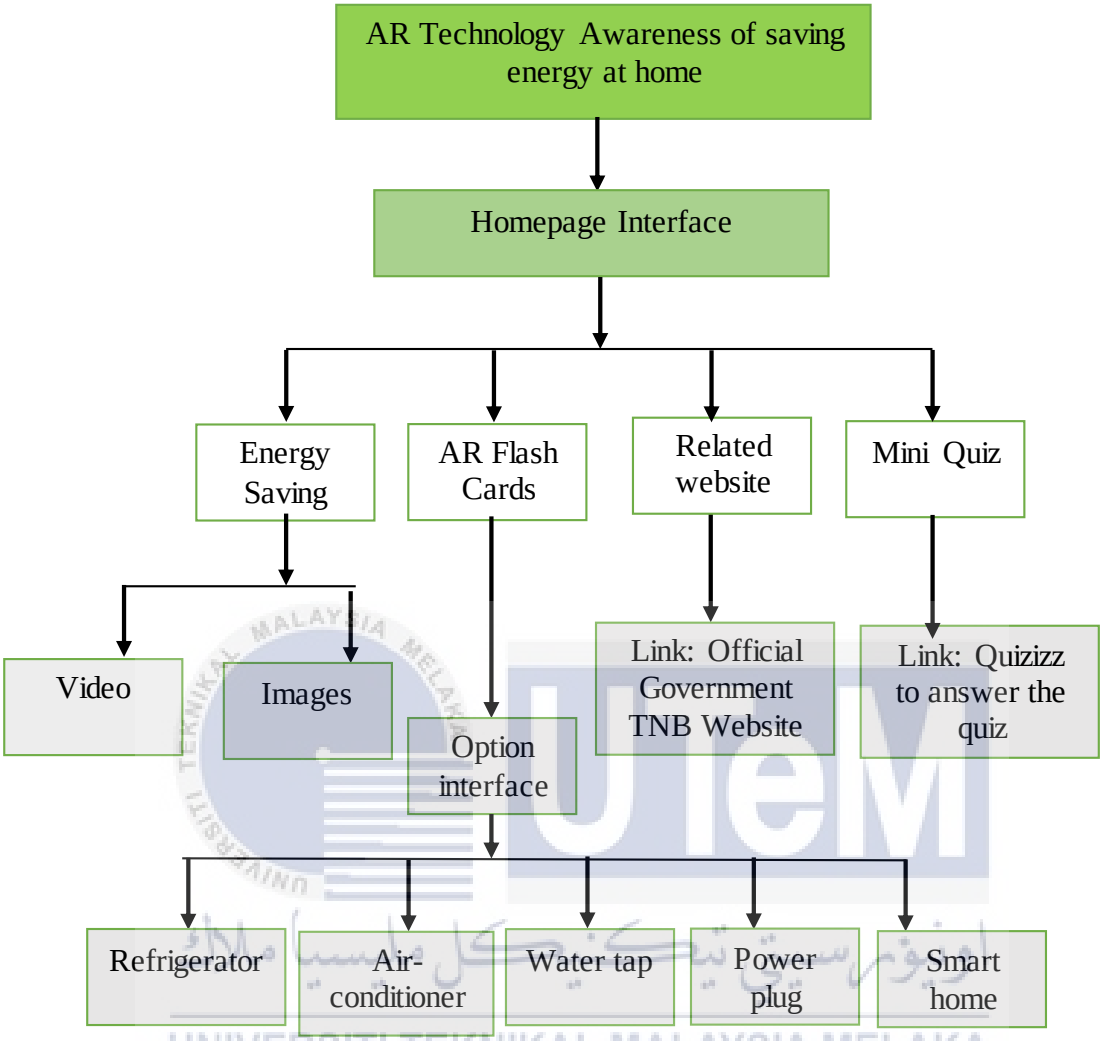
4.4 User Interface Design

User interface for the AR Technology Awareness of saving energy at home is described in the figure below:

4.4.1 Navigation Design

Navigation design as shown in figure 4.1 is a step by step flow that shows the application's navigation along the whole application. It is an application product with platform that provides the interactivity for user. It explains the actions user can do with the application. Figure below show the navigation for AR Technology Awareness of saving energy at home.

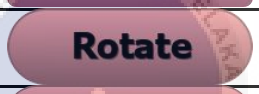
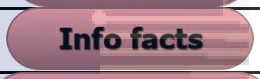
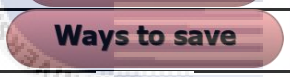
Figure 4-1 Navigation Design



4.4.2 Icon Design

Icon or button are important for an application especially that is implement on the smartphone. It is to ensure user can interact with the usability of the application. Icon created need to be visible and attractive to user's vision to make the user know which one to be clicked. In the Table 4-2, the icon design has shown:

Table 4-2 Additional Requirements

Icon	Function
	Button to energy saving menu
	Button to AR Flash Cards menu
	Button to related website menu
	Button to mini quiz menu
	Button to rotate 3D object
	Button to listen to audio: fact
	Button to listen to audio: ways to save
	Icon button to homepage
	Icon button to back

4.4.3 Output Design

In this section, output design is crucial in order to help user knows after the button is pressed. So the output would be shown. Below is the output and input design for AR Technology Awareness of saving energy at home application.

4.4.4 Media Creation and Integration

The short video on "Other ways to Save Energy at Home" was created and edited using Adobe Premiere Pro and the audio was recorded using smartphone and being raw imported to the software. The images info are searched on Google. The mini quiz was created using Quizzes website.

The flash card to be used with this application are created and designed by Adobe Illustrator. Then it is printed on A4 230gsm paper card. The designs are as shown in figure 4.2 – figure 4.6 below:

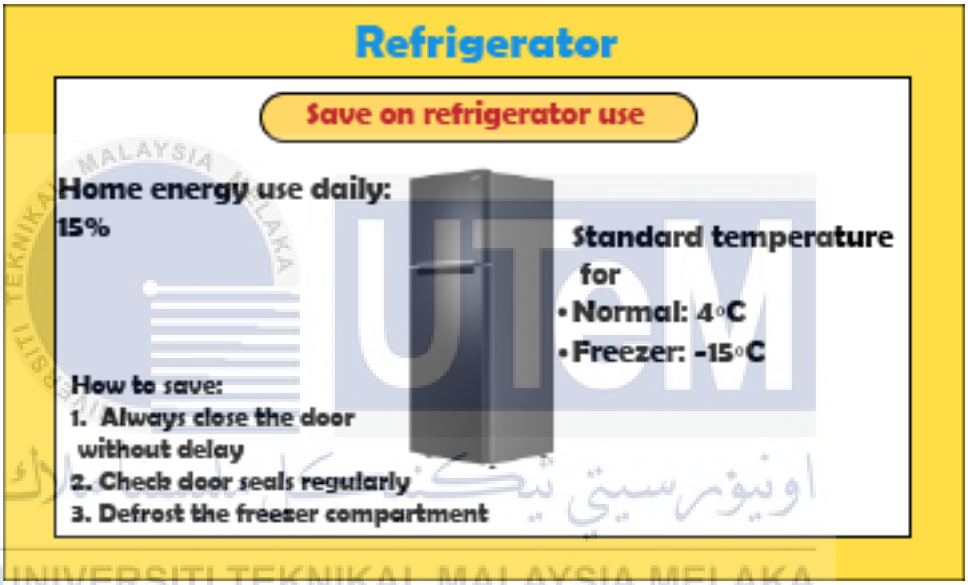


Figure 4-2 Flash card 1 Refrigerator

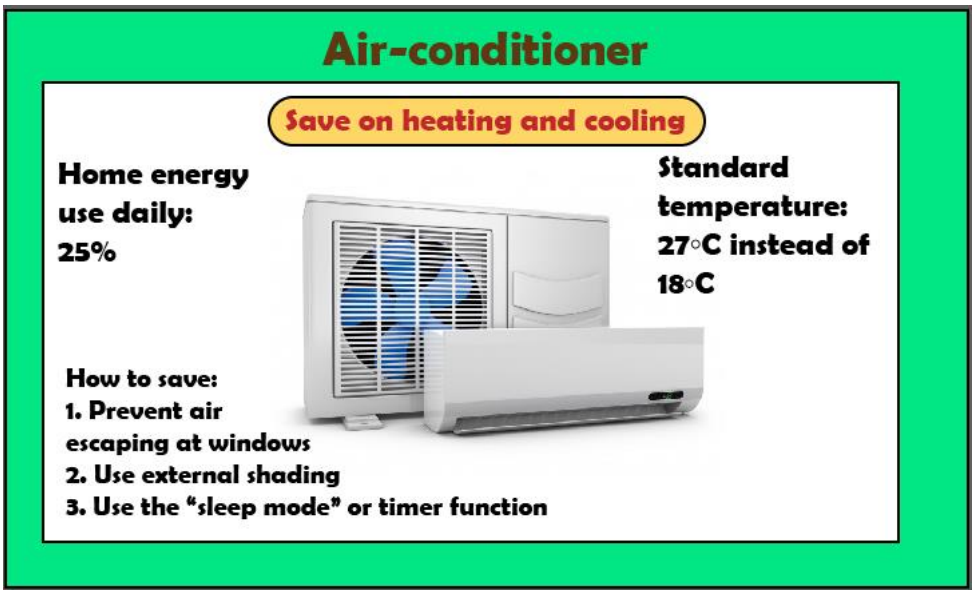


Figure 4-3 Flash card 2 Air- conditioner

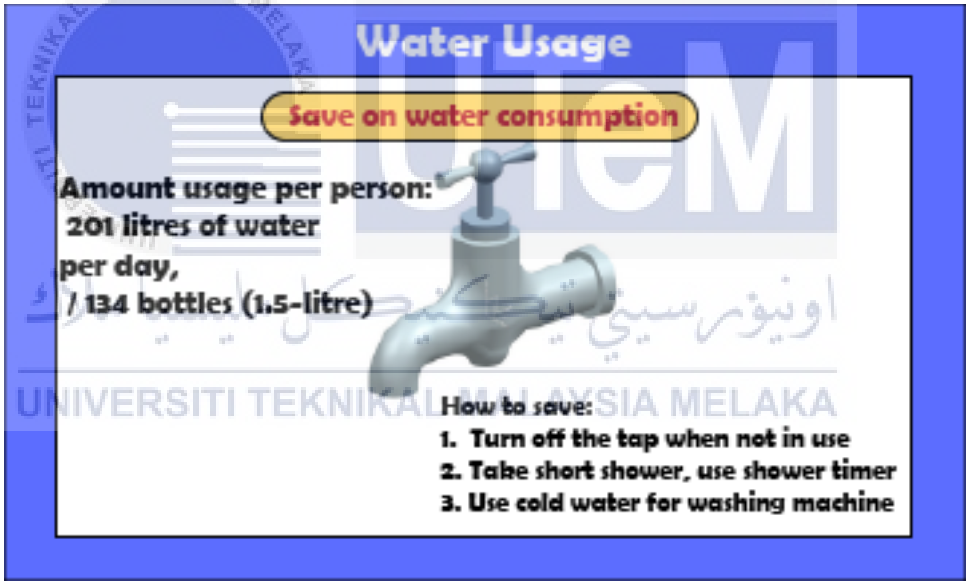


Figure 4-4 flash card 3 water tap

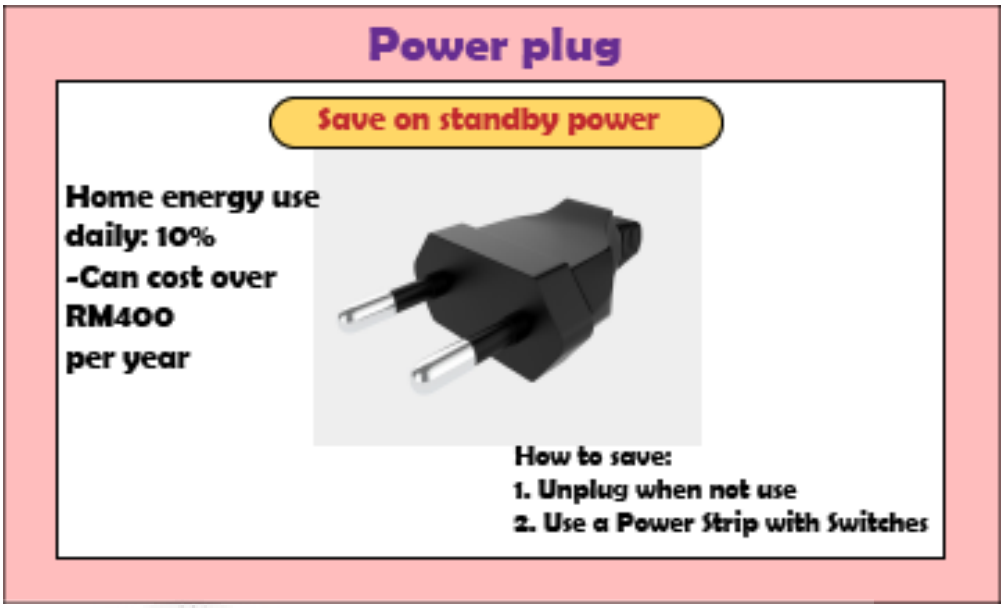


Figure 4-5 flash card 4 power plug

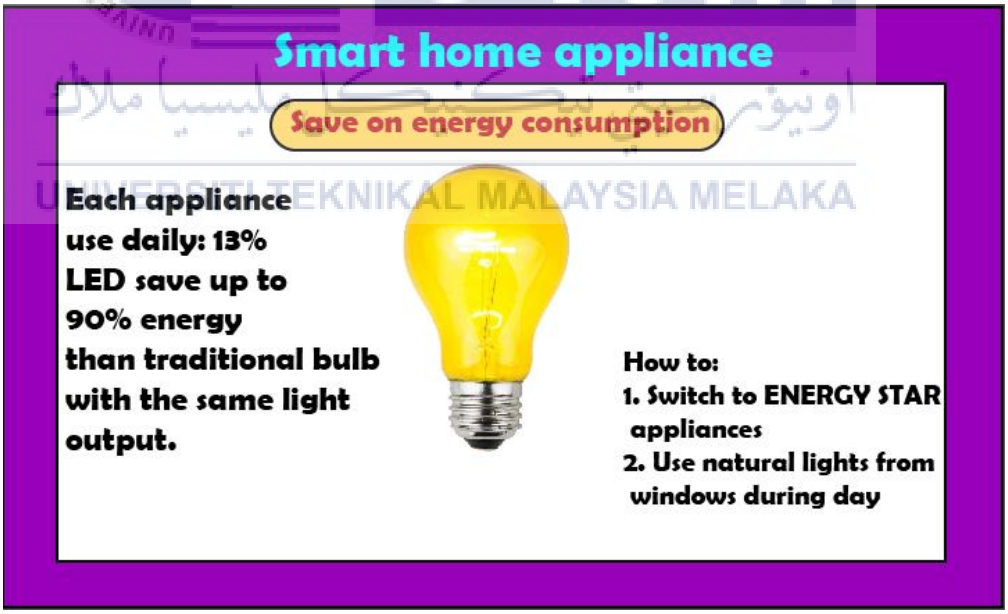


Figure 4-6 flash card 5 smart home

4.5 Conclusion

To conclude this chapter, the user interface and user experience are the main core of any application. A good design means user-friendly which can give user convenient in using the application without confusion. The system architecture diagram flow are also shown to explain the application interactivity to the user. For the next chapter, the implementation progress of the project will be explained.

