# DEVELOPMENT OF VIRTUAL REALITY TECHNOLOGY: HOME TOUR FOR REAL ESTATE PURCHASE DECISION MAKING

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***ABSTRACT***

*Virtual reality (VR) is a technology; derived with various potential benefits for many aspects of rehabilitation assessment, treatment, and research. The emphasis of VR is computational rather than experiential. To preview Quill Residences houses, a buyer had to go to the showroom that was only located at two places in Kuala Lumpur. The showroom houses often lack depth and a sense of reality and take quite a bit of imagination to realize what the effect will look like in the real environment. There is a less interactive virtual reality walkthrough application from a local company for real estate marketing purposes. Therefore, this research aims to evaluate the effectiveness of interactive virtual reality walkthrough applications in home interior design for the real estate purchase decision. This research focuses on the interior design of Quill Residences and helps the real estate's buyer to identify the home interior design criteria for the purchase decision. The current study has employed the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model representing a home tour immersive framework (HTIF) in creating practical resources to support VR application development. Results have shown that 90% of respondents believe that interactive virtual reality walkthrough application is effective in assisting the real estate's purchase decision. Hence, this study will contribute to the effectiveness of interactive virtual reality walkthrough applications for real estate purchase decisions.*

***Keywords: Virtual reality, purchase decision, walkthrough application***

## 1.0 INTRODUCTION

Virtual Reality (VR) of Quill Residence's showroom is a platform for users to access the residence's floorplan with the real estate's virtual reality for convenience function. Virtual reality is not new, but in today's luxury real estate market, it gave buyers chances to tour a property without having to see them in person. It can also be used for a luxury property that has not been completed yet. This also made foreign buyers who do not necessarily want to fly in to check out new investments.

VR has an interactive approach as it is a user-friendly application. When the user entered the showroom, they will be given a choice to turn on the lights and change certain items' colours. Other than that, the user can also move freely inside the showroom to view the details of the room.

### 1.1 Demographic in Real Estate Buying

According to [4], 41% of buyers choose a real estate agent based on a recommendation. About half of all prospective buyers depend on their partners, neighbours, or relatives' advice when selecting their realtor. Just 12% of customers vote for brokers they have dealt with before. 73% of realtors use Facebook for their work. Statistics of real estate agents reveal that most licensed agents rely on Facebook for their marketing immobility needs. Therefore, it is logical, as it is one of the world's biggest networks with more than 2.4 billion subscribers worldwide.

There are 93% of people who visit websites when searching for homes. The best choice for nearly all age ranges appears to visit a website and search for the most attractive deals available. Millennials with ages ranging from 29 until 38, dominate with a whopping 98% of internet-relying home buyers. Numbers from the real estate industry support reports the so-called Silent Generation leaders are going in a new direction.

Although 72% of them switch to online reviews, about 86% of old-timers choose to work with a property consultant. Nearly half (46%) of all customers get updated by yard signs, and marginally more than open house activities. The data shows that VR application in dealing with property sales is still relevant. This can be seen in the statistics of digital platforms nowadays that deal with real estate. The data shows that the use of VR applications in dealing with property sales is still relevant. This is based on the current statistics of the use of digital platforms that deal with real estate.

### 1.2 Category of Virtual Reality Technology

VR research is turning the corner from concentrating only on hardware to focusing gradually on what can be achieved with VR content, which is now pushing the application. The VR medium, including technologies needed to accomplish the physically immersive effect and the nature of the interface, provides valuable and meaningful content [6]. Three types of VR application contains different element (a) fully immersive VR, (b) semi-immersive VR and non-immersive VR.

#### 1.2.1 Fully Immersive VR

Fully Immersive VR gives users an entirely virtual environment experience. It involves the use of VR hardware to help users through the virtual experience. Users need to wear a headset-mounted display (HMD) and trackers and haptic devices such as the Omni Binocular Orientation Monitor (BOOM) to view the virtual environment. HMD is a small monitor mounted in front of each eye that provides stereo, bi-ocular or monocular images.

#### 1.2.2 Semi-Immersive VR Systems

Semi-immersive VR involves the use of high-performance graphics equipment to bring users into the virtual world. The graphics device combines a large screen monitor with an extensive screen projection system or a multi-television television system.

