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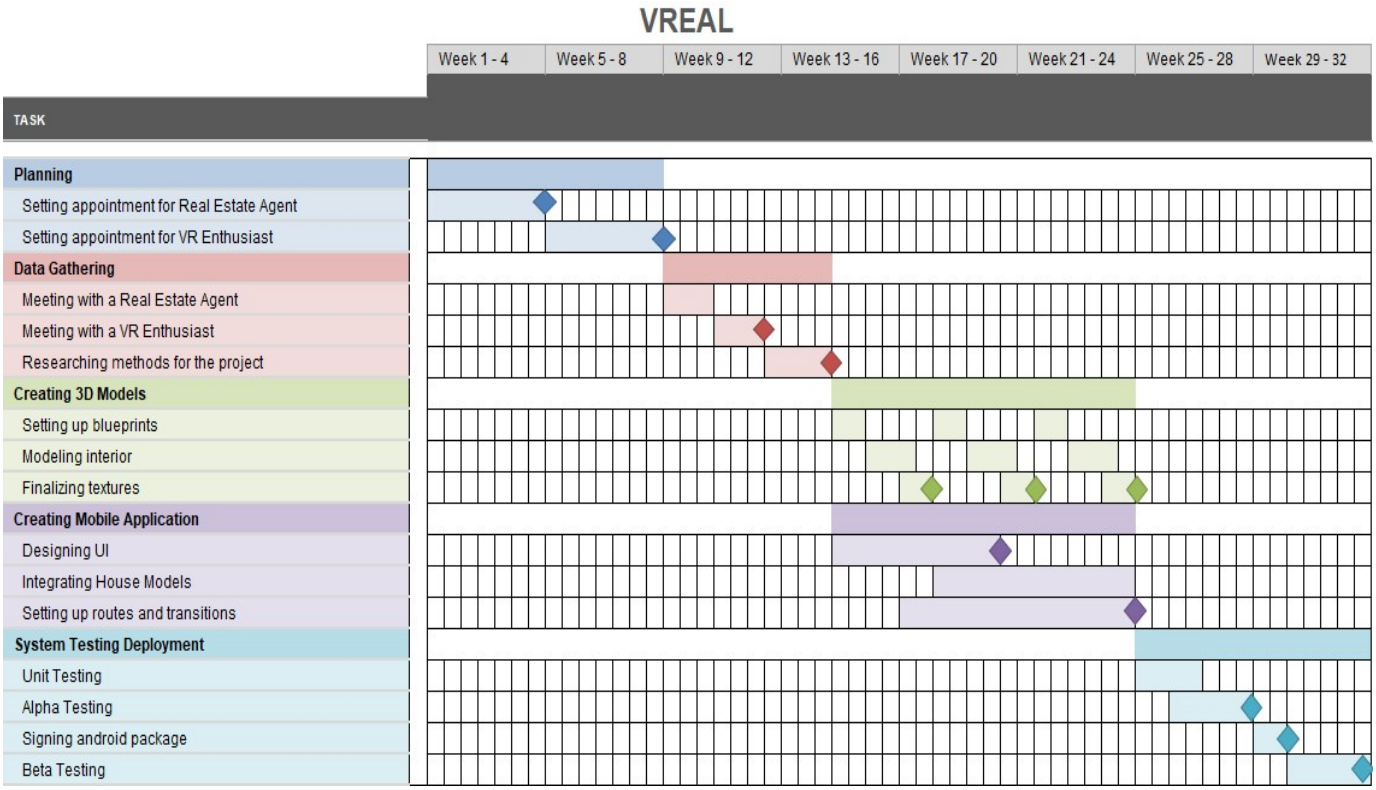
3.5 Gantt Chart

The table 3.5 shows the timeline of activities involving from planning to implementation of the mobile application.