CHAPTER 5: IMPLEMENTATION

5.1 Introduction

Implementation are the phase which every design and elements created in the design phase are implemented in the project to make a project functioning well. In this phase, the implementation process explained in several aspects which are media creation, the production of graphics, 3D model, the integration with the media and all configuration.

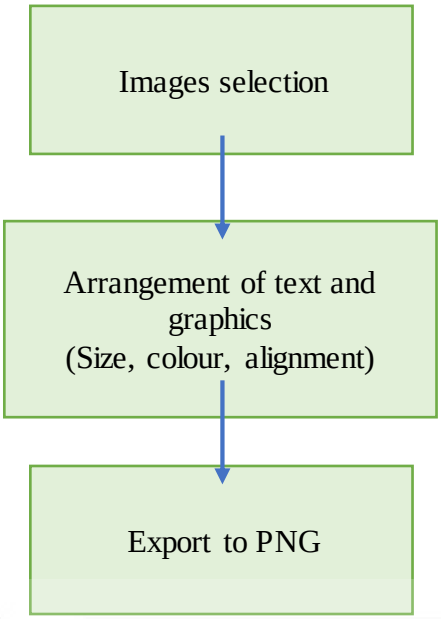
5.2 Media Creation

Media creation refers to the fabrication of contents such as images, graphics, animation, audio and video components for this project. Each step will be elaborated into details for clear breakdown. Compilation of each component is vital in producing the final output.

5.2.1 Production of Flash Card

Flash card is a physical resource which also act as a crucial integration of the project. It is comprised of information which would later helps in memory recollection. Being a versatile learning material, flashcards are commonly used in repetition method for a quick review hence the term flash card.

Flash card used in this project were created using attractive design to attract user's attention. The appropriate images and color was used to create an understandable flash cards. The suitable font types and sizes are used to make the fonts visible. The different color are used for every flash card to make the user easy to recognize the different contents of flash cards.



5.2.2 Production of Graphic

Graphics is the most important element in any multimedia product. Graphics will make a product more interesting. Graphic elements are generated for image target cards and vector assets for animation to be appeared. The colors, fonts and graphics used will be customized. This project implemented 2D graphics in the entire project created using Adobe Illustrator.

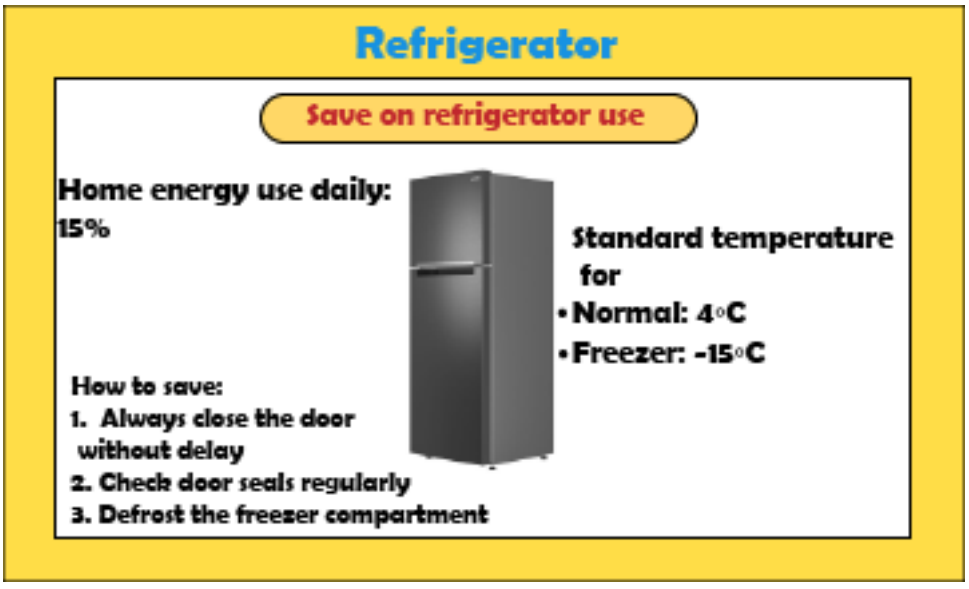


Figure 5-1 target image 1 Refrigerator

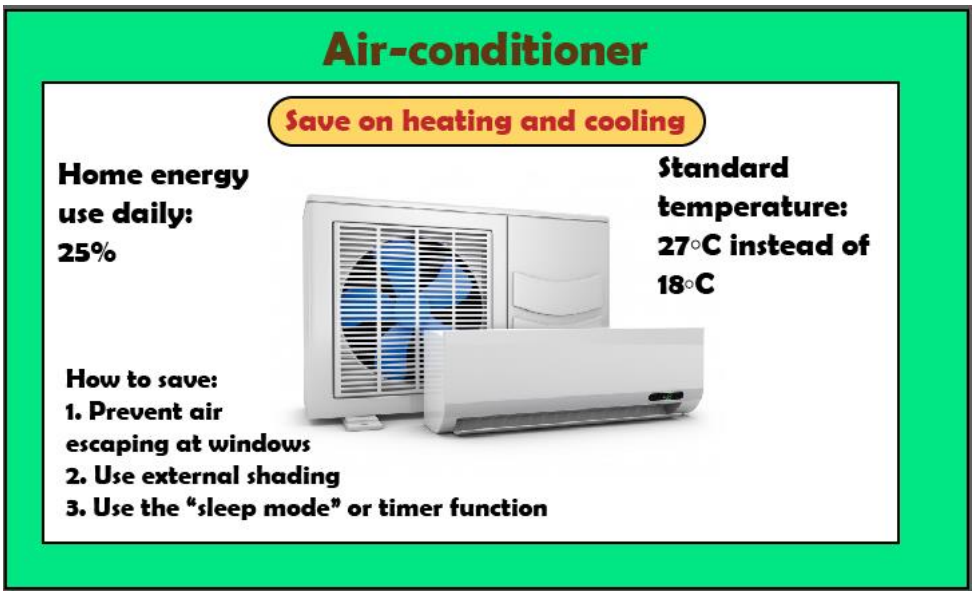


Figure 5-2 target image 2 Air-conditioner

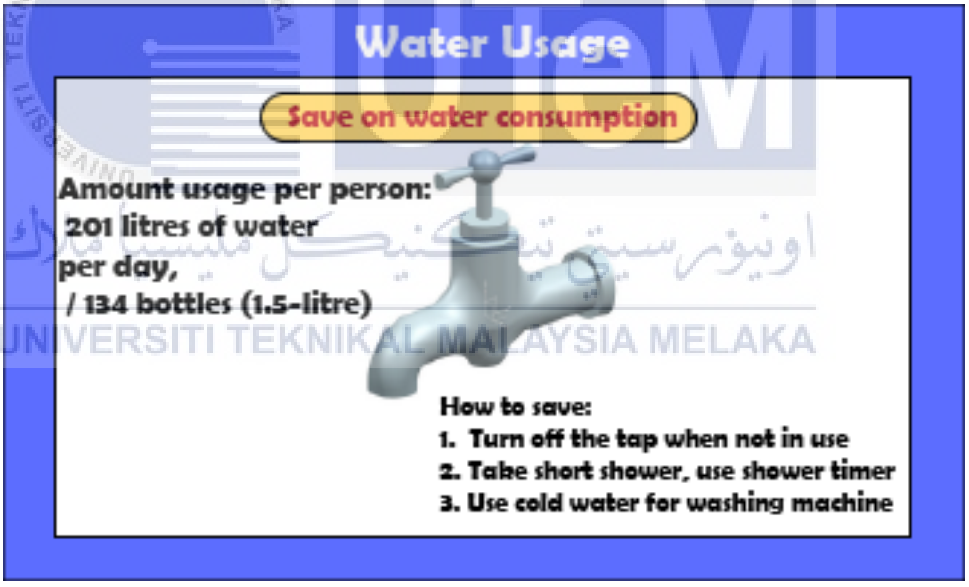


Figure 5-3 target image 3 water usage

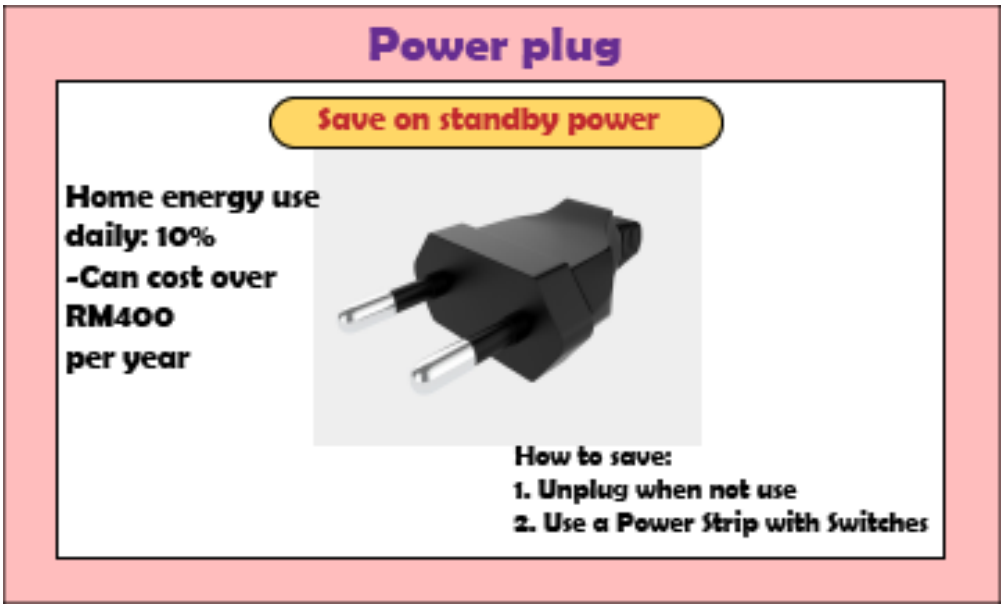


Figure 5-4 target image 4 power plug

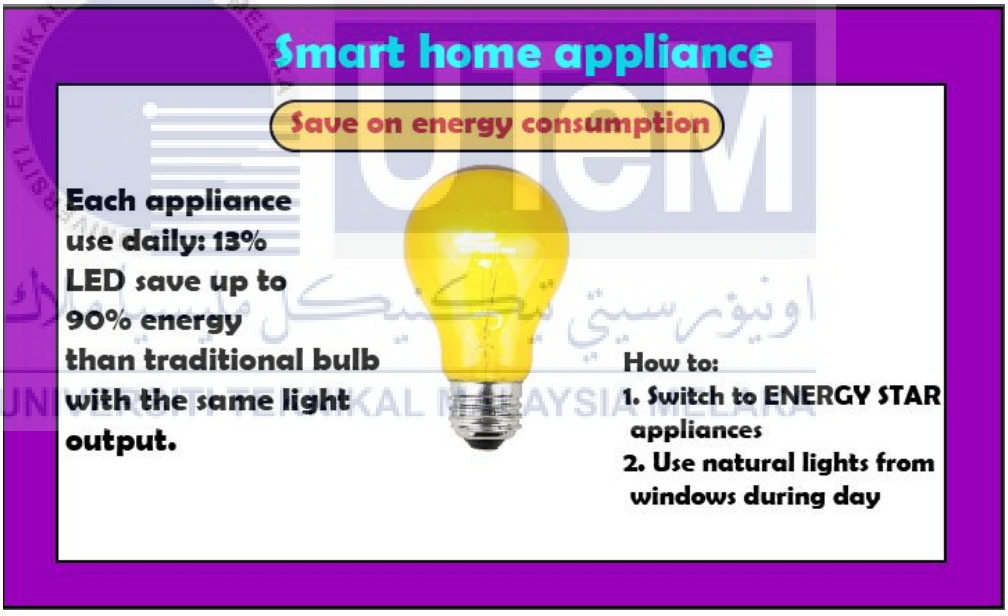


Figure 5-5 target image 5 smart home appliances

5.2.3 Production of 3D Model

The uses of 3D model with Augmented Reality (AR) are to make the users get their immersive experience with their learning progress. 3D model is important in AR as user can see from static to live object.

