User interaction enhancement for Online Marketing Platforms through Augmented Reality systems

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ABSTRACT

As online shopping has grown more popular over the last decade, the online shopping experience has come to develop a number of limitations. For example, customers may receive products that do not match their expectations from what they assumed from information provided by the online platform. This can create dissatisfaction in users that may dissuade them from future purchases.

To address this issue, Augmented reality technology has been proposed to add to a customer's online retail experience by improving how they interact with products by providing customers with information that they would not usually have, such as virtual representations of dimensions of products or overlaying the models in real space to illustrate how said products may interact with the environment.

This study also broadens the knowledge of AR implementation by illustrating how a novel approach to information presentation can influence the confidence of users of online purchasing platforms and lead to higher probabilities of purchase. The results are expected to show that when using the proposed AR system,

Participants perceptions of information quality positively influence the confidence to purchase a product , that current platforms do not always provide enough information for customers to make a satisfied decision when purchasing products and that the additional presentation for information does have a significant impact in customer interest. These results may then be used in future practical implications for online retailers seeking to implement novel product presentation in their commerce sites

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DECLARATION OF ORIGINAL WORK

INTI INTERNATIONAL UNIVERSITY

DECLARATION OF ORIGINAL WORK

This declaration is made on the 27-08-2021

Student's Declaration:

I **Aziz Hasan Hossain I13002999, FACULTY OF INFORMATION TECHNOLOGY** hereby declare that the work entitled **User interaction enhancement for Online Marketing Platforms through Augmented Reality systems** is my original work. I have not copied from any other students' work or from any other sources except where due reference or acknowledgement is made explicitly in the text, nor has any part been written for me by another person.

27-08-2021
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Supervisor's Declaration:
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rajer

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Date: 27-08-2021

1 INTRODUCTION

1.1 BACKGROUND

Over the past few years, advancements in information technology has seen numerous changes in how people interact with the world and each other, and one key advancement that has helped makemany people's lives easier is the shift of many businesses to establishing their own e-commerce platforms, allowing them to market their goods and services to a wider market worldwide.

Research into the psychological drivers for shopping for clothes online showed that one of the keyfactors in stimulating potential customers to buy products on online platforms was how innovative and engaging the experience of shopping online was rather than the clothes or products themselves.(Goldsmith, Ronald & Flynn, Leisa, 2004) this shows the importance of innovative designs and experiences play in attracting and retaining customers in online platforms

So to encourage further success, online retailers should look into adapting new technologies to further engage with their customer. And to do that, Augmented Reality (AR) technologies can beused to create more interactive environments and experiences where retailers would be able to display their goods not only as 2-d images but as 3d models as well.

AR technologies are the latest advancements in Real-Based Reality representation and is seeing use in a number of different fields, from factories, laboratories, commerce and has even been implemented in a number of physical retail environments. (Krevelen, V. D.2010).

When one compares it to similar technologies such as Virtual Reality (VR), Augmented Reality (AR) focuses on placing virtual imitations of objects into the real world environment were users can interact with them and enhance their experiences, whereas VR technologies aim to immerse users in a virtual environment with hardware such as Oculus Rift, VR Glass and HTC Vive. (Azuma, R.T., 1997)

In addition, Smart Phone technology is key for the greatest impact of AR with advancements withfeatures such as accelerometer, Global Positioning Systems technology, advanced cameras and gyroscopes and are seeinguse in various fields such as retail healthcare automation and

education. By combining graphics, audio and natural feedback through touch feedback interfaces also enhance the users AR experiences when they use the technology to interact with the real world.

The three main characteristics of AR technologies, as described by Azuma (Azuma,R.T.,1997) includes blending the real and the virtual presentation, insuring that it is interactive in real time and the model ins registered in 3D. As AR allows of intuitive and interactive engagement, AR applications can be developed to allow customers a novel shopping experience.

By implementing AR technologies in their current systems, it can assist its customers in making better decisions in the products they wish to purchase as well as giving the companies an edge overtheir competitors by allowing its customers to interact directly with the products, presenting theirproducts with a representation of products as if they were purchasing them in a physical retail store, from the comfort of their own homes,

While initial entries into AR implementation has only seen experimental usage in retail marketing and as mostly been used in promotional campaigns, though they have seen mostly positive engagement from their market base, currently a growing number of organizations are integrating AR as a key feature into the overall user experience. From this the author has concluded that AR has the potential to attract customers to interact with a company's products and increase their interest in purchasing them.