#### 1.2.3 Non-Immersive VR Systems

Compared to the other two categories of VR, Non-immersive VR is the category of VR applications that are least felt by users. Through this VR category, exploring the virtual world through portals or windows using necessary hardware such as desktop computers, keyboards, and mice. It is also known as Window on World (WoW) [11].

### 1.3 Interior design through Virtual Reality

Human life experience is mostly played out in interior spaces [12]. Traditional internal design methods usually lack depth and sense of realism and require the designer and the client to meet in one place [16]. Using collaborative virtual technology in the design process will address specific problems. This research will be using virtual reality systems to build a home interior environment. The planner and the consumer will operate together using the program without meeting at the same location.

The device suggested can be used to improve the sense of presence significantly. In the conceptual design point, the easiest way to share the vision of an interior design project with the client is to execute it in a dynamic 3D environment, based on the internal design function. Traditional 3D interior room designs are produced by designers and tested by consumers, but we want to extend customer requirements in conceptual design.

According to [10], virtual reality functions as a pedagogical instrument in an interior design foundation course. One of the newest applications of virtual reality in the business world is ads. The marketing technologies for virtual reality are as nuanced as the marketing techniques themselves. Until the right technology, the introduction of virtual reality will not excel in connecting consumers to each other and the experience you have tried to create for so long.

New technologies are evolving that contribute to the way homes are being built. Virtual reality (VR) has started to radically transform architecture, giving rise to "virtual property inspections" that provide a clear view of the premises even before construction crews break ground. Contrary to what people see on their beloved real estate reality shows,

which shows a smooth cycle of constructing and decorating a beautiful home within 30 minutes (including commercials), having a high-cost real estate dream come true is no easy feat.

According to [5], each application area has its hardware and software platforms to support this alternative experience; depending on the VR environment's role and interactivity of the users involved. VR is an enticing and intuitive way of visualizing and discovering the past and is therefore used in cultural heritage and archaeology in education, tourism, and science. According to [14], virtual reality (VR) is an emerging technology that diversifies possible advantages for many aspects of rehabilitation assessment, treatment, and research.

## 2.0 REAL ESTATE PURCHASE DECISION MAKING

Building companies and real estate services have, in recent years, focused more on customer activity and demand. Many residential real estate's purchasing behaviour changes have occurred in the past decades, allowing consumers to be more attentive to specifics of apartments and external factors such as climate and finance.

Besides, it is also challenging to determine the details of the purchase for a living. The questions arose here where and what sort of residential property to consider for the purchase of living—considering housing standard, interior design, apartment size, residence configuration, natural lighting, parking area and playground for children etcetera.

Today, any company that performs market research and that study has continually understood the relevance of market participants' behaviour. Most of the market research has focused on customer satisfaction, buyer desire in recent years. However, they typically do not concern about consumer needs and the reason for the purchase decision.

## 3.0 THE PURPOSE OF DEVELOPMENT

VR home tours allow agents to circumvent traditional one sheet of glossy and fundamental web pages and market land uniquely. VR dramatically alters the loop of home shopping. This virtual reality walkthrough showroom aims to define home interior design requirements for the real estate purchase decision.

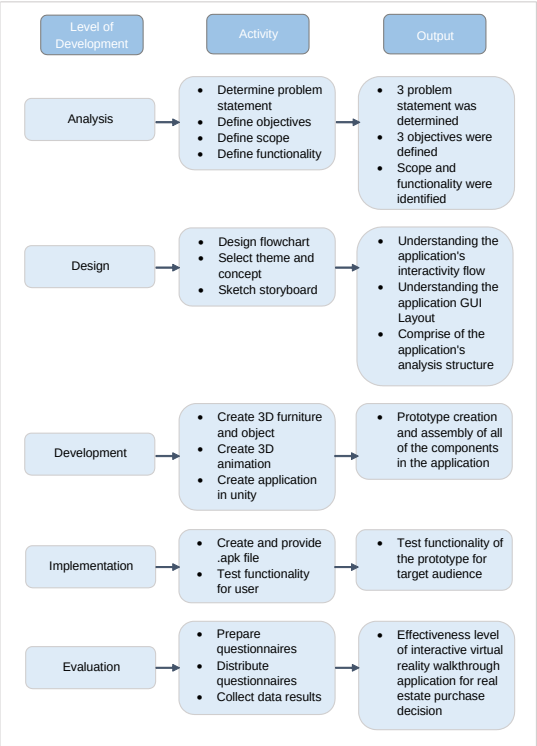


Fig. 1: Home Tour Immersive (HTI) Framework

This research creates a framework named as home tour immersive (HTI) framework for the interior design showroom virtual reality walkthrough and tests the real estate purchase decision's efficacy, as shown in fig. 1. Along with this research, the VR application was developed based on the research objective that consists of:

i. Identify the home interior design criteria for the real estate purchase decision.
ii. Develop an interactive virtual reality walkthrough application for interior design showroom
iii. Evaluate the effectiveness of interactive virtual reality walkthrough application for the real estate purchase decision.

The research objectives will solve three problems as below:

i. Limited numbers of showroom's locations – To see Quill Residence's showroom, the buyer had to go to the real showroom situated at 2 locations in Kuala Lumpur. Buyers from other states were only expected to travel to Kuala Lumpur to see the showroom.
ii. Lack of depth and sense of reality - Nowadays, the showroom is presented using a 360-degree panorama picture tour comprising of a sequence. The approaches also lack complexity and a sense of fact and require quite a bit of creativity to consider in the modern world what the result would look like.
iii. Less interactive virtual reality walkthrough - For real estate marketing purposes, the local company's virtual reality walkthrough programme is less interactive. In 2019, virtual reality was used each month by just 13.0% of the population.

## 4.0 METHODOLOGY

The techniques used to complete the project are illustrated in this section. The HTI framework details the steps and methods necessary to achieve this project's aim. The first approach is to adopt the principle of analysis, design, development, implementation, and evaluation (ADDIE), which represents the entire project in this methodology.

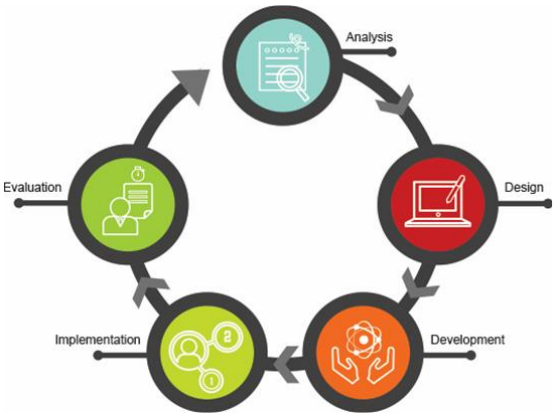


Fig. 2: ADDIE Model

According to the fig. 2, the ADDIE model is ADDIE model is the common paradigm traditionally utilized by instructional designers and software managers. The five phases represent a dynamic, flexible process in which appropriate curricula and tools are built to maximize performance. In any environment, the elements created using the ADDIE model can be used online or face-to-face [2].

### 4.1 Phase 1: Analysis

The analysis process was carried out primarily by using secondary data. Secondary data are collected and documented by someone else before, for reasons other than the current mission. Secondary data use requires fewer costs, reduced time and little effort. Many of the secondary data gathered was from papers, articles, and books in the first place. In this phase. Besides, the researcher also determines the problem statement, objectives, scope, and functionality. As an outcome, the three problems statement and objectives were determined. The scope of the study and the functionality of the project that has been developed was also identified.

This project aims to create an immersive virtual reality walkthrough program using both 3ds max and Unity for the interior design showroom. This research aims to describe the home interior design requirements for real estate purchasing and create an HTI framework for interior design showroom virtual reality walkthrough. This study would concentrate on Quill Residences' interior design and allow the buyer of the real estate to define the purchasing decision requirements for home interior design. The usefulness of the immersive virtual reality walkthrough technology for real estate buying decisions using quantitative analysis will also be measured in this report.

### 4.2 Phase 2: Design

According to Peterson (2003), the design phase methodology should be managed with a logical, systematic method of identifying, applying, and evaluating suggested methods to achieve the project's objectives. This is done when aligning goals and objectives with assessments, designers refer to the analysis phase for data that provides requisite information about user characteristics.