Production of 3D models of this project using Cinema4D. Firstly, the exact figure and idea need to be gain to create the model. Based on some images references on internet, the model are created. After modelling, the model also been textured to add the colors. Then, the asset are saved to .fbx format. Finally, the model assets are imported in Unity to make it work together with marker-based Augmented Reality.

5.3 Media Integration

After the production of media was done, the media need to be integrate together. Every content elements were integrated including images, videos, 3D models and other assets like buttons are being imported and set up in Unity to develop a complete Augmented Reality application. The target image are also being imported into Unity to create a marker- based Augmented Reality. Target images were uploaded in Vuforia to create the database to work with Unity.

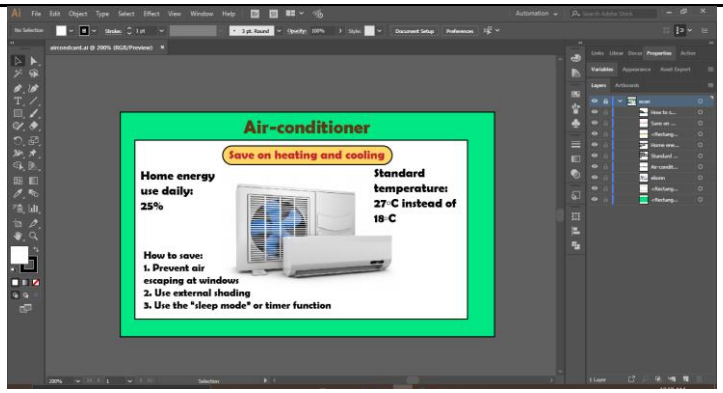
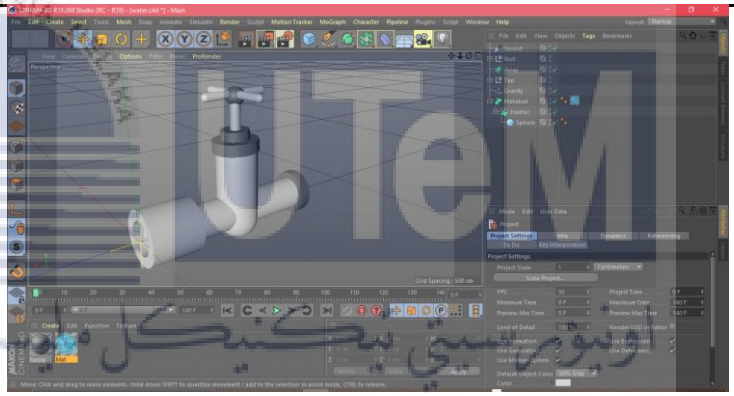
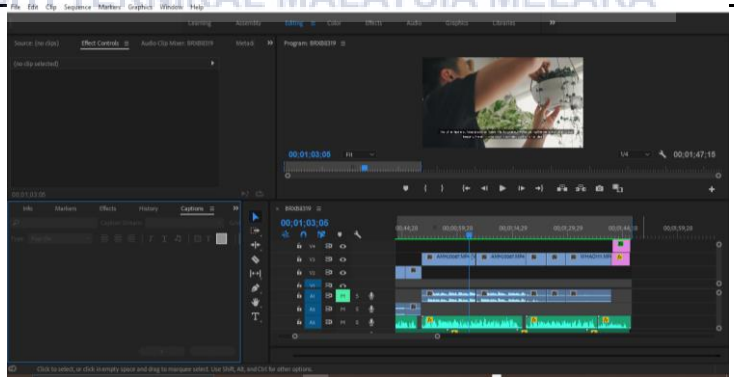
5.4 Product Configuration Management

It is a process where the entire configuration needed to be done to the product to achieve desired outcome which is included version control and configuration environment setup.

5.4.1 Configuration Management Setup

This project use Unity development platform to build up the AR Awareness for Saving Energy at Home application. This application can be used with Android since majority of users uses android. It is to make most of the users be able to use this application. Microsoft Visual Studio was used for purpose to create scripts functions to work together with the application's navigation. After that, the complete configuration in Unity was export to an APK format so it can be install in Android device. Software used to develop the content are including Adobe Illustrator, Adobe

Premiere, Microsoft Visual Studio, and Unity. Table 11 below shows the setup configuration of this project.

Application Software	Configuration
Adobe Illustrator	
Cinema4D	
Adobe Premiere Pro	
Unity 2020	

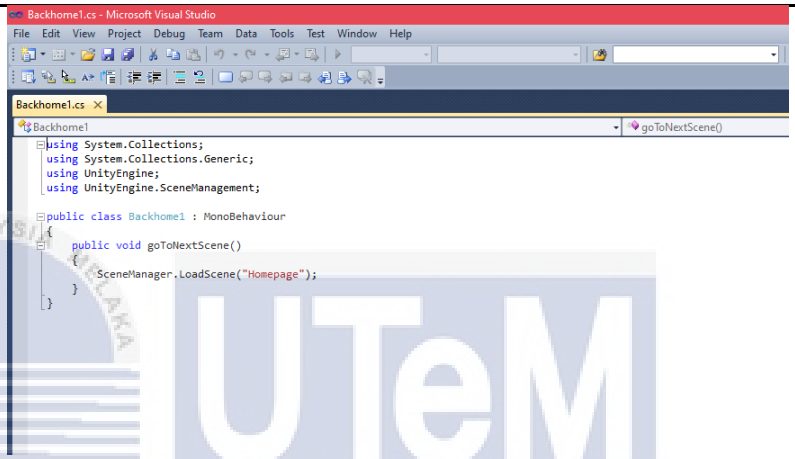
	
Microsoft Visual Studio	

Table 5-1 Application Configuration

5.5 Implementation Status

Implementation status are to keep track all the progress of project development. The purpose are to elaborate the development progress of this augmented reality, which is function as to manage in order to finish the task according to the project needed.

5.6 Conclusion

In conclusion, implementation methods are important to meet project demand and standards. This chapter will increase effectiveness and productivity as well as raise end product standards.

CHAPTER 6: TESTING

6.1 Introduction

Application Testing aims are to finding errors in an application. Testing phase are always carried out after the application development. It deals with tests for the entire application. It is usually required before and after the system is installed. This procedure gives the tester instructions on the application's functionality and the specific details where it always getting errors. The testing phase can help developer in finding the problems in the application they developed. It also helps in saving time for development if the application got malfunctioning in future in the same time reducing the costs of development.

6.2 Test Plan

In testing phase, proper test plan has to be made. Test plan are including test user, test environment, test schedule, and test strategy and test implementation. After the project are successfully tested, the analysis testing need to be made.

6.2.1 Test User

Test user explain on how many respondent or target user will be participate in the testing phase. In this project, there are 4 multimedia expert whom participate in the first phase of testing and 28 target user are participating in end-user testing. This category involve in both genders, male and female, from any ages. They will be tested based on their experience and understanding of the project. In this product testing, target user will be given Youtube link to watch the product demonstration videos. Some of the nearby target user will test this product physically and directly using the tools.

6.2.2 Test Environment

Target users will be given the flash card provided and an "Energy Home" application installed in an android to test out the products.

6.2.3 Test Schedule

It is a flexible time schedule given to every user in this test since the contactless test had been carried out. For in-contact target user, the test held on 23/8/2021 at night with my few family members. It can only be carried out among my family members due to Movement Control Order (MCO).

6.3 Test Strategy

In order to carry out the test, we need to have test strategy. On top of that, the test will be divided to two types which are alpha testing and beta testing. Then, the questionnaires for the testing need to be conducted appropriately to these two kind of testing. We can use only one questionnaire since the target user are the same with the alpha tester, which is general population. If the target user are different, the questionnaire for alpha and beta testing need to be separated. Also, the testing strategy must ensure the testing result will help in achieving the objective of the project.

6.3.1 Alpha Testing

Alpha testing need to be carried out by the multimedia expert or subject matter expert who have a good knowledge of the elements and content itself. The test will be done by them at the end of the application development to ensure the functionality before it will be use. When alpha testing goes well, the application will be ready to be tested on beta testing.

6.3.2 Beta Testing

Beta testing need to be carried out by the target user or customer which are in this project is general population. They need to test the product and giving feedback from their own perspective of opinion and acceptance. Beta testing is to collect the

feedback from the real user to reduced product failure risk and increase the quality of the real product. This is the final test before the real product is release to the end user.

6.3.3 Acceptance Testing

The user acceptance testing are carried out to determine if the application is good for use. Respondents will be given 10 to 30 minutes to test the application. After that, they need to answer a questionnaire based on the application's usability and its content. User also need to give feedback based on their opinion. It is the same for the tester who watch the video demo. The total of respondents are 31 including multimedia experts.

Table 6-1 Acceptance testing details

	Alpha Testing	**Beta Testing**
Testing type	Usability/ functionality	User acceptance
Tester	Multimedia expert	Target user (any age)
Testing task	Test the application and answer the questionnaires given	Test the application and answer the questionnaires given
Duration	10 to 30 minutes	10 to 30 minutes
Number of tester	4	28

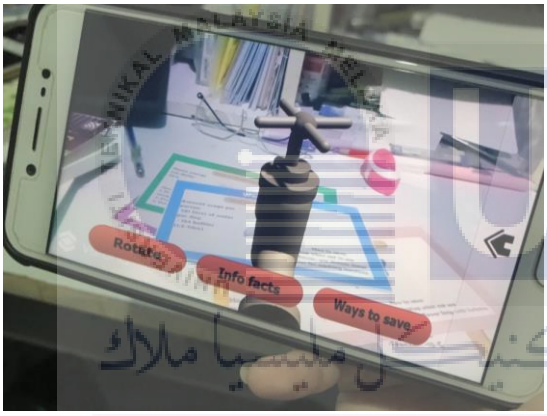
6.4 Test Implementation

6.4.1 Test Description

In test description, there are two types of testing which is alpha testing, which is to test the functionality and beta testing, to test the user acceptance. For alpha testing, testing will be carried out by the multimedia expert. Multimedia expert have to answer

the questionnaire and giving feedback from their perspective. All comments would be given by other developer to improve the project. If there are a major mistake, a change will be made before proceed to the next process.

For user acceptance testing, for contactless, the questionnaires form has been spread out to any age of target users. All respondents will watch the video demonstration individually and they need to understand the function of the application after they read the instructions. Then, they need to answer the questionnaires and give the feedback on the application. For in-contact testing, a few target user need to be participate in this testing process. The respondents will do the test individually after they receive explanation from developer to them about what to do. Below shows a few photo of target user testing out the application.



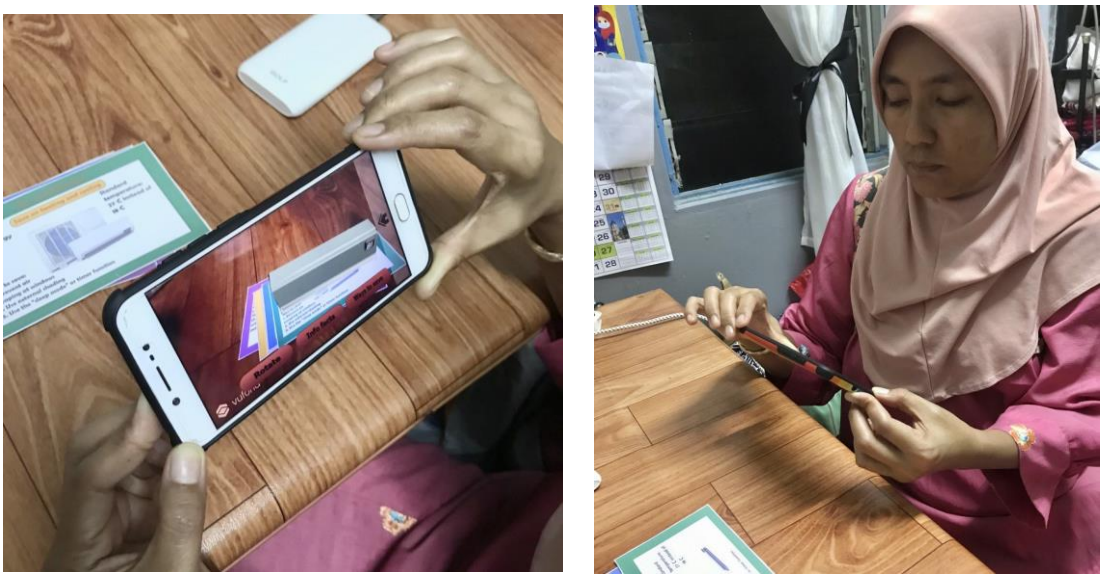


Figure 6-1 Beta testing Process

6.5 Test Result and Analysis

In this part, the result of testing analysis will be summarized in chart. Target user had been given the questionnaires in Google Form. Below shows the questions in the questionnaires to both alpha and beta testing target users.

For questions 15 a-l, in the scale 1-5, from strongly disagree to strongly agree, user need to tick the best option for the following questions.