This engagement has the added benefit of creating a positive engagement between brands and customers by allowing customers to interact with their products in novel ways.

Also by creating product catalogues and displaying information on products such as complete descriptions and specifications of goods that can be accessed by AR systems, it can assist customers in decisions regarding the products they would like to purchase.

By presenting customers with virtual representation of products they may be purchasing form thousands of miles away, with no other way to assess of examine the products themselves, the hope is that implementing AR would increase customer satisfaction with their online shopping experience and encourage further engagement and loyalty to the brand or company.

1.2 PROBLEM STATEMENT

This research aims to address the issues faced by customers wishing to purchase products online but are unable to make a confident decision in a product due to uncertainty caused by a lack of sufficient information, such as a proper representation of the dimensions of a product or how the product may appear in their environment. To achieve a greater impact or outcome, this research aims to focus on the importance of the user's confidence as well as study the user's engagement and interest in purchasing when using the Augmented Reality features in an online shopping environment.

1.3 RESEARCH OBJECTIVES

Through the conducting of this research, the aim is to develop a system that is able to assess the engagement and interactions with AR technology in order to achieve the following research objective.

To investigate the current existing online purchasing platform environment and how users are affected by a lack of information when making a purchase.

To implement an augmented reality system in an online purchasing platform and its effect on users confidence in products.

To evaluate how augmented reality integration can improve the process of purchasing online products for customers and user's satisfaction with their purchases.

1.4 RESEARCH QUESTIONS

To address the aforementioned research objectives, below are the three main research questions toask in regards to this study.

RQ1: How does uncertainty affect a customer's commitment to purchase a product such as electronic devices on an online purchasing platform?

RQ2: Does the implementation of Augmented Reality in an online purchases platform improve user's confidence in choosing an item?

RQ3: Does the implementation of augmented reality technology provide a novel and informative experience for users in an online shopping that they may not otherwise have, such as a visualization of the dimensions of a product?

1.5 SIGNIFICANT OF THE STUDY

The finding from this study will contribute to the field of academia in that it would illustrate the correlation between the implementation of new advanced technologies, in this case augmented reality into existing platforms, such as the online purchasing experience and how it affects consumer confidence and satisfaction. For researcher this adds to the current body of research intoaugmented reality and online platform interactions.

1.6 THE IMPORTANCE OF THE STUDY TO ACADEMIA

The expectation from this research is to add to the current body of research regarding the implementation of augmented reality technology in the online commercial platform. This in turn may be used to further improve on research conducted by other bodies on the implementation of said technology in future platforms.

1.7 LIMITATION OF THE STUDY

There are a number of limitations expected from the study. The first being that the expected samplesize may be smaller than needed to draw definitive conclusions from the study. Taking into accountthe possibility of invalid responses as well as assumptions that the system cannot be tested by many participants do to current travel restrictions the projected sample size while being enough todraw a proper conclusion, it may not be enough to get a full understanding of the participants experience with the system.

1.8 SCOPE OF THE STUDY

This research aims to evaluate the influences in customer experience interactions with online

platforms using augmented reality. This can furthermore add the existing body of research concerning the implementation of augmented reality systems into other fields by demonstrating the effect it would have on a user's perception of a product.

1.9 ETHICAL CONSIDERATION

Consent is to be obtained from the individual participants and organization, and the survey to be conducted within ethical aspects. Given the participation of the survey is voluntary therefore the individual participants have the freedom to decide either to participate or not. They may withdrawat any time during the survey. The researcher shall not influence the participants' decision on thesurvey input.

2 LITERATURE REVIEW

2.1 OVERVIEW

For many in the past, the only way to access goods and products that they would have to visit theirlocal retail stores for their needs. This would in turn restrict the options of where they can shop and what they can buy to products that are available to said stores or what they can order in.

In recent years though there has been a shift toward customers purchasing their products through online retail marketplaces. This would open a wider selection of products for customers to choosefrom as they would be able to buy products from anywhere in the world through online platforms such as Amazon and EBay, rather than being restricted to marketplaces that are only within physical reach. Though retail stores have also open their own online stores giving their customers more options on how they can purchase their products.