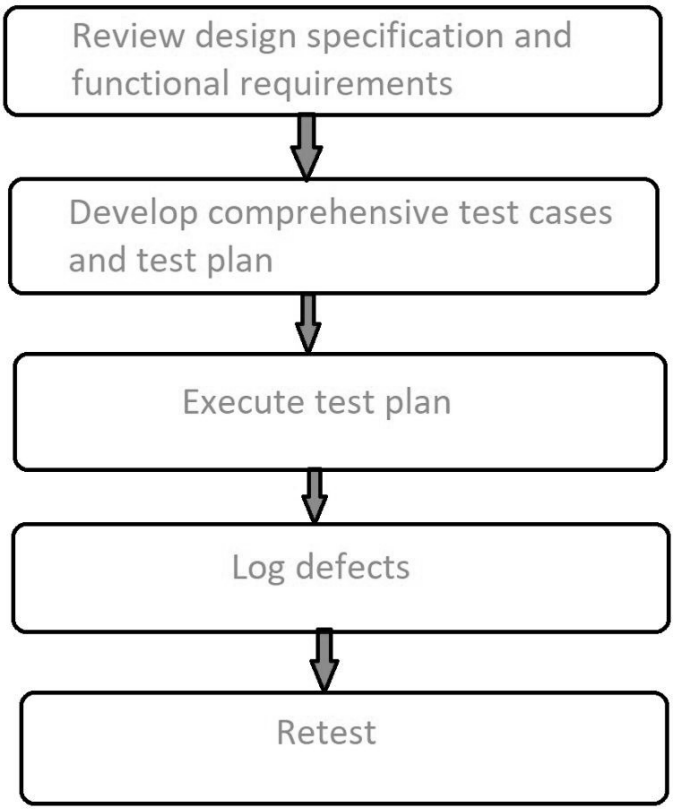


Figure 3.4.2.2 Alpha Test

3.4.2.3 Beta Test

Beta testing is performed by real users of the software application in a real environment. The researchers will perform beta testing to get direct feedback from customers. The researchers intend to perform this test with the real estate agents of Bria Homes to evaluate and get their feedback.

3.4.2 Functionality Test

Functionality test are series of test performed by the researchers to ensure quality and efficiency of the mobile application. The tests includes Unit test, Alpha test and Beta test.

3.4.2.1 Unit Test

The researchers will perform unit test to ensure that the code for the mobile application are more reusable. For the unit testing to be possible, the code needs to be modular, hence a code that will be much more easier to detect errors and debug them. The cost of fixing a defect detected during unit testing is lesser in comparison to that of defects detected after building the mobile application.

Unit test will be performed inside Unity 3D and Visual Studio Code. Unity 3D offers a live log of bug reports in console and Visual Studio Code offers debugging of scripts involved in the mobile application.

3.4.2.2 Alpha Test

Alpha testing is a type of software testing performed to identify bugs before releasing the product to real users or to the public. The researchers will perform alpha test before deploying the mobile application to Google Playstore to ensure the quality of the mobile application before forwarding to beta testing. The alpha test will be performed by the researchers. The figure 3.4.2.2 shows how the researchers intend to perform the test.

3.4 Testing Phase

3.4.1 Usability Test

The table 3.4.1 is the usability test questionnaire, the researchers provides a survey questionnaire to assess the usability of the mobile application. The target respondents are the real estate agents of BRIA Homes who will be rating the mobile application with the following scale :

5 = Strongly Agree, 4 = Agree, 3 = Fine , 2 = Disagree , 1 = Strongly Disagree

QUESTIONS	1	2	3	4	5
I found VReal to be useful.					
The functions and features were well organized and easy to use.					
I immediately understood how to use the application without the support of a technical person.					
The application is very immersive.					
The virtual showroom and real showroom are alike.					

Table 3.4.1 Usability Questionnaire

3.3.7 C# for Visual Studio Code

This extension provides lightweight development tools for .NET Core, great C# editing support, including syntax highlighting, IntelliSense, Go to Definition, Find All References. The researchers use this extension to ensure good quality of code and to lessen time consumed in debugging. This extension is also free to use and has a great documentation.

3.3.8 Git and GitHub

Git is a revision control system, a tool to manage your source code history. GitHub is a hosting service for Git repositories. The researchers uses these tools to lessen workspace consumed and to keep track of changes made. Keeping track of changes made will benefit the researchers giving them edge to switch to previous versions if needed and to download the documents needed anywhere.

3.3.9 Trello

Trello is a collaboration tool that organizes your projects into boards. In one glance, Trello tells you what's being worked on, who's working on what, and where something is in a process. The researchers opt to use Trello because it’s free and it’s easy to use. The researchers intend to use Trello to delegate tasks between the group and keep track of what task are being worked on.