Table 6-2 Questionnaires in Google Form

No	Questions
1	Gender / Jantina
2	Age/ Umur
3	Occupation/ Pekerjaan
4	Are you familiar with Augmented Reality?/ Adakah anda biasa dengan penggunaan "Augmented Reality"?
5	How much time you require on using this Augmented Reality application?/ Berapa lamakah masa yang anda perlukan untuk menggunakan aplikasi ini?
6	Are you aware of ways on how to save energy at home?/ Adakah anda sedar tentang langkah bagaimana untuk menjimatkan tenaga di rumah?
7	Using this AR application, which one you think the best to describe your understanding about saving energy awareness at home? / Dengan menggunakan aplikasi AR ini, yang manakah penjelasan terbaik anda mengenai kefahaman anda tentang kesedaran penjimatan tenaga di rumah?
8	Do you think you always practicing saving energy at home in your daily life?/ Adakah anda rasa anda sentiasa mengamalkan penjimatan tenaga di rumah anda dalam kehidupan seharian anda?
9	Which of the following that you practice the most in your daily life?/ Manakah antara berikut yang paling anda amalkan dalam kehidupan seharian?
10	Is the short video on the other ways of saving energy at home are giving you good knowledge?/ Adakah video pendek mengenai langkah lain penjimatan tenaga di rumah memberi anda pengetahuan yang bermanfaat?
11	What do you think and feel after answering the mini quiz at the end of the application?/ Apakah pendapat dan perasaan anda setelah menjawab kuiz mini di akhir aplikasi?

12	When the application was opened for the first time, is it hard for you to understand the function of every menu options?/ Semasa pertama kali aplikasi dibuka, adakah susah bagi anda untuk memahami fungsi setiap pilihan menu?
13	What do you think of this application?/ Apakah pendapat anda mengenai aplikasi ini?
14	Do you think the use of animations with AR are able to help you understand something better?/ Adakah anda fikir penggunaan animasi dengan AR bersama dapat membantu anda memahami sesuatu dengan lebih baik?
15a	Augmented Reality can create an interesting learning experience especially regarding awareness of saving energy at home./ Augmented Reality dapat mewujudkan pengalaman belajar yang menarik terutamanya mengenai kesedaran penjimatan tenaga di rumah.
15b	I am interested to use this application for saving energy at home information other than reading them in other media./ Saya berminat ingin menggunakan aplikasi ini untuk ilmu penjimatan tenaga di rumah selain daripada membacanya di media lain.
15c	I think short quizzes or mini games are able to help me to recall back what I just learnt/ Saya rasa kuiz pendek atau mini kuiz dapat membantu saya mengingat kembali apa yang baru saya pelajari.
15d	Augmented Reality can help me to get information without reading / Augmented Reality dapat membantu saya mendapat maklumat tanpa membaca.
15e	This AR application saves time to understand the content related/ Aplikasi AR ini dapat menjimatkan masa untuk memahami kandungan yang berkaitan
15f	The content arrangement are neat and effective in conveying information/ Susunan kandungan adalah kemas dan berkesan dalam menyampaikan maklumat.
15g	The color and font used in this AR application is appropriate/ Warna dan jenis tulisan yang digunakan dalam aplikasi AR ini adalah bersesuaian.
15h	The graphic used in this application are visible and clear/ Grafik yang digunakan dalam aplikasi ini dapat dilihat dan jelas.
15i	The audio used in this application is good and clear / Audio yang digunakan dalam aplikasi ini adalah berkualiti dan jelas.
15j	The application are convenient to use/ Aplikasi ini mudah digunakan.
15k	The button used in this application are attractive and easy to be seen/ Butang yang digunakan dalam aplikasi ini menarik dan mudah dilihat.

15l	The navigation in this application are convenient to use/ Navigasi dalam aplikasi ini mudah digunakan.
16	Do you have any comment(s) for this application? If YES, please state your answer./ Adakah anda mempunyai komen berkaitan aplikasi ini? Sekiranya YA, sila nyatakan jawapan anda.
17	Do you have any opinion/ suggestion(s) for this application? If YES, please state the answer. / Adakah anda mempunyai sebarang pendapat / cadangan berkaitan aplikasi ini? Sekiranya YA, sila nyatakan jawapan anda.
18	How likely you recommend this application to your friends?/ Seberapa besarkah kemungkinan anda akan mengesyorkan aplikasi ini kepada rakan anda?

6.6 Analysis Testing

Analysis testing are been made to summarize the user acceptance and feedback towards this AR Awareness for Saving Energy at Home application. Questionnaire in google form has been used as data collection method to gather the results from respondents. The analysis for alpha testing are listed out in the Table 6-2 and for beta testing are in the following charts and graphs.

6.6.1 Analysis Testing for Alpha Testing

Table 6-3 Alpha Testing Result

Expert / Questions	Multimedia Expert 1	Multimedia Expert 2	Multimedia Expert 3	Multimedia Expert 4
1	Male	Female	Male	Male
2	28-39	28-39	19-27	40 or above
3	Lecturer	Lecturer	Software engineer	Lecturer
4	Yes	Yes	Yes	Yes
5	10 minutes	30 minutes	10 minutes	15 minutes

6	Yes	Yes	Yes	Yes
7	Very understand	Very understand	Very understand	Very understand
8	Not really	Yes, most of the time	Yes, most of the time	Not really
9	Save on refrigerator use, Save on heating and cooling, Save on water usage, Save on standby power, Using smart home appliances	Save on standby power	Save on water usage, Save on standby power, Using smart home appliances	Save on heating and cooling, Save on standby power
10	Average, not really	Yes, very interesting	Yes, very interesting	Yes, very interesting
11	Good, some questions are hard	Good, some questions are hard	Very fun and interesting	Very fun and interesting
12	Average	Easy to understand	Easy to understand	Easy to understand
13	Average	Satisfied	Very interesting	Satisfied
14	Yes	Yes	Yes	Yes
15. a	5	4	5	4
15. b	5	2	5	4
15. c	3	5	5	4
15. d	4	4	5	4
15. e	3	4	5	4
15. f	3	5	5	4

15. g	3	4	4	4
15. h	3	2	4	4
15. i	3	4	5	4
15. j	3	4	5	4
15. k	3	5	5	4
15. l	3	4	5	4
16.	soalan 16 dan 17 ni sama. So saya akan jawab di soalan 17	The 3D models can be improved. We hardly seen the 3D models. As it has top view not front view. Also provide the zoom in zoom out interaction.	Maybe vuforia can be integrated with flutter in the future	Overall is good, user interface is acceptable, however I'm not sure how you measure the degree of awareness towards energy saving before and after using the AR apps. This will help to guide your study.
17.	Pada pendapat saya, perlunya beberapa improvement dibuat di dalam aplikasi ini. Pertamanya dari segi UI/UX untuk beberapa menu yang dibuat seperti half baked. Penggunaan warna untuk aplikasi ini tidak seragam dan harus diseragamkan. Selain itu, untuk	And for future work, can improve the application using markerless AR.	Adding app splashscreen	Reminder system maybe to alert user to take action such as check you power plug,

	bahagian AR, tidak banyak yang menarik kecuali apabila kita scan kita nampak 3D model itu timbul dan boleh rotate. Information untuk barangan tersebut pun tidak interactive dan sekadar nampak model sahaja. Sekadar scan dan nampak model bentuk AR adalah sesuatu yg amat mudah dibuat tetapi benda mudah boleh dijadikan interactive dengan kaedah yang betul. Oleh itu saya tak nampak element keistimewaan yang ada dalam aplikasi ini dan sekadar just another simple AR project aje sedangkan diberi masa 15 minggu pada PSM 1 untuk menyiapkannya. Mungkin banyak masa diberikan kepada design. Oleh itu pastikan fokus utama adalah kepada bidang computer science tersebut iaitu lebih merujuk kepada elemen teknikal			

	berbanding design.			
18.	Recommend them using this application	Recommend them using this application	Highly recommend them to use this application	Recommend them using this application

6.6.2 Analysis Testing for Beta Testing

PART A: General

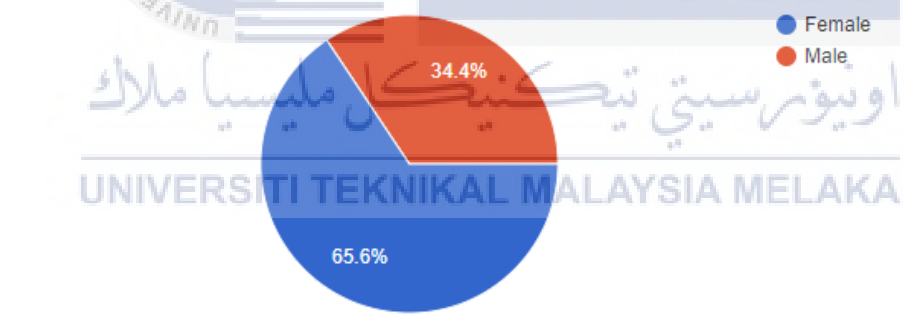


Figure 6-2 Question 1

The question asked about gender. As Figures 6-1, 65.6% are female and 34.4% are male.

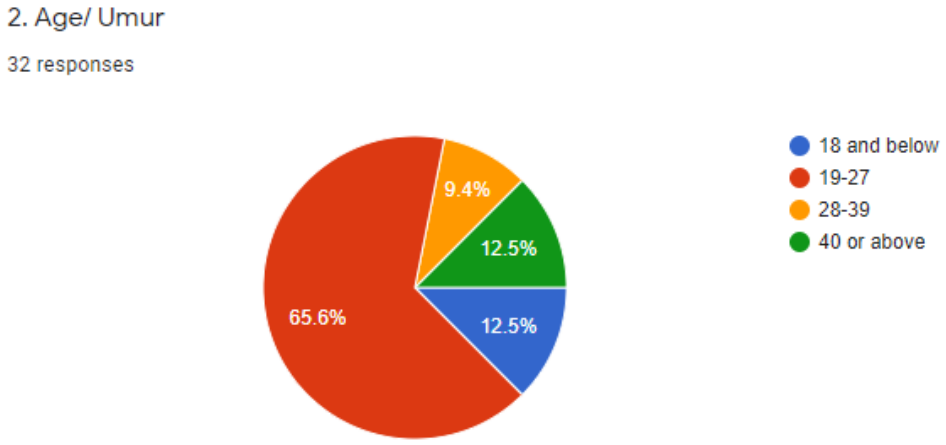


Figure 6-3 Question 2

The question asked about target users' age. As Figure 6-2, 65.6% which is majority of respondents are in age 19-27. Others are from 18 and below, 28-39 and 40 or above. There are also a few target user aged 28-39. From the result, general population of respondents successfully collected.

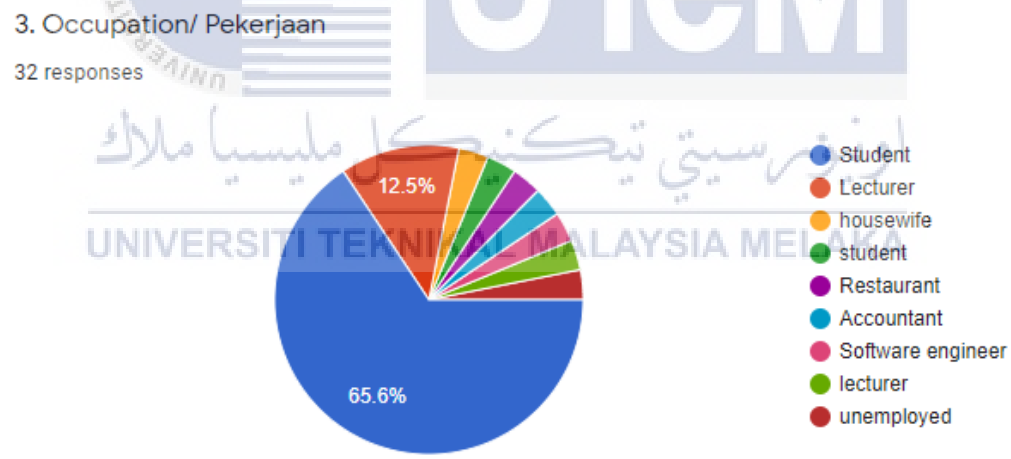


Figure 6-4 Question 3

The question asked about target users' occupation. As Figure 6-3, 65.6% which is majority of respondents are a student. 12.5% are lecturer, which are most of them are multimedia expert. Others are working as accountant, housewife, unemployed and more. From the result, the respondents are working in varieties environments.

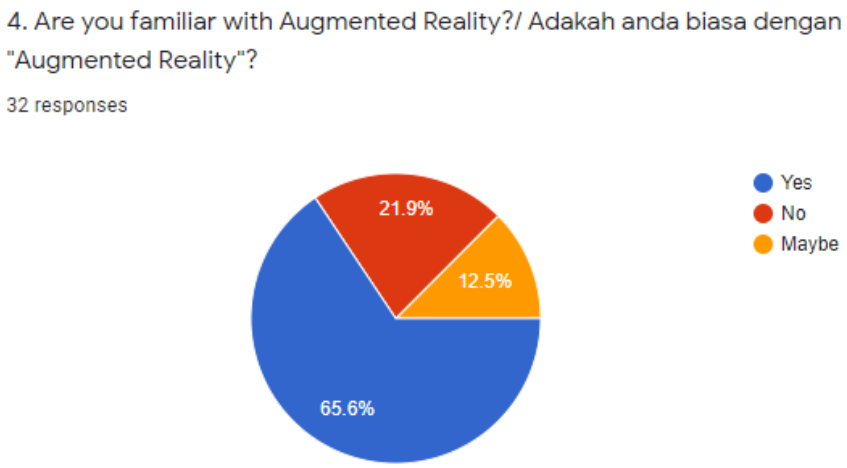


Figure 6-5 Question 4

This question asked about are respondent are familiar with Augmented Reality (AR) technology. Majority of respondent answered yes with 65.6% and also respondent answered no with 21.9%. The least of them said maybe which is 12.5%.