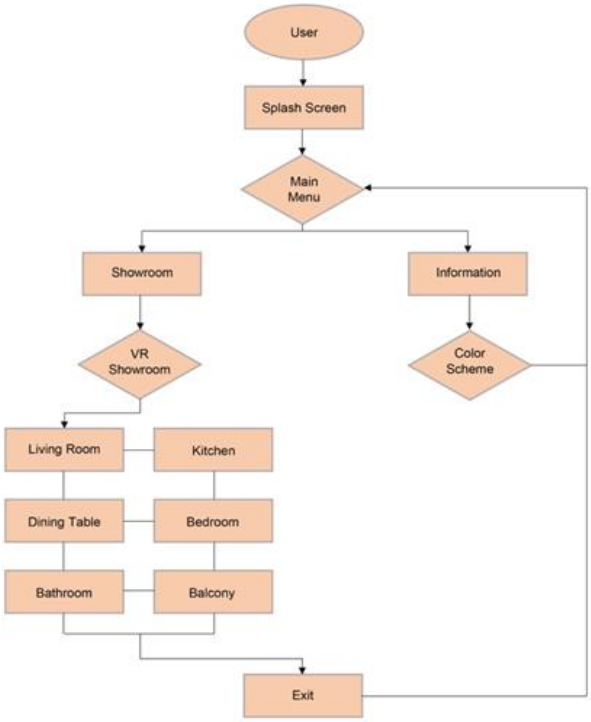


Fig. 3: VR project flowchart

According to Fig. 3, a flowchart is done for the project management process and the storyboard for development preparation. A flowchart is a graphical assist that visualizes the sequence of actions to be taken in project management. According to [11], a flowchart's purpose is to help visualize required steps, significant for a project management process. Then, the storyboard is needed to understand the application of the graphic user interface layout.

### 4.3 Phase 3: Development

The design task has defined the storyboard's interface layout for the project, as per the fig. 4. Typography size and shape, 3d model design, animation, colour, icons and buttons working in the sense of content- the appropriate user interface is the subject of this virtual design to be emphasized during this process. The outcome is that the design phase will proceed to the development phase.

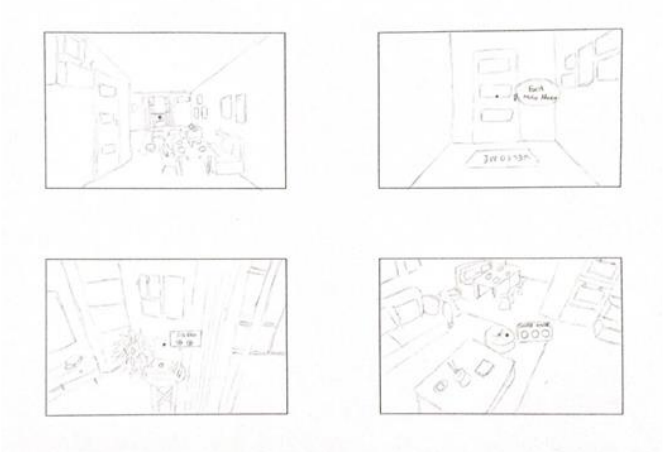

Fig. 4: VR application storyboard design sketch

This approach extended from the prior procedure, which was the step of the analysis and design phase. According to fig. 5, it is shown that the designer in the development phase has created 3D furniture and 3D animation. In the Unity programme, the application is then generated. Using a digital framework called Unity, this immersive walkthrough showroom in virtual reality was built with functions and navigation, including buttons, text, 3D animation and sound. The language of programming used in the programmes is C#.


Fig. 5: VR application home tour 3D model

The 3D objects were created by the developer using 3ds Max 2016. While Unity 2018.3.5f1 (64-bit) is used to build the VR programme. 8.00 GB Intel Core i7 RAM, 2.40Ghz, 64-bit operating system, and NVIDIA GeForce GTX 1080 are the hardware needed for this project.

### 4.4 Phase 4: Implementation

Implementation is the fourth stage in the ADDIE model. The researcher continues to plan the content for the entire target market and prepare the distribution alternative. The real estate's buyer should participate in it and complete the survey set of reviews. This interactive virtual reality home tour has been published in .exe and .apk file, which will be uploaded on an android phone and be placed inside a virtual reality google. The researcher tested the functionality for the target audience using the VR goggle device. The application will also be exported as a CD-ROM file then transmitted to the administrator and accessor.