3.3.4 Android SDK

Android SDK is composed of modular packages that you can download separately using the Android SDK Manager. The researchers use Android SDK to build the apk for the application, it contains tools for debugging and testing, plus other utilities that are required to develop an app. The Android SDK is used in the game engine for building the apk file of the VR application.

3.3.5 VR Headgear / Google Cardboard

VR Headgear / Google cardboard refers to a mount for the phone wearable in the head, it contains two lenses to magnify the split screen of the application. The researchers use VR Headgear/ Google Cardboard because of its cost efficiency and portability.

3.3.6 Mobile Phone

The table 3.3.6 below are the minimum specification of the mobile for the application to be usable.

Sensors	Gyroscope and Accelerometer
Phone size	Phone size < 6.7inch
Memory	2GB RAM At least 200mb free space
Platform OS	At least Android 5.0 (Lollipop)

Table 3.3.6 Mobile Phone Specifications

distort the edges of the rendered VR content that's been displaying in the mobile phone.

These are the following software that the system required in building the VR Application:

3.3.1 Unity 3D

Unity is a cross-platform game engine developed by Unity Technologies and used to develop video games for PC, consoles, mobile devices and websites. The researchers use Unity 3D because apart from it being free for personal purposes, it has a wide community base and that it has a great rendering capabilities. It is also easier to use compared to other technologies.

3.3.2 Blender

Blender is a professional free and open-source 3D computer graphics software product used for creating animated films, visual effects, art, 3D printed models, interactive 3D applications and video games. The researchers chose to use Blender not only because it is free, it is also compatible to run on any machine. It is also easier to use.

3.3.3 Visual Studio Code

Visual Studio Code is a source-code editor developed by Microsoft for Windows, Linux and macOS. Among many source-code editor, the researchers opted to use Visual Studio Code because it’s capabilities to integrate extensions that makes it easier to edit and debug your source-code.

3.2 Development Phase

3.2.1 Developing the Environment and Objects

Environment and objects of the mobile application are developed by the researchers using Blender. After getting the house model from the client, the researchers will proceed in making the 3D house model in Blender. In order to ensure that the VR simulation model runs as efficiently as possible, the researchers aims to reduce the number of polygons in the 3D objects. 3D files typically include more information than is necessary. Removing excess polygons will improve the visual performance of the 3D model.

3.2.2 Developing the Virtual Reality Application

In the development of the mobile application, the researchers used Unity 3D game engine which offers a wide variety of tools. The engine can be used to create three-dimensional, two-dimensional, virtual reality, and augmented reality games, as well as simulations and other experiences. Unity 3D is free for individual use.

3.3 Software and Hardware Requirements

The mobile application needs two hardware, a mobile phone and a VR headgear. The mobile application needs a mobile phone with gyroscope and accelerometer sensors in order for the mobile application to read the movement and rotation of the phone. The VR headgear will be mounted on the user's head and will serve as the house of the mobile phone. The lenses inside the VR headgear will magnify and

3.1.4 System Architecture

Figure 3.1.4 shows the system architecture of Virtual Reality and the interaction between the whole components needed for the mobile application software to work. 3D Objects and Environment will be loaded to the mobile phone's System-on-a-Chip (SoC) as the VR Content and the SoC will render these VR Content. The user's mobile phone need to have a gyroscope and accelerometer sensors in order for the software to detect the phone movement and rotation. Signals from the sensors will be read by the mobile phone SoC thus simulating the movement to the rendered VR Content. And finally the VR Content will be received by the user wearing the VR Headgear/Google Cardboard.