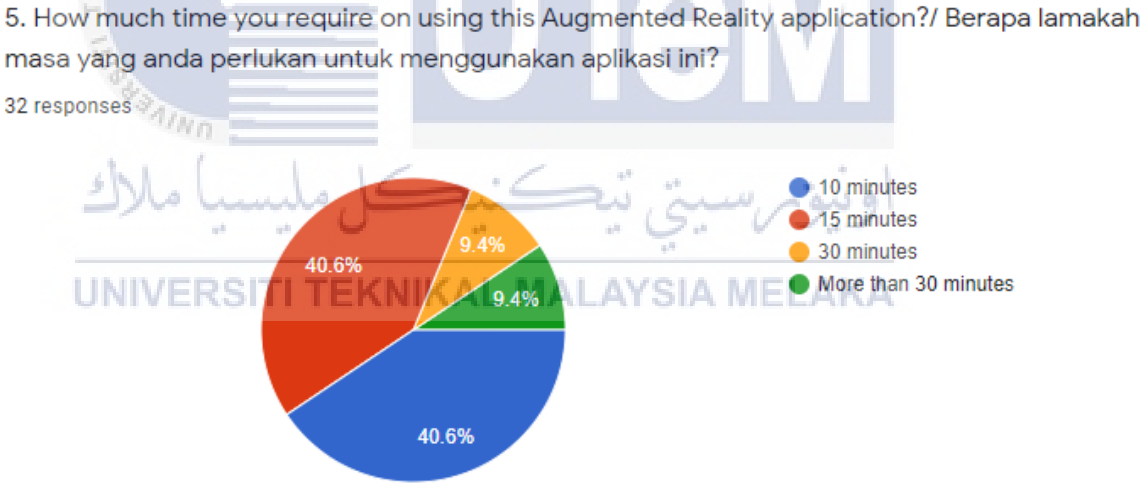


Figure 6-6 Question 5

This question asked about how much they require on using this Augmented Reality (AR) application. Majority of respondent only need 10-15 minutes to finish up the whole application with 40.6%. The rest of them need 30 minutes and more.

PART B: Content Application

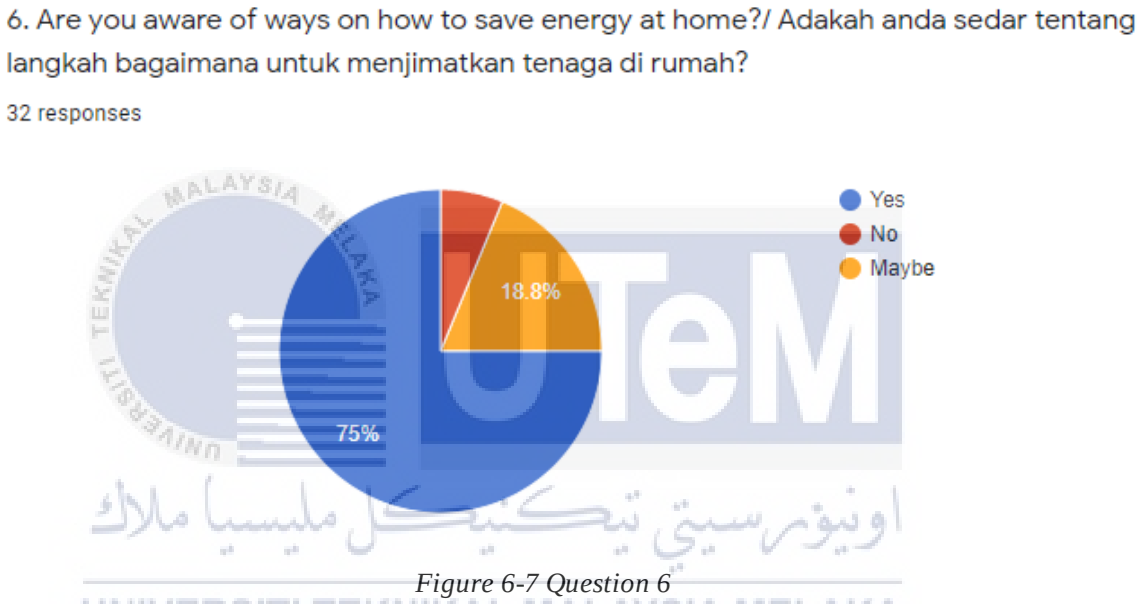


Figure 6-7 Question 6

This question asked about are respondent aware of ways on how to save energy at home. Majority of respondent answered yes with 75% and also respondent answered maybe with 18.8%.

Figure 6-8 Question 7

This question asked respondent's level of understanding about saving energy awareness at home after they using this application. Majority of respondents are very understand with 78.1% and 18.8% of them are partly understand. There are also respondent hardly understand. From the result, it shows the application are successfully helps target user to understand the content.

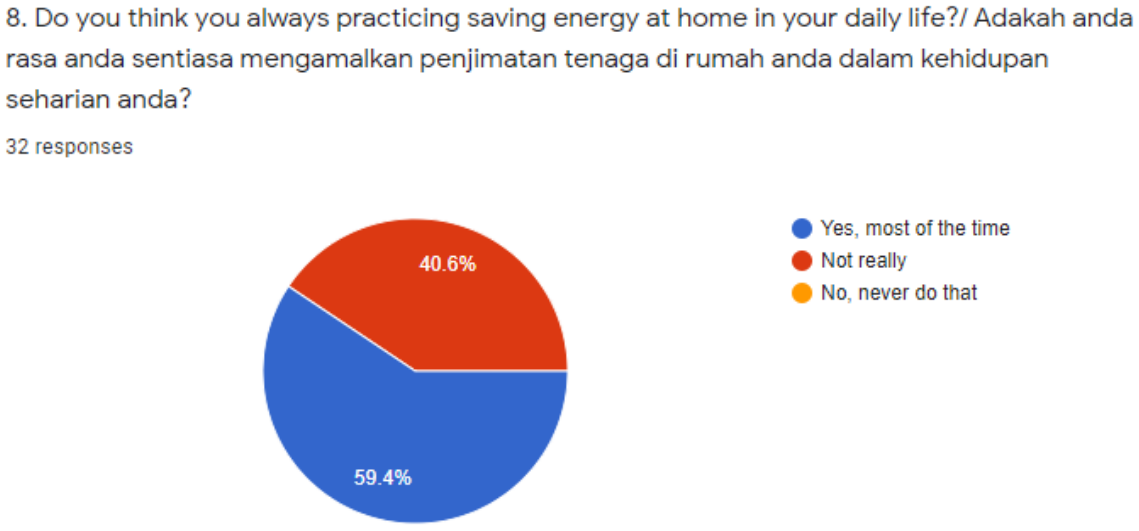


Figure 6-9 Question 8

This question asked respondent if they always practicing saving energy at home in their daily life. Majority of respondents answered yes with 59.4% but also a large number of respondent answered not really with 40.6%. From the result, we know not a lot of people are practicing saving energy at home in their daily life.

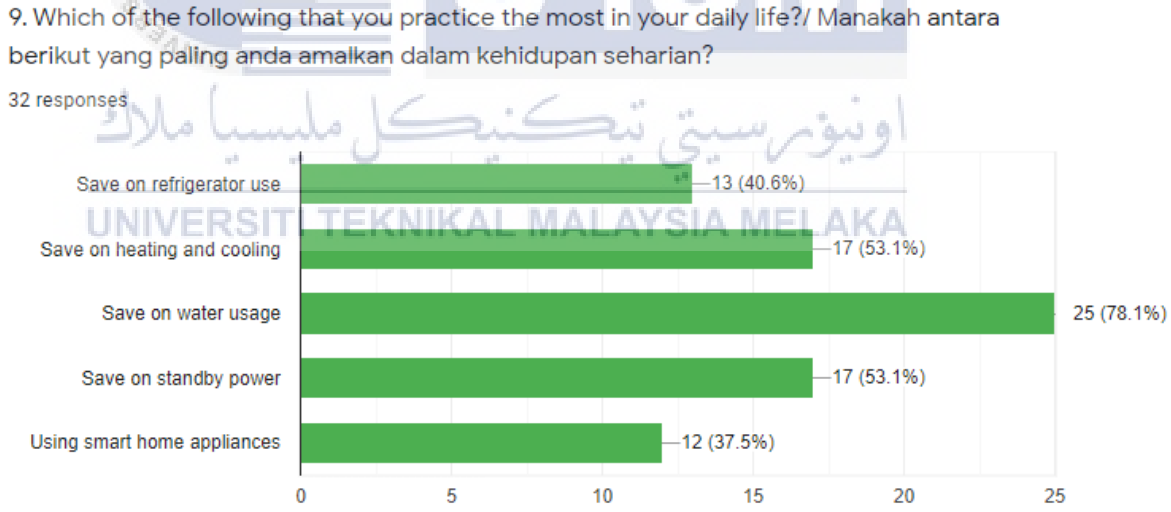


Figure 6-10 Question 9

This question asked respondent which they used to practice the most in their daily life based on the options. Respondent can choose more than one options. Majority of respondents did save on water usage with 78.1%. The least is using smart home appliances with 37.5%.

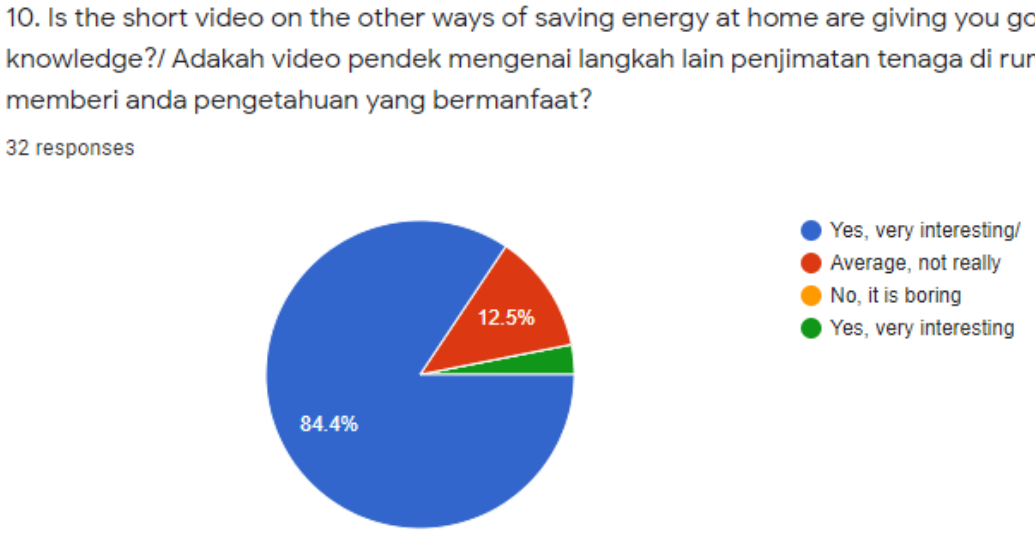


Figure 6-11 Question 10

This question asked respondent if they think the short video in the application giving them good knowledge about saving energy at home. Majority of respondents answered it is very interesting with 84.4%. Others said it is average with 12.5% of them.

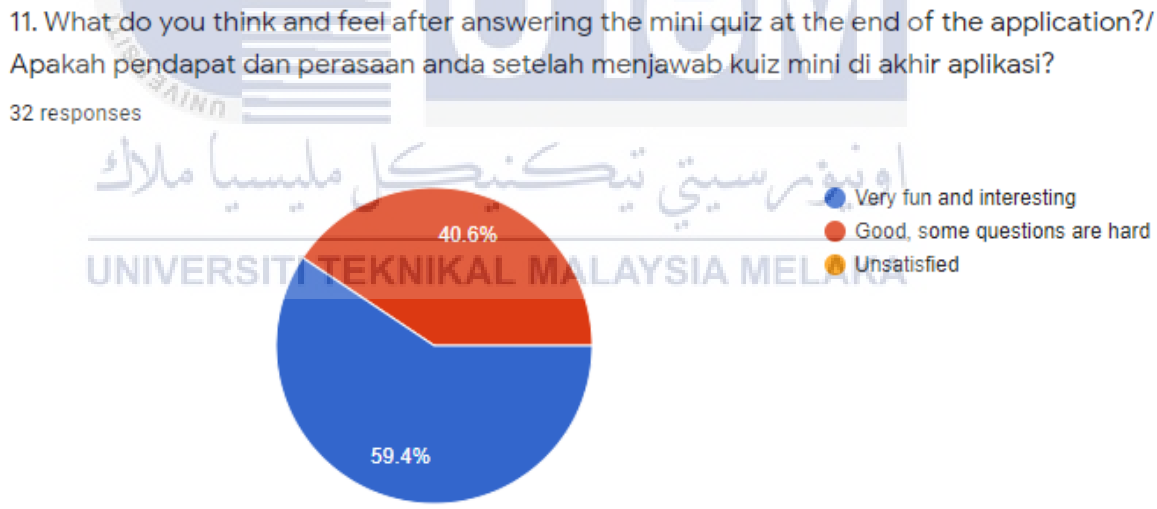


Figure 6-12 Question 11

This question asked respondent what they feel after answering the mini quiz at the end of the application. Majority of respondents answered it is very fun and interesting with 59.4% and also large number of them saying some questions are hard with 40.6% of them.