From the start of the 2000s, retailers in both their physical and online stores have been looking touse advanced technology in order to enhance both the shopping experience of the customers and how the purchasing and consumption of products are influenced. (Pantano, 2015).In particular, this is the case with what can be called "consumer facing technologies" i.e. technologies and devices that consumers interact with directly during digital or physical shopping, such as interactive platforms, digitized product modeling viewing and customization, digital display platforms and so on. Such developments provide increasingly emerging uses AR in retail environments. (Javornik, 2016)

2.2 TRADITIONAL SYSTEM

Online shopping is commonly be defined as the "use of online stores by consumers up until the transactional stage of purchasing and logistics" (Monsuwé, Dellaert & Ruyter, p.103). This is specifically identified as the buying and selling of products and services over the Internet providing analogues of services offered by traditional physical retail services, providing product searching, purchasing and delivery of their products.

Online shopping has seen rapid growth over the last 10 years due to the unique benefits offered to both retailers and customers over traditional physical retail shops. These benefits can be seen through the opportunity for retailers to deliver their marketing values such as product, price, place and promotion quickly and effectively to their target audiences, offering a wide array of products and services to a wider range of customers compared to traditional retailers.

A further benefit is that online businesses are able to offer their products at lower prices compared to their physical counterparts through all the cost savings earned from eliminating location costs. The removal of location needs and time barriers allows customers to engage and make purchases online at any time and any place. Finally, when it comes to the right promotion, businesses have a plethora of options for direct marketing, advertising, and other promotional campaigns (Barutçu, 2010).

From the perspective of the customer, online shopping circumvents the Spatio-temporal boundary, implying that the customer can purchase at any time and place so long as they have an internet connection. Another advantage available to customers who shop online is a thorough understanding of product information. Consumers can appreciate the full range of product details, including origin, manufacturer, price, features, and functions. Customers can also take advantage of options such as convenient payment and savings options when shopping.

AR has developed tremendously from its beginnings in cinematography in the 1950s.It continued to see developments until after the 1990s where smartphone AR and wearable technologies had begun to be developed and used, fostering interest in the areas of computer

science, VR, 3-D technology and interactive technologies (Javornik, 2016).

Since then, innovations in the technology has since seen use in a number of fields such as transportation, entertainment, medicine, navigation and education. The use of AR technologies inretail industry has taken place at different points of contact in the consumer's experience – physical,mobile and internet. Studies and implementations of AR in retail show that it has already been used as promoting advertising strategies.

Contrasting views on the benefits on implementing AR have developed where some believe that it can only be used for promotional campaigns, (Woods, 2009), to others focusing on its ability todevelop positive interactions between customers and brands (Owyang, 2010) and even how it influences the satisfaction by producing an experiential value effect (Chou, 2009).

Studies by Bulearca and Tamarjan's (2010) also illustrate that use of AR was shown to be beneficial for companies and brands in that customer loyalty was shown to increase from interactions with products campaigns using AR, while studies on in-store and online adoption of AR showed that consumers tend to show positive responses to the technology, leading them to interact with retailers and be more interested in shopping at outlets that implement this technology (Pantano, 2015; McCormick et al, 2014).

2.3 CURRENT SYSTEM

More recently, though Kang's (2013) research on the use of AR for e-shopping apparel found that customer functional success preferences (e.g. comfort, mental, financial and social values) are strongly linked to user goals and hedonic success, preferences were not. Other studies show the effect of AR on user engagement, happiness, increased understanding of reality and, overall, a positive, pleasant and customized experience that is important to users (Pushneh and Vasquez- Parraga, 2017).

It was also reinforced by the observations of Pachoulakis and Kapetanakis (2012) in which it studied environments where AR used virtual dressing rooms from the user's device or mobile camera (allowing people to digitally view how a dress matches them via a simulated

change roomfrom their own houses as seen in the studies by Kumari and Bakan, 2015 and Kang, 2013) – was seen as adding to the 'Fun Factor' of shopping (Pachoulakis, I. & Kapetanakis, K. ,2012)

The exponential growth of mobile AR applications has accelerated with the technology that takesadvantage of broadly available personal electronic devices such as smartphones and tablets (Craig,2013; Javornik, 2016). This involves of a form of consumer-led experiences, optimization,configuration and AR (Magrath and McCormick, 2013), such as IKEA's AR app's ability to calculate the width and height of the real-life room viewed through the camera's lens and then construct a very realistic piece of furniture in comparison to the rest of the actual surroundings' (Tăbuşcă, 2014).