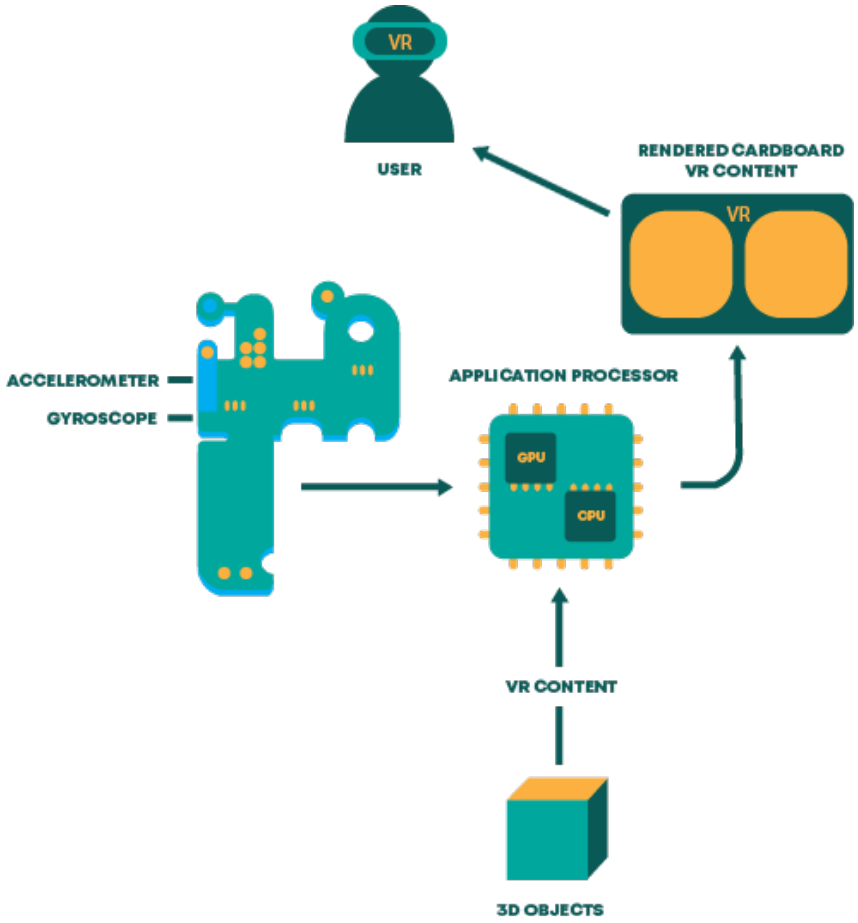


Figure 3.1.4 System Architecture Diagram

3.1.3 Activity Flow Diagram

Figure 3.1.3 shows the activity flow between the user and the mobile application. After opening the mobile application, the user can choose the preferred house model. After choosing the house model, the user can decide to view the model in the VR showroom. The user can also select a different house model after viewing the showroom.