PART C: USER EXPERIENCE

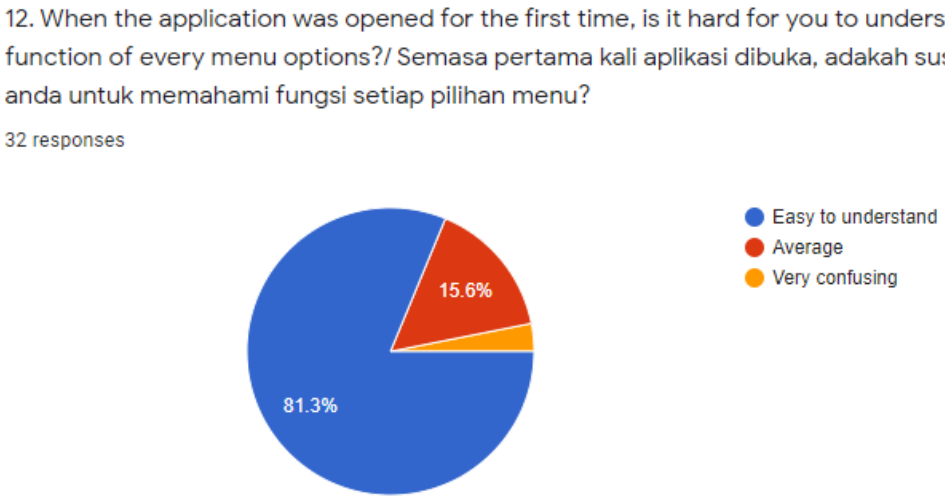


Figure 6-13 Question 12

This question asked respondents' experience if they understand the function of every menu options when the application was opened for the first time. Majority of respondents said it is easy to understand with 81.3% and others said average with 15.6% and also a few of them said confusing.

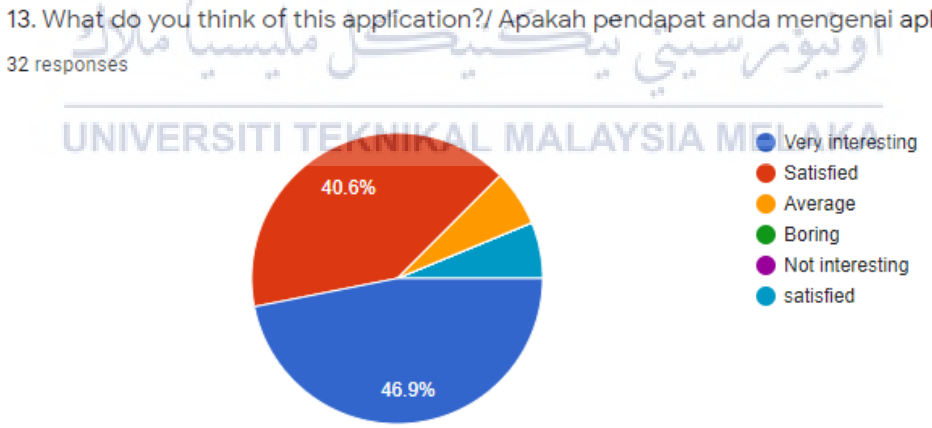


Figure 6-14 Question 13

This question asked respondent what they think of this application. Majority of respondents answered satisfied with 46.9% and the rest said very interesting with 40.6% and also said average. From the result, we know this application need to be improved in future.

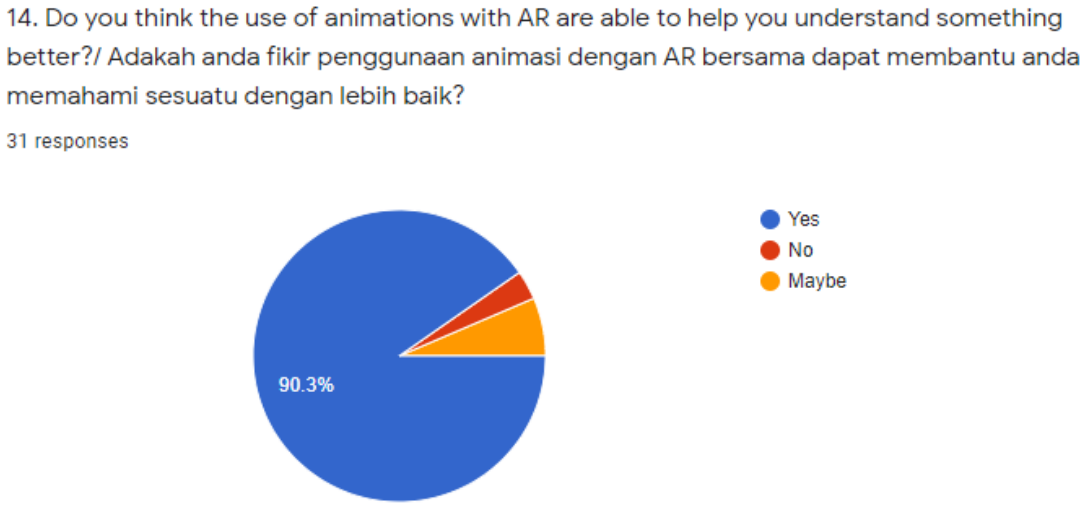


Figure 6-15 Question 14

This question asked about if respondent think the use of animations with AR are able to help them understand something better. Most of respondents answered yes with 90.3% and also few respondent answered maybe and no.

15. In the scale 1-5, from strongly disagree to strongly agree, please tick the best option for the following questions. / Dalam skala 1-5, dari paling tidak setuju ke paling setuju, sila tandakan pilihan terbaik untuk soalan berikut.

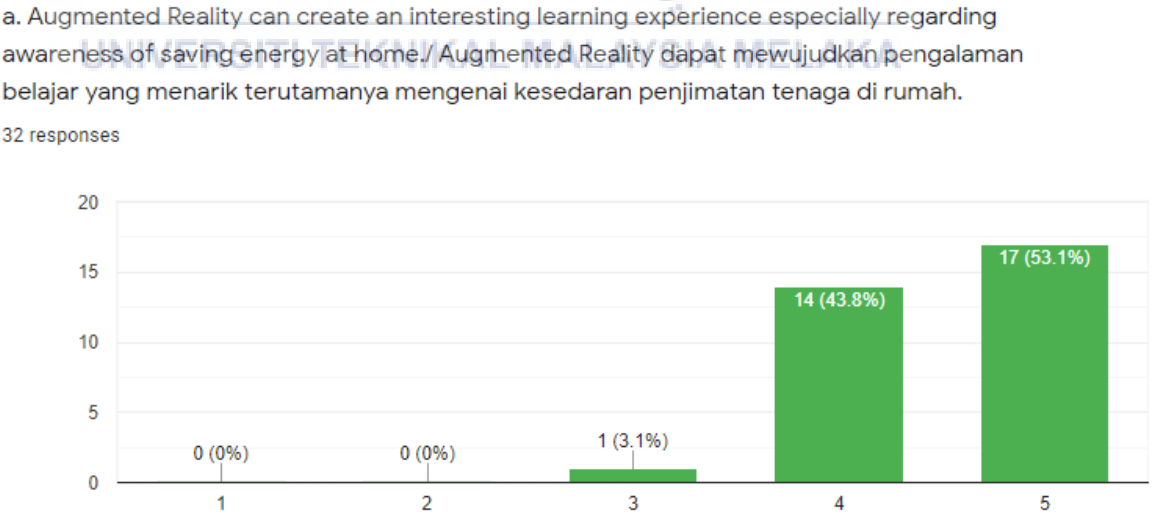


Figure 6-16 Question 15a

This question asked about is respondent think Augmented Reality can create an interesting learning experience especially regarding saving energy at home. In Figure

6-15, most of respondents strongly agree with the scale of 5 with 53.1%. Others said agree with the scale of 4 with 43.8%. There are also a respondent said it is average.

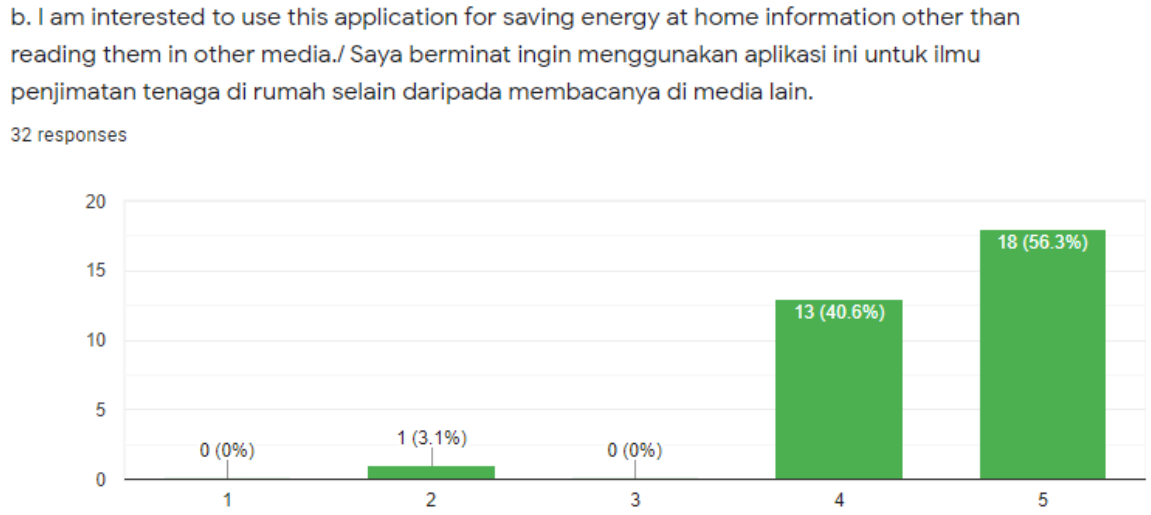


Figure 6-17 Question 15b

This question asked about is respondent feel interested to use the application for saving energy at home information other than reading them in other media. In Figure 6-16, most of respondents strongly agree with the scale of 5 with 56.3%. Others said agree with the scale of 4 with 40.6%. There are also a respondent disagree.

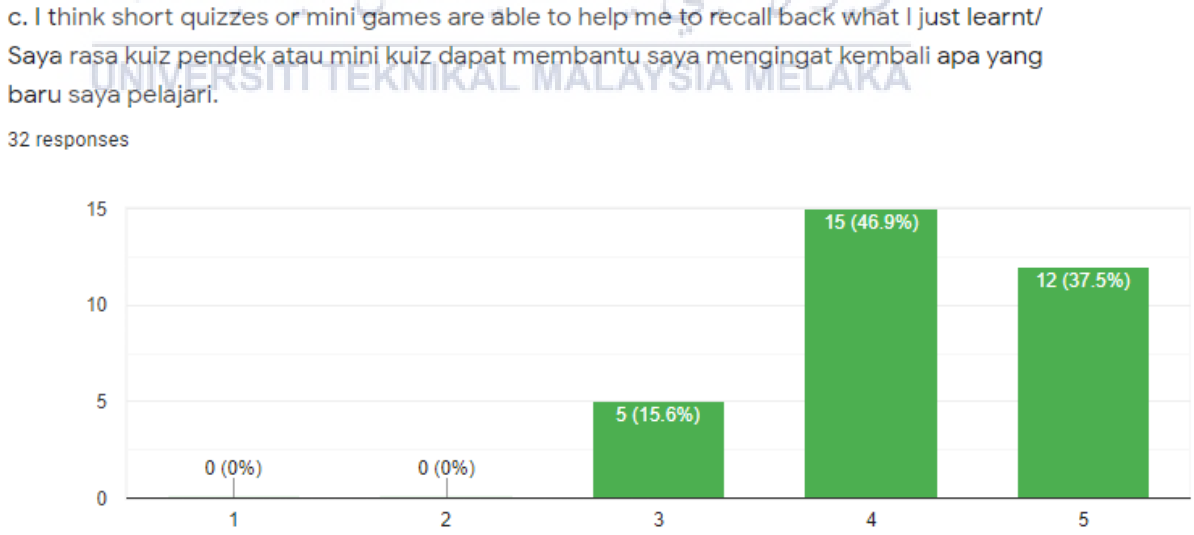


Figure 6-18 Question 15c

This question asked about is respondent think short quizzes or mini games are able to help me to recall back what they just learnt. In Figure 6-17, most of respondents agree with the scale of 4 with 46.9%. Others said strongly agree with the scale of 5 with

37.5%. There are also some respondent think it is average with the scale of 5 with 15.6%.