Mobile shopping app research using AR show that take-up is projected to be widespread due to relatively high customer loyalty correlated with experiential rewards and advantages for retailers (Dacko, 2016). In addition , large AR mirrors in-store often constitute a type of AR application (Craig, 2013). An example would the augmented reality mirror created by ModiFace interactive technology firm that simulates the effects of makeup, skincare and teeth whitening items to provideusers with a more immersive shopping experience (Podeszwa and Baron, 2016). Similarly, the fashion retailer Rebecca Minkoff 's AR mirrors fit clothes into the body form of the customer by pressing them against the body of the person (McCormick et al, 2014).

Finally as the technology for online integration of Augmented Reality has advanced, such as through the use of alternate shopping applications that utilize AR technology such as Warby Parkers Virtual Try-on (*1) feature on their mobile application that uses the devices camera (Limited to Iphones only at the moment) to scan and measure the dimensions of a customer’s face and project a realistic depiction of the style and color of the frames on the user’s face.

Another implementation of the AR experience in shopping would be the Sephora’s Virtual Artist tool, a cosmetic demonstration tool to allow its customers to try on their products before committing to purchase them. Initially the app would require its users to upload selfies to test their range of cosmetic products on but after its AR features were integrated, it allows

for real time overlays of the cosmetics on offer through the camera of a customer's AR enabled device.

Expanding further on augmented reality being used for furniture purchases, industry leaders such as Wayfair and Ikea have embraced the user of AR technology in their apps allowing users to place and fit pieces of furniture in their homes. Wayfair's View in Room app utilizes its LiDAR technology to place its virtual products anywhere in a customer's room to allow them to see how the result would look before committing to a purchase.

The rise in interest in the use of Augmented Reality in the ecommerce space has also given rise to solutions and services that allow for the integration of AR services into their online platforms without having to create their own in-built solutions.

Services such as Augment, an augmented reality platform, or UniteAR allow for users to view a product from the company using the application in real time allowing them to interact with the product while being able to better visualize it in a natural setting.

They also offers further features such as changing of product colors and finishes, move objects around the users home and even allowing animations for the product. These cloud based services allow for the adoption of AR solutions for companies or organizations which would normally not have the in-house ability or technical knowledge to develop them themselves.

Furthermore, Scholz and Smith (2016) highlight the relevance for marketers of virtual AR, the creation of value-generating opportunities for customers, and thus the relevance of concentratingon customer interaction as more than half of consumers are now prefer to make their purchases online using mobile devices, companies that choose to include a virtualized AR solution would help boost sales and increase consumer confidence in their purchases.

2.4 PROPOSED SYSTEM

Introduction to the proposed system

Online shopping made shopping more convenient for people to purchase their products from the comfort of their own home. In the last few years, users are more inclined to purchase their products from home, with them focusing on the product specifications and studying comparisons, reviews and pictures. Even though they have access to this product information, many cannot be completely confident in their purchase. This is mostly because they have no ability to visualize their product in their environment, or how it may interact with it. As such many customers may buy these products without confidence that the product will be what they expect or may even return as it does not suit the need after received. Integration of AR technologies into the online shoppingexperience will offer the means to overcome these major issues.

As such the proposed system aims to introduce an augmented reality framework for an online platform through the use of mobile devices that would allow for a representation of a product to be projected into a user's real space and study their engagement and interest in the product from using the system.

By allowing for 3d representations of products to be modelled and shared with customers, they will be able to assess and deliberate on factors such as the dimensions and characteristics of a product that they would not be able to otherwise due to the spatial constraints expected from the online shopping experience. This then will improve the customer's confidence in their purchases as well as increase the satisfaction of their purchases by ensuring that the product matches closer to their expectations. The application will also allow the user to train represented scales in their environment to more accurately display the size of the product.

2.5 ADVANTAGES AND DISADVANTAGES OF PROPOSED SYSTEM

The primary advantage of the proposed system is that it would address the issue of customers lacking dimensional knowledge of the products that they wish to purchase but are not physically capable of assessing them. The system will be able to scale the products based on information in the environment as well as user input for more accuracy.

There are three primary disadvantages of the system.

1) Due to the limitations of AR in mobile technology, the models will not be able to directly interact with environment and may only give a rough estimate in that regard. While the model of a chair can be placed in a room and rotated to match the floor plane, it won't be a completely accurate representation.
2) More complex models may have to be reduced to simple representative shapes based on the resources available to model and process the product.
3) This system is made with non-mutable, non-perishable standardized products in mind i.e. furniture, clothing, electronics etc. Product such as foodstuffs can be approximated, but will not be able to ensure that customer expectation and results are properly matched.