### 4.5 Phase 5: Evaluation

Evaluation is the final stage of the ADDIE method. Formative assessments are carried out on the move by obtaining input from the lecturers and conducting the adjustment based on the supervised lecturer. It helps to monitor how well the project's goals and targets are being accomplished. As for the summative appraisal, the questionnaires are allocated to 30 participants. The respondents, including potential real estate potential buyers from age of 25 to 40 years old.

## 5.0 RESULT AND DISCUSSION

Table 1: VR application evaluation result

| No. | Question | Strongly disagree | Disagreed | Neither agree nor disagree | Agree | Strongly agree |
|---|---|---|---|---|---|---|
| 1 | Application is placed in a suitable position | | | | 6 (20%) | 24 (80%) |
| 2 | Application is easy to use | | | 3 (10%) | 9 (30%) | **18 (60%)** |
| 3 | Application may help them get more information and experience on real estate | | | | 9 (30%) | **21 (70%)** |
| 4 | Application made them in control of the virtual experience | | | 3 (10%) | 6 (20%) | **21 (70%)** |
| 5 | Instruction given are clear and understandable | | | | **15 (50%)** | **15 (50%)** |
| 6 | Acceleration of the movement does not cause them sickness | | | 9 (30%) | **12 (40%)** | 9 (30%) |
| 7 | Navigation buttons provided are easy to use | | | | **15 (50%)** | **15 (50%)** |
| 8 | The realistic of the 3D visualizations | | | 3 (10%) | 6 (20%) | **21 (70%)** |
| 9 | Animation made the application more interactive | | | 3 (10%) | 6 (20%) | **21 (70%)** |
| 10 | Ability to explore the environment with an immersive experience | | | | 12 (40%) | **18 (60%)** |
| | **TOTAL** | | | | **3 (30%)** | **9 (90%)** |

Based on table 1, the result shows that the respondents strongly agree with questions number 1, 2, 3, 4, 5, 7, 8, 9, and 10. Meanwhile, agree and strongly agree is balanced for questions number 5 and 7. The result shows respondents agree with question number 6. Total from the analysis shows 90% of respondents strongly agree with interactive virtual reality walkthrough application is effective for real estate purchase decisions. From the result that has been conducted in the evaluation phase, it means that:

i. Question number 1: The features in the application indicate the purpose of the application which was to develop an interactive virtual reality walkthrough application for interior design showroom.
ii. Question number 2: All of the info panels and buttons on the application are put in an appropriate position in the application and are easy to understand by the user. This could result in users being able to follow the flow of the application seamlessly.
iii. Question number 3: The showroom area in the application is designed with realistic 3D objects to give users more experience. Moreover, the information such as colour scheme on the furniture and measurement of the apartment are displayed for the user to get more information on the real estate for purchase decision making.
iv. Question number 4: Users can interact with an interactive interaction provided while they move around the showroom by using a controller.
v. Question number 5: The info panel provided in the application is included with instructions that use san-serif font type for text content and were scaled and positioned to help improve the readability and legibility of the content.
vi. Question number 6: The speed of the movement was set to 30f, units per second which allow users to move at an average speed to reduce motion sickness.
vii. Question number 7: The user needs to use the VR gaze and gaze at the furniture for 2 seconds for it to have an interaction. The icons and buttons that were used were labelled according to their usability. In addition, the icon buttons used a user-friendly icon context for the user to recognize the functionality of the buttons easily.

viii. Question number 8: The furniture and the decoration displayed in the application are created and designed in 3ds max software by using techniques such as Boolean operation, topology freeform, and splines modelling. Each size of the furniture is being measured according to the actual size to give a realistic visualization. The colour of each piece of furniture and decorations are then being added in Unity.

ix. Question number 9: several animations are being created to make the showroom more interactive such as the main entrance door, bathroom door, ceiling fan, and balcony chair.

x. Question number 10: there are several interactive interactions, such as the stereo, the colour modification of the sofas and wardrobe, as well as the television that immerses the user in a digital simulation in which they can engage. To ensure that the user feels like they are in the virtual environment, engaging as many senses as possible is important.

## 6.0 CONCLUSION

At the end of the research project, an HTI framework was created based on the ADDIE model, consisting of analysis, design, development, implementation and evaluation. In summary, during the study process, researchers defined the objective, problem statements, scope and functionality of the VR application developed. After that, researchers started designing storyboards and creating the user interface and the user experience flowchart. Next, the interactivity of the prototype started to be developed. The design components were then assembled into the submission.

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