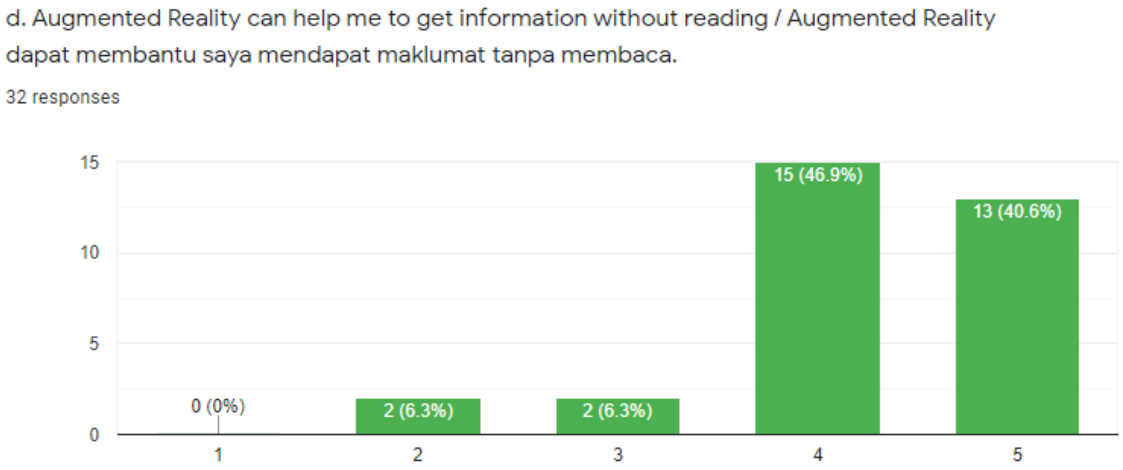


Figure 6-19 Question 15d

This question asked about if respondent think Augmented Reality can help they get information without reading. In Figure 6-18, most of respondents agree with the scale of 4 with 46.9%. Others said strongly agree with the scale of 5 with 40.6%. There are also some respondent think it is average and disagree with scale 3 and 2.

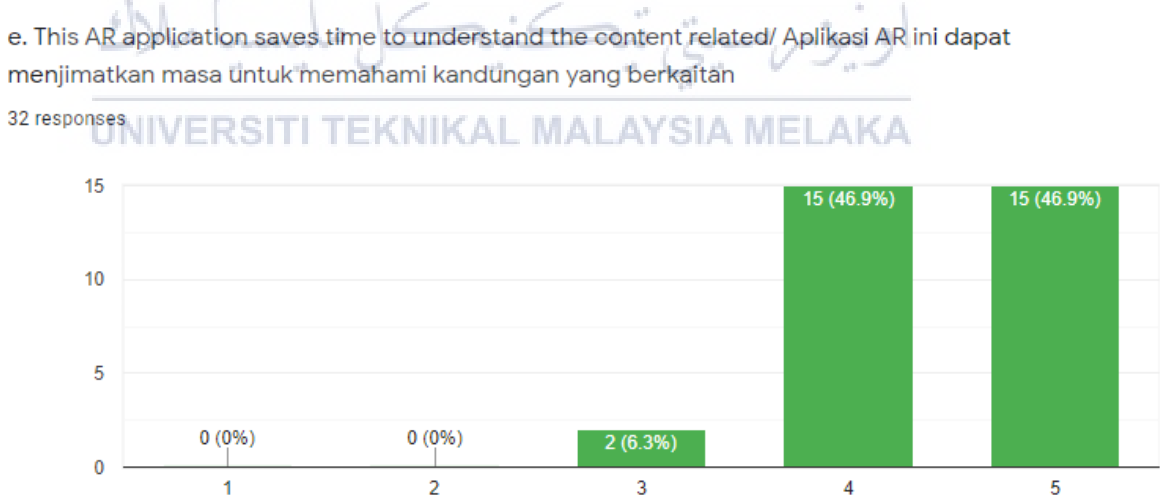


Figure 6-20 Question 15e

This question asked about is respondent think this AR application saves time to understand the content related. In Figure 6-19, most of respondents strongly agree and agree with the scale of 5 and 4 with 46.9%. Others said average with the scale of 3 with 6.3%.

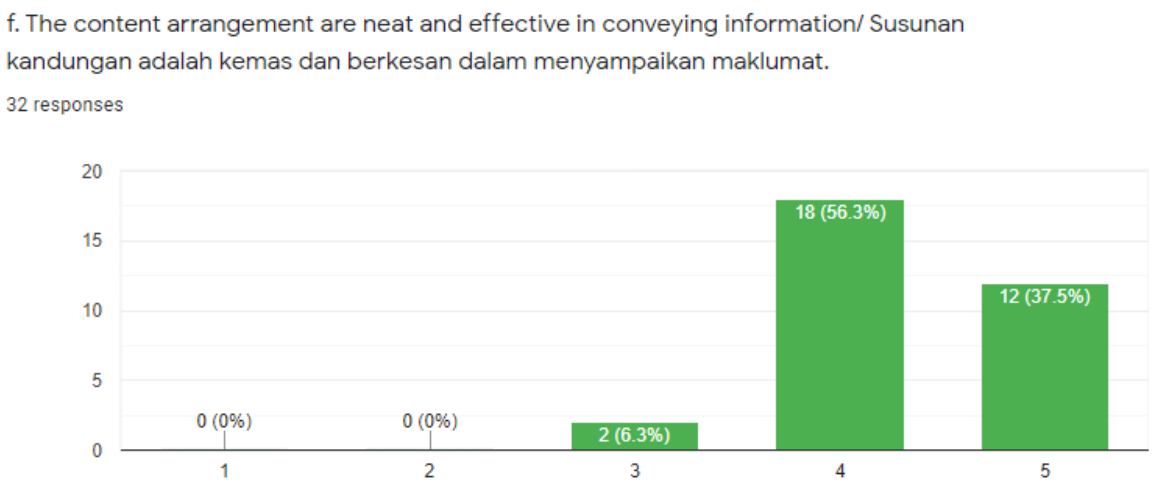


Figure 6-21 Question 15f

This question asked about are the content arrangement are neat and effective in conveying information. In Figure 6-20, most of respondents agree with the scale of 4 with 56.3%. Others said strongly agree with the scale of 5 with 37.5%. There are also some respondent think it is average with the scale of 3 with 6.3%.

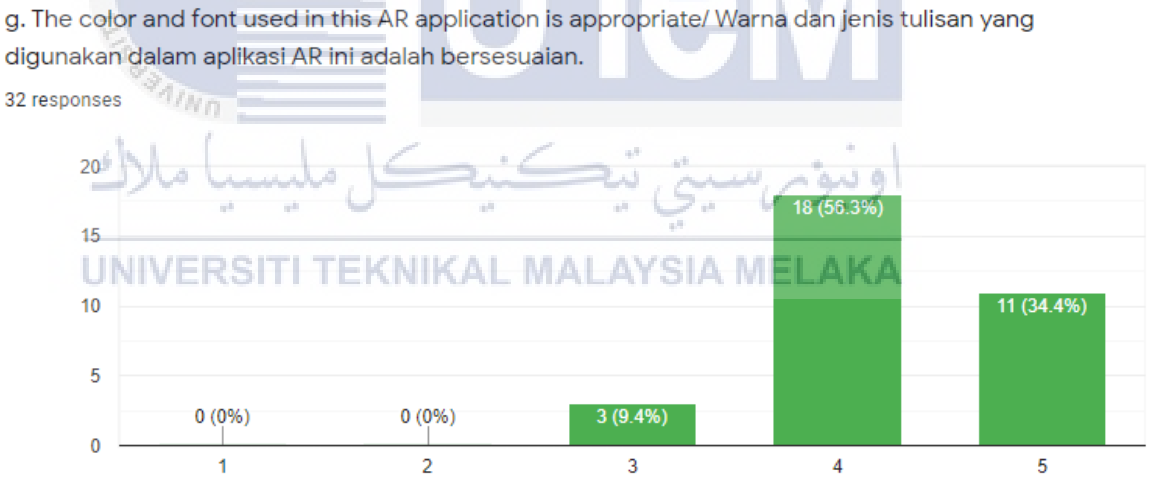


Figure 6-22 Question 15g

This question asked about is the color and font used in this AR application is appropriate. In Figure 6-21, most of respondents agree with the scale of 4 with 56.3%. Others said strongly agree with the scale of 5 with 34.4%. There are also some respondent think it is average with the scale of 3 with 9.4%.

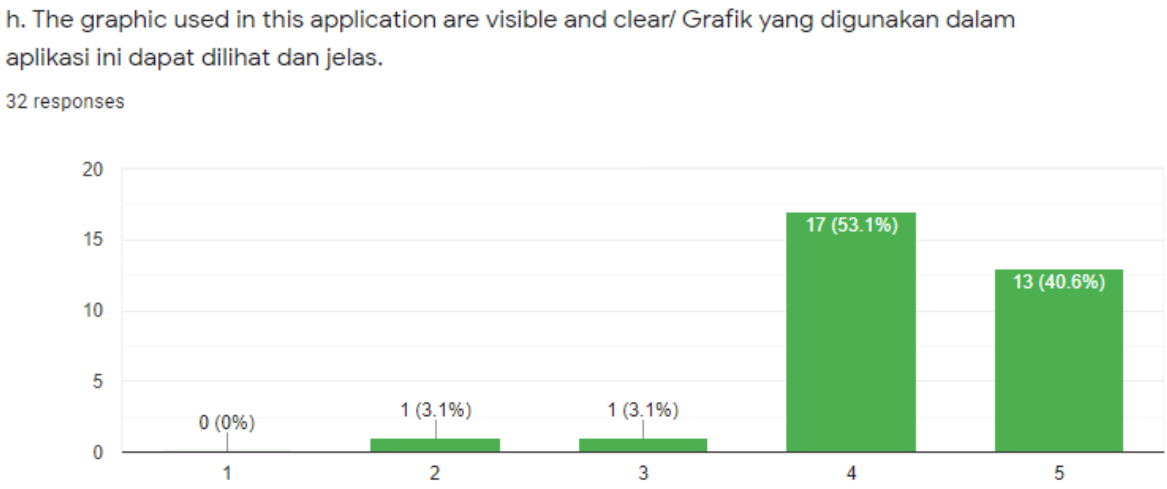


Figure 6-23 Question 15h

This question asked about is the graphic used in this AR application are visible and clear. In Figure 6-22, most of respondents agree with the scale of 4 with 53.1%. Others said strongly agree with the scale of 5 with 40.6%. There are also some respondent think it is average and disagree with the scale of 3 and 2 with 3.1%.

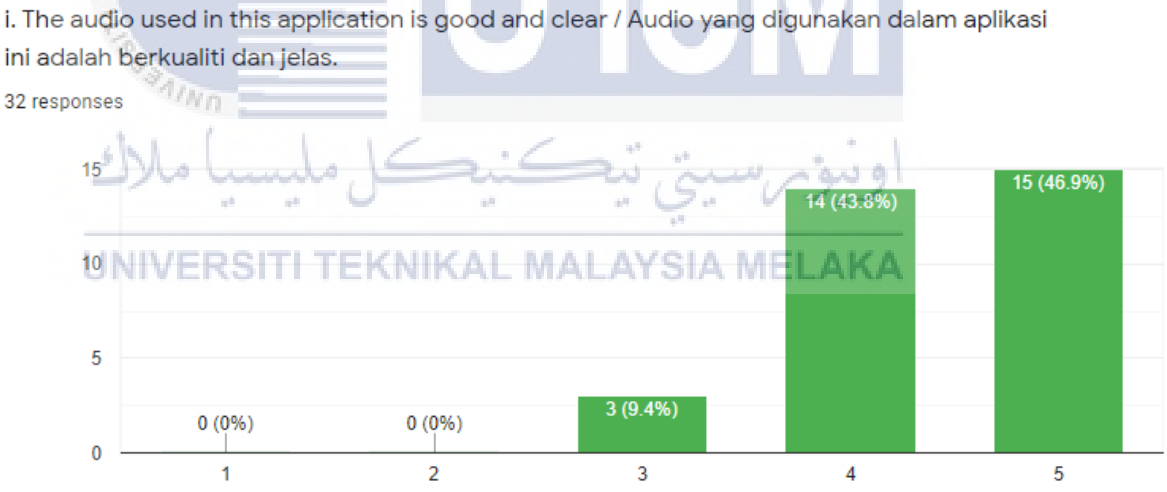


Figure 6-24 Question 15i

This question asked about is the audio used in this AR application is good and clear. In Figure 6-23, most of respondents strongly agree with the scale of 5 with 46.9%. There are also large number of them said agree with the scale of 4 with 43.8%. There are also some respondent think it is average with the scale of 3 with 9.4%.

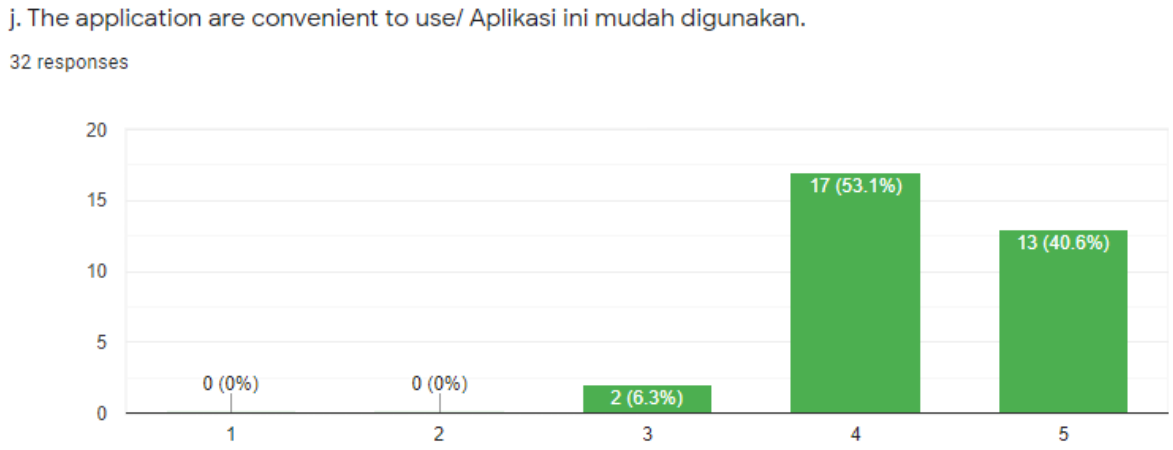


Figure 6-25 Question 15j

This question asked about is the AR application are convenient to use. In Figure 6-24, most of respondents agree with the scale of 4 with 53.1%. Others said strongly agree with the scale of 5 with 40.6%. There are also some respondent think it is average with the scale of 3 with 6.3%.