2.6 HYPOTHESIS

For this study, the following hypotheses have been proposed.

H1: Uncertainty does have a significant effect a customer's commitment to purchase a product onan online purchasing platform.

H2: The implementation of Augmented Reality in an online purchases platform can improve user's confidence in choosing an item.

H3: The use of augmented reality technology does provide a novel and informative experience thatis able to match the customers' expectations and provide satisfaction.

2.7 SIMILARITIES AND DIFFERENCES AMONGST THE EXISTING SYSTEMS AND THE PROPOSED SYSTEM

Criteria	System 1	System 2	System 3	Proposed System
Platform	App Based, IOS Android	App Based, IOS Android	App Based, IOS Android	Web based. Opens in any browser
Year Published	2017	2018	2016	2021
Systems Used	Apple ARKit	RealityKit, LiDAR	Modiface	EchoAR
AR Integration	In App Integration	In App Integration	In App Integration	Cloud Based Integration
Product catalogue	In App catalogue	In App catalogue	In App Catalogue	Website or In App Catalogue
Product categories	Furniture	Furniture	Make Up Try-Ons	Electronics
Product Visualization	Fully Interactive.	Fully Interactive.	Limited	Fully Interactive.
Product Scaling	True-to-scale, Scalable.	True-to-scale, Scalable.	Not Applicable	Scalable
Product Deployment	In viewed environment.	In viewed environment	On Users Appearance	In viewed environment
AR Feature Access	Inbuilt AR Functionality	Inbuilt AR Functionality	Inbuilt AR Functionality	Through browser and QR Code.
Accessibility	AR Capable Device. Model viewable without AR Capable Device.	AR Capable Device. Model viewable without AR Capable Device.	AR Capable Device. Scanned image can be used as well.	Model viewable without AR Capable Device. AR Capable Device required for AR functionality

Table 2-1 Comparison of existing systems and the proposed system.

Legend

System 1: IKEA Place

System 2: Wayfair View in Room 3D

System 3: Sephora Virtual Artist.

3 METHODOLOGY

3.1 OVERVIEW

In this chapter, the author will discuss the methodology chosen for the study with justification forwhy the method was chosen as well as providing a description of the research design proposed. Additionally, the framework of the research proposal will be expanded. Finally, a Gantt chart willbe provided to illustrate the timelines and milestones of the study.

Research methodology can be understood as the specific set of procedures or identified techniques that is used to find, select, process & analyze information about a topic of research. Typically, in a research paper, the research methodology part enables the reader to critically evaluate the study's whole validity and reliability. Research Methodology part answers two basic questions. These are: How was the data generated and/or collected and how was the data analyzed?

3.2 RESEARCH DESIGN

This study aims to use the quantitative method of data collection and analysis to address the research questions posed in the report. This method was chosen as it allows the collection of definitive data from participants to ensure ease of data collection, data analysis and verification and validation. This study will develop a prototype augmented reality system for a mock online purchasing platform that would allow for the participants to experience a number of purchasing scenarios where the data collection is expectedto conduct via online survey due to Movement Control Order (MCO) that may any face-to - face meetings. The study will aim to have about 100-40 participating respondents. They will be solicited from groupssuch as housewives, college students etc. or the most likely participants to have knowledge and experience in online shopping. The study will use the Google forms applications to collect data.