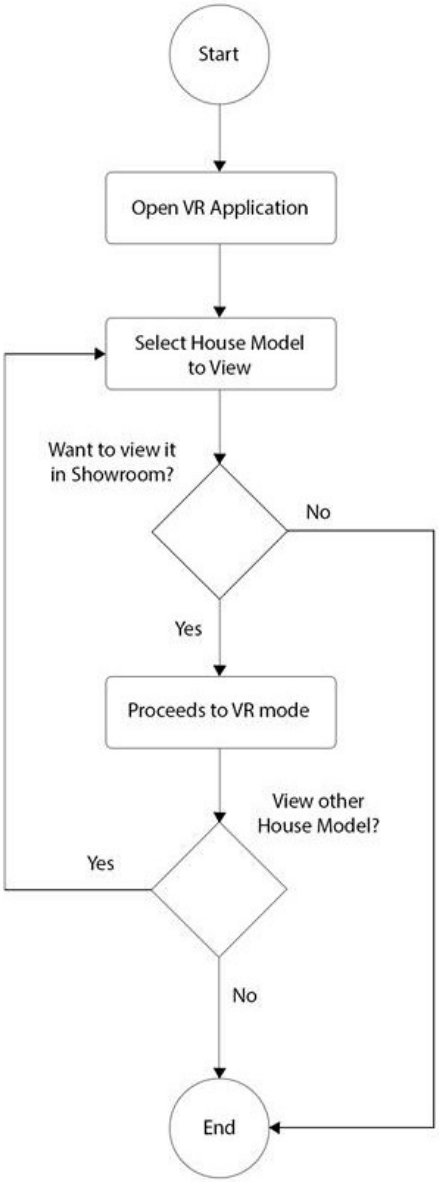


Figure 3.1.4 Activity Flow Diagram

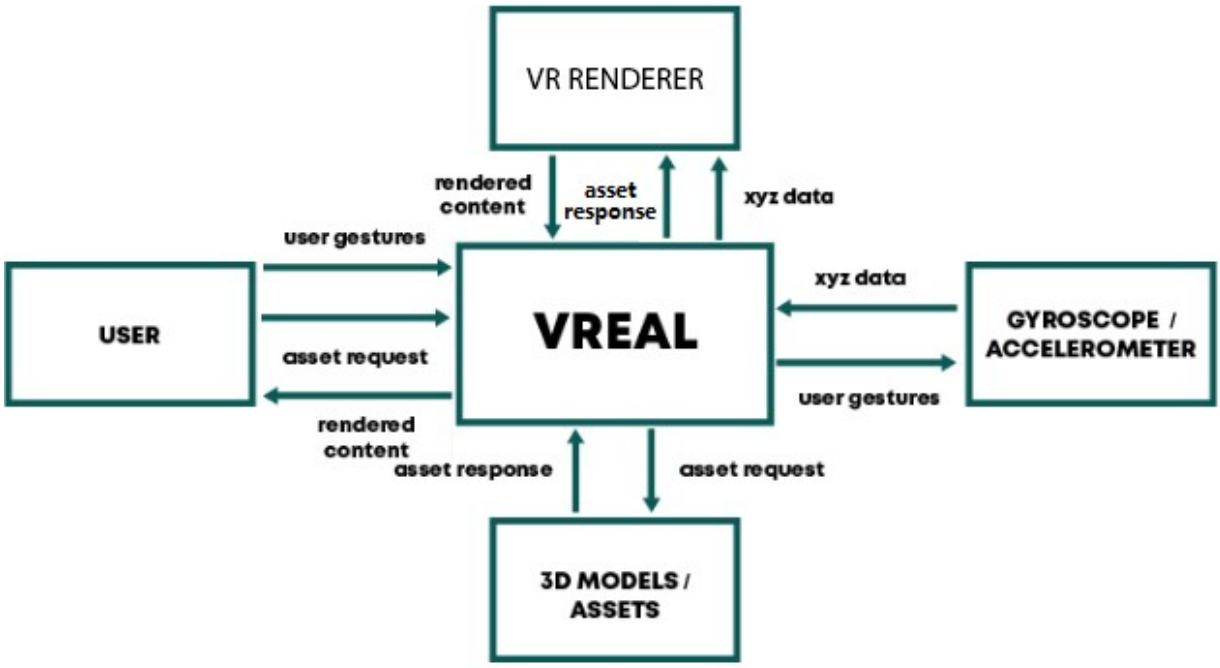


Figure 3.1.1 Context Diagram

3.1.2 Use Case Diagram

Figure 3.1.2 were used to illustrate the general overview of the role between the mobile application and the user.

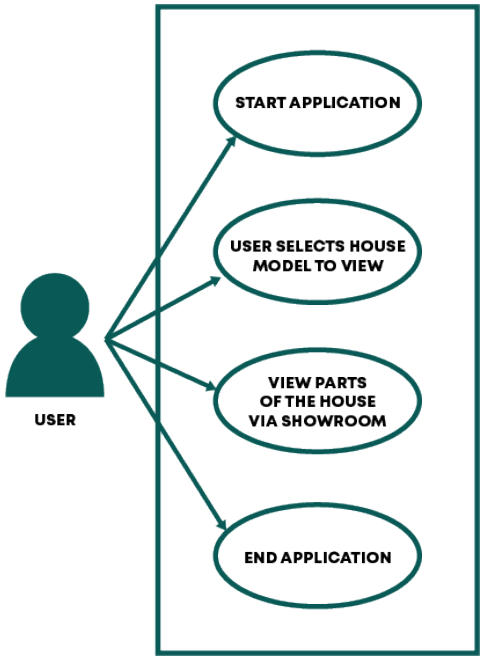


Figure 3.1.2 Use Case Diagram

CHAPTER III

METHODOLOGY

This chapter provides the methods of the study of how the researchers design, develop and implement the system. It also shows the software and hardware needed for the study in order to solve the problem.