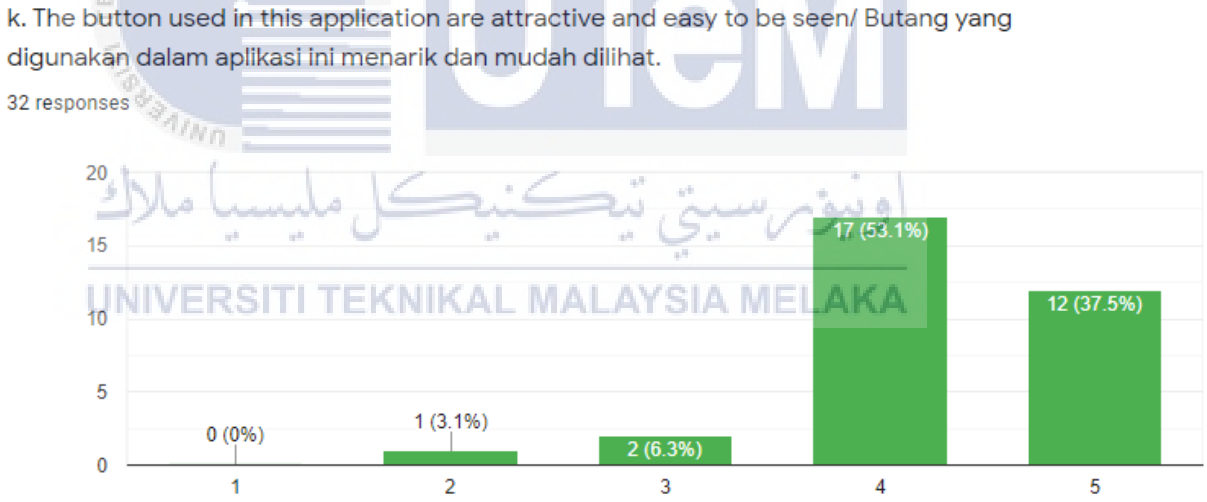


Figure 6-26 Question 15k

This question asked about is the button used in this AR application are attractive and easy to be seen. In Figure 6-25, most of respondents agree with the scale of 4 with 53.1%. Others said strongly agree with the scale of 5 with 37.5%. There are also some respondent think it is average with the scale of 3 with 6.3%.

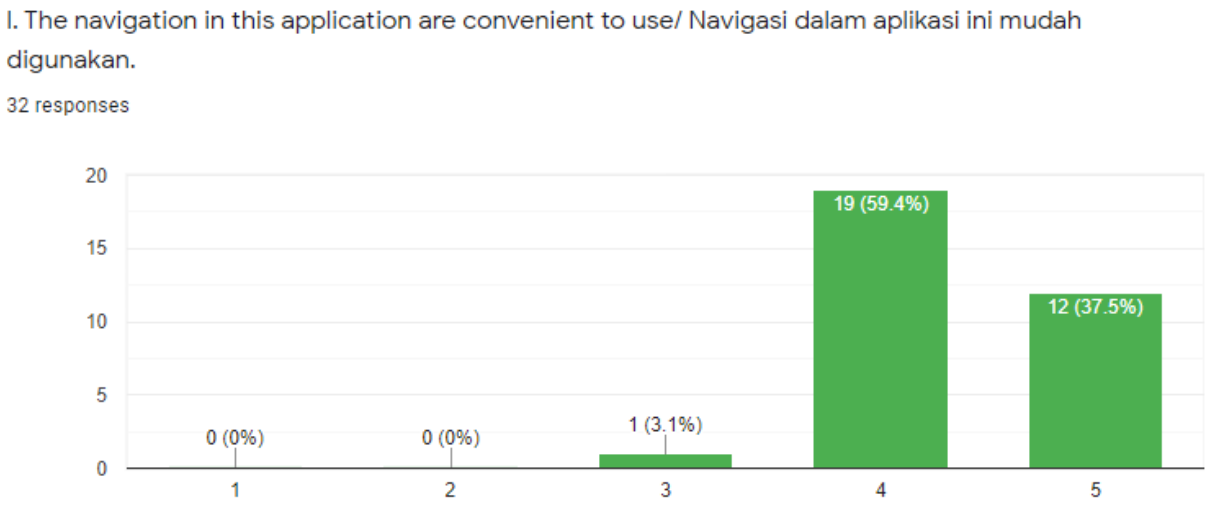


Figure 6-27 Question 15l

This question asked about is the navigation used in this AR application are convenient to use. In Figure 6-26, most of respondents agree with the scale of 4 with 59.4%. Others said strongly agree with the scale of 5 with 37.5%. There are also some respondent think it is average with the scale of 3 with 3.1%.

PART D: USER FEEDBACK

16. Do you have any comment(s) for this application? If YES, please state your answer.

16. Do you have any comment(s) for this application? If YES, please state your answer./ Adakah anda mempunyai komen berkaitan aplikasi ini? Sekiranya YA, sila nyatakan jawapan anda.

15 responses

No

Nice

Terbaik

no

Ia dapat menarik minat saya

Ya ia sangat menarik

very interesting

not really..

Nice AR for creating healthy earth

Maybe vuforia can be integrated with flutter in the future

The 3D models can be improved. We hardly seen the 3D models. As it has top view not front view. Also provide the zoom in zoom out interaction. And for future work, can improve the application using markerless AR.

soalan 16 dan 17 ni sama. So saya akan jawab di soalan 17

No, I think this AR is perfect as it is

good

Overall is good, user interface is acceptable, however I'm not sure how you measure the degree of awareness towards energy saving before and after using the AR apps. This will help to guide your study.

17. Do you have any opinion/ suggestion(s) for this application? If YES, please state the answer.

17. Do you have any opinion/ suggestion(s) for this application? If YES, please state the answer. / Adakah anda mempunyai sebarang pendapat / cadangan berkaitan aplikasi ini? Sekiranya YA, sila nyatakan jawapan anda.

12 responses

Tiada

No

Interesting

Tiada...tetapi aplikasi ini sangat bagus untuk mengingati dan memahami...

nope too

Nope

Adding app splashscreen

Pada pendapat saya, perlunya beberapa improvement dibuat di dalam aplikasi ini. Pertamanya dari segi UI/UX untuk beberapa menu yang dibuat seperti half baked. Penggunaan warna untuk aplikasi ini tidak seragam dan harus diseragamkan. Selain itu, untuk bahagian AR, tidak banyak yang menarik kecuali apabila kita scan kita nampak 3D model itu timbul dan boleh rotate. Information untuk barangan tersebut pun tidak interactive dan sekadar nampak model sahaja. Sekadar scan dan nampak model bentuk AR adalah sesuatu yg amat mudah dibuat tetapi benda mudah boleh dijadikan interactive dengan kaedah yang betul. Oleh itu saya tak nampak element keistimewaan yang ada dalam aplikasi ini dan sekadar just another simple AR project aje sedangkan diberi masa 15 minggu pada PSM 1 untuk menyiapkannya. Mungkin banyak masa diberikan kepada design. Oleh itu pastikan fokus utama adalah kepada bidang computer science tersebut iaitu lebih merujuk kepada elemen teknikal berbanding design.

add more product

If the 3D object can be seen more smoothly and more clear, it will be good

Reminder system maybe to alert user to take action such as check you power plug,

6.7 Conclusion

In conclusion, from this testing analysis, we are able to ensure this AR Technology Implementation on Promoting Saving Energy Awareness Application are functioning well if all the function requirements met. From the result, we know that this application getting a lot of good feedback from respondent but also still a lot of weaknesses noticed from the target user. In order to solve the weakness from this application, future improvements need to be made from time to time for more features in the future. In the last chapter will explain about the whole conclusion, strengths and weakness of the application.

CHAPTER 7: PROJECT CONCLUSION

7.1 Introduction

For the last chapter, every project comes with conclusion. There are the weakness and the strengths of this AR Technology Implementation on Promoting Saving Energy Awareness Application. The weakness and the strengths of the application had been observed along the development of the project. There are also the propositions for improvements and project's obstacles.

7.2 Observation on Weakness and Strengths

Application weakness	**Description**
This application can only be used on android	It cannot be used in different platform for example iOS
Internet connection	User who use this application need to have good internet connection for smooth jump to related website and mini quiz
Material	User who want to use this application need to have the physical or digital material which are the flash cards to scan the AR.

Table 7-1 Project weakness

Application Strengths	Description
Fun and interesting application	Since the content are about saving energy, it is quite boring if user reads it from any book or pamphlets. Through AR, using it together with flash cards, user will feel more fun when experiencing them.
Good for general knowledge	This apps can be used by any age of user, they can practice saving energy at their home in their daily life to maintain the green earth.
User-friendly interface	The interface of this apps are very simple and visible, most of the user had no problem to use the functions in this application.

Table 7-2 Project strengths

7.3 Propositions for Improvement

Every developed application coming from prototype to the advanced application. The improvement is important from time to time for the application to keep functioning well. It is to enhance the usability of the system. Since the app sometimes got crash, the bugs need to be fix. Also, for future improvements, this app need to be available in other platform like iOS, too. With this, this app can be considered multi-platform and everyone can use it.

7.4 Project's Obstacles

While developing this application, they are a lot of obstacles in order to achieve the final success of this application. One of the challenge to develop this application are the target image. It is quite challenging to find accurate target image to scan the AR. The problems are also to find the best lighting to make the AR happens and pop out. Sometimes, the apps keep crashing when open the AR camera. User need to quit the app and reopen it.

Besides, the animation are also challenging to create. Most of the animation were created smoothly and more advanced in the first place but not everything can be imported to Unity as perfect as they are. Unfortunately, the final result in the 3D model are only basic animation.

Next, the challenges are the respondents are limited to test out the application due to Movement Control Order (MCO) because of the Covid-19 pandemic. The respondents can only be tested with video demonstration. Most of the real AR experience cannot be experienced by user. Only nearby target user can only experience this AR application.

7.5 Conclusion

To sum it up, for this chapter and overall chapter, every application had their own advantages and disadvantages. It is a good thing if people with any age can actually use it to obtain their own general knowledge and in order to help being a part of contributing in maintaining green earth.

During the development of this application, it is fun to do research on the green earth information together with the technology of Augmented Reality which gives me the best and valuable experience for my final year project. Hopefully, one day this application are able to be used by general population in future.

REFERENCES

10 ways to save Energy, waste, and money with a more sustainable home. Earthwatch. (n.d.). https://earthwatch.org/stories/10-ways-save-energy-waste-and-money-more-sustainable-home?gclid=Cj0KCQjwweyFBhDvARIsAA67M71jFkO7RfrsQN3Wr4kUl5nDDOYcVAlI3gCb7_tGbXu0QnpVALPEajcaAoK9EALw_wcB.

31 ways to save energy in your Home: Constellation. Constellation Residential and Small Business Blog. (2021, July 6). https://blog.constellation.com/2016/01/01/31-ways-to-save-energy-in-your-home/.

6 unique ways to save energy I DEJARDINS Insurance. Desjardins Insurance. (2017, October 19). https://www.desjardinsgeneralinsurance.com/blog/-/6-unique-ways-to-save-energy.

Agile software development LIFECYCLE Phases explained. Relevant Software. (2021, August 27). https://relevant.software/blog/agile-software-development-lifecycle-phases-explained/.

Augmented reality – 5 facts you should know: Viewar blog. ViewAR. (2019, December 12). https://www.viewar.com/blog/augmented-reality-5-facts-you-should-know/.

Green earth - the only place for a sustainable human life! Follow Green Living. (2014, November 21). https://followgreenliving.com/green-earth-prolonging-earths-life/.

Hayes, A. (2021, May 19). *Augmented reality definition*. Investopedia. https://www.investopedia.com/terms/a/augmented-reality.asp.

How does saving energy help the environment. Save On Energy Blog. (2018, August 7). https://www.saveonenergy.com/learning-center/energy-saving-tips/how-does-saving-energy-help-the-environment/#:~:text=Save%20energy%2C%20save%20the%20environment&text=When%20you%20consume%20less%20power,a%20healthier%20and%20happier%20world.

Saran, S. (2018, June 28). *Running your AC At 27°C VS 18°c can cut your electricity bill by over 30%*. mint. https://www.livemint.com/Money/VOUrj7s47bJreraISIca0J/Running-your-AC-at-27C-vs-18C-can-cut-your-electricity-bil.html.

Wasteworld case study. Wasteworld Case Study. (n.d.). https://www.apptension.com/case-studies/wasteworld-case-study.

What is Alpha TESTING? Definition of alpha testing, alpha Testing meaning. The Economic Times. (n.d.). https://economictimes.indiatimes.com/definition/alpha-testing.

World Wildlife Fund. (n.d.). *Explore WWF Free Rivers, a new augmented reality app*. WWF. https://www.worldwildlife.org/pages/explore-wwf-free-rivers-a-new-augmented-reality-app#:~:text=Discover%20Free%2DFlowing%20Rivers%20in,and%20wildlife%20that%20live%20here.