3.1 Designing the System

3.1.1 Context Diagram

Figure 3.1.1 shows the abstract view of the system with the external agents namely user, assets, sensors and VR Renderer. The user can request an asset to be loaded, 3D models and asset receives and respond the appropriate asset and the mobile application receives the response and will send the asset response to the renderer. The renderer sends out a rendered content and the mobile application sends the rendered content to the user for live viewing. The user also sends gestures and the mobile application sends this to the gyroscope/accelerometer sensors and the sensors replies with xyz data and the mobile application sends it to the renderer. The renderer will now send a rendered content to the mobile application and the mobile application will send the rendered content to the user for live viewing.

and enhances the understandings of a project's usefulness, however the operation of virtual reality is still the major problem that affect clients' satisfaction and challenges the developer's acceptance in applying it to future housing sales.

There are also a lot of existing virtual reality applications on Google Play. An application named VR case 3D uses virtual reality to show the inside and outside of a house. However, you cannot walk around the house. It will only position you to a certain point and allows you to rotate your head to see the environment around. In order to go to other points, you need to click the point where you want to go next. Another application named Real Estate VR/AR uses augmented and virtual reality to show the interior of an office. It uses happy path for you to walk through the premise of the office, which might lead to neck strains.

As indicated here, it shows that there is a gap of knowledge on virtual reality, specifically in the real estate industry. It also shows that the utilization of virtual reality in housing industry is not yet fully exploited in the Philippines. Though there are a lot of existing virtual reality applications, what sets this study apart is that it has a unique model which comes from view real estate site (of Bria Homes). Also, those applications from Google play doesn't have written documents. Thus, this scenario made the researchers explore other usage of virtual reality, specifically in housing industry.

instruction purposes. With the use of medical devices such as Oculus Rift and Raxer Hydra, an immersive experience can be given with a hand interactivity. Trainees can learn by doing, albeit in the virtual environment, thus identification of certain organs to perform an actual incision is not a problem anymore.

As virtual reality slowly dominates the field of medicine, it is also becoming a widespread on medical education. An existing study by Izard, S. G. et al (2017) about virtual reality educational tool for human anatomy stated that by allowing virtual immersion in the body structure, for instance interior of the cranium, stereoscopic vision goggles make these innovative teaching technologies a powerful tool for training in all areas of health sciences. Basically, the aim of this study is to illustrate the parts of human body by applying virtual reality in the field of medical education specifically, human anatomy.

Recently, virtual reality has been rapidly recognized and implemented in construction engineering education and training. A study by Wang, P. et al (2018) stated that this study provides the integration of VR with emerging education paradigms and visualization technologies. This would help both educators and researchers to fully use integrated VR in their education and training programs to improve their performance.

Virtual reality is also taking a step higher in the field of housing industry. In a study by Juan, Y.-K. et al (2018) about developing and evaluating a virtual reality-based navigation system for pre-sale housing sales in Taiwan, wherein they invite thirty clients to test and explore the suggestions of using it for project navigation. Results shows that virtual reality increases clients' intention to purchase

CHAPTER II

REVIEW OF RELATED LITERATURE

Virtual reality is an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment. On a computer, virtual reality is primarily experienced through two of the five senses: sight and sound *(https://whatis.techtarget.com/)*.

Three-dimensional image is the simplest form of virtual reality that can be further explored interactively. In an international scene, a study by Huang, Y.C. et al (2015) stated that technological innovations have transformed tourism industry and affected how tourism destinations are perceived and consumed. The virtual world offers opportunities for destination marketing to communicate with spotted markets by offering an environment for potential visitors to explore tourism destinations. They also stated in their study that it contributes to understanding how best to construct interactive as well as informative 3D virtual tourist destinations to attract potential online and real-world tourists.

Virtual reality also advances in the field of medicine. A study by Keller, J. L. et al (2017) about the use of virtual reality technology in the treatment of anxiety and other psychiatric disorder. It is also stated in this study that a systematic literature search was conducted for them to identify different studies utilizing VR- based treatment for anxiety and other psychiatric disorders, specifically on exposure-based intervention for psychiatric disorders. In another study by Mathur, A. S. (2015), about the low cost virtual reality for medical training states that his study is a low cost virtual reality set-up that can be used for medical training and

1.4 Significance of the Study

This study is intended for real estate agents in showcasing their property or house models virtually. It will benefit realty agents as it lessen the multiple site viewing with the use of virtual reality application as a showroom to the clients or homebuyers. It is also beneficial to clients for it provides a detailed outline model that lets them experience the actual property without visiting multiple properties.

1.5 Scope and Limitation

This research aims to create three model properties from a real estate company (Bria Homes) as a pilot testing in creating the 3D assets for the mobile application. The mobile application will be exclusively built for the real estate company and the platform for the mobile application will be Android.

models while immersing them on the unit without spending too much time and money travelling to scope out properties, making them feel real with VReal.

1.2 Statement of the Problem

Real-estate agents have multiple-site viewing conducted every day, with almost 4 up to 6 home visits. However, the number of site visitations varies on the client's decision and before the client decides on which one they really want, it would take approximately 4 or more weeks of site visitations. Based on the data gathered, real estate agents have spent long duration on site visitations leading to close a deal longer and other potential clients will have to wait until the other site visitation ends.

1.3 Objectives of the Study

1.3 Objectives of the Study

This study generally aims to develop a mobile application that can be used by the real-estate agents as a tool in multiple-site viewing.

Specifically, this study aims:

- To design 3D models from real estate properties.
- To develop a mobile application that uses virtual reality and will enable the user to have its 360 virtual tour to a property they want to acquire.
- To test and evaluate usability and functionality of the mobile application.
- To deploy and publish the mobile application to Google Play Store for real estate agents download and install in their mobile phones.

There are already existing technologies of creating a virtual reality. From the first virtual reality modelling language to web3D consortium then to the modern WebVR that supports various virtual reality devices. One of which is the Oculus Rift wherein users are immersed in an environment using a pair of screens that displays two images side by side, one for each eye. A set of lenses is placed on top of the panels, focusing and reshaping the picture and creating a stereoscopic 3D image. The goggles also have embedded sensors that monitor the head motions and adjust the image accordingly. It is widely and is commonly used in virtual reality however, the main problem with this is that it is very expensive, hard to develop and it requires high end devices to work. An existing application on Google Play named VR case 3D uses virtual reality to show the inside and outside of a house. However, it is not very immersive because you cannot walk around the house. It will only position you to a certain point and allows you to rotate your head to see the environment around. Another application named Real Estate VR/AR uses augmented and virtual reality to show the interior of an office. It uses happy path for you to walkthrough the premise of the office, which might lead to neck strains.

In this paper, the researchers propose to develop a mobile app that will be compatible with Google cardboard and also portable to view real estate site (of Bria Homes). This study produces an immersive virtual showroom for users to try before they buy – without spending too much time and money travelling to scope out properties. It contains unique models that are from the realtors blue prints of the units. It focuses on helping clients to choose their dream house with a pool of

CHAPTER I

INTRODUCTION

1.1 Background of the Study

Technology is rapidly changing the real estate industry and several trends are leading the way. Various technology are being used in the real estate industry. Examples are automated tool, IoTs, Augmented realities and virtual realities. Virtual Reality is a three-dimensional, computer generated environment which can be explored and interacted by a person, and it is slowly revolutionizing the fields of medicine, engineering, tourism and real estate industry. Dwelling in real estate industry, realtors spends 4 weeks or more in site visitation with a particular client (*www.zolo.ca*). Once a particular client is on site visitation, another client can't check the place at the same time. Thus, virtual reality opens an avenue or opportunity for realtors to market their units faster and conveniently to multiple potential clients which will probably boost their selling efficiency.

In the Philippines alone, a survey conducted by the Annual Survey of Philippine Business and Industry (ASPBI) in 2017 showed that a total of 519 establishments with total employment (TE) of 20 and over in the formal sector of the economy were engaged in real estate activities. This number represents a decrease of 11.1 percent for the year compared with the 584 establishments in 2016. (*psa.gov.ph*). The real estate industry has remained static over the past years in the Philippines. Traditional practices are still commonplace, especially in the Philippines which is in fact an inconvenience and time-consuming for both realtors and homebuyers.

VReal : A Real Estate Virtual Showroom

Members:

Battung , Tyrone
Arbues, Yves

Amil, Lance

Jabla, Arch