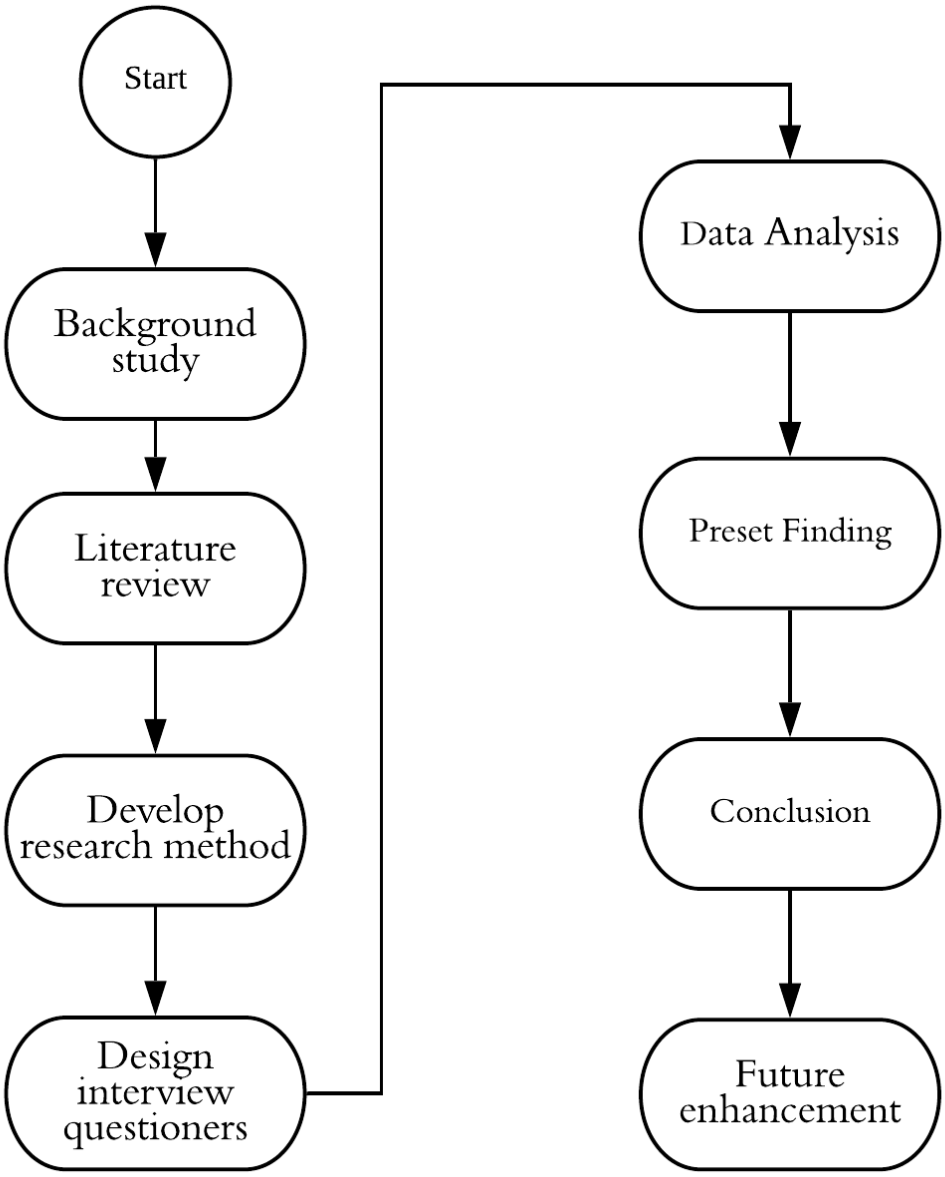

Figure 3-1: Flowchart of the Research Methodology

3.3 FRAMEWORK EXPLAINED

1) BACKGROUND STUDY

The first phase is the background study phase where the author will conduct research into various papers and journal of systems and studies similar to the authors proposed system. The main focus will be on journal from the last five years, referring to journals from earlier than that to define and support concepts that present augmented technology and its relationto online shopping.

2) LITERATURE REVIEW

The literature review is where the traditional, current and proposed systems are presented. The traditional system section will look through articles and journals that study the historyof Augmented Reality technology and as well as traditional application of AR technologyin the fields of retail.

The current system section will focus more on presenting current systems and applicationof AR technologies in online and retail scenarios and how companies leverage thetechnology to increase customer interaction and retention.

Finally the proposed system section will present the concept and aims of the authors proposed system to address the problem statement presented in this project proposal. Finally, the Hypothesis of this research will be defined and proposed.

3) DEVELOP RESEARCH METHODS

As the research will focus on Qualitative methods of data gathering, a system will be developed to allow the author to gather feedback from the target demographic of the

Proposed system through the use of online feedback forms and questionnaires and methods will be designed to store and analyze the data collected in the research.

4) DESIGN INTERVIEW QUESTIONNAIRES

Once the target demographic is defined and methods for data storage and analysis are established, questionnaires will be developed to better collect data firstly from the users experiences on how their interactions of ecommerce systems online and how the use of the proposed system influences the online shopping experience.

5) DATA ANALYSIS

Once the data is collected from the questionnaires, data analysis applications such as SAS enterprise will be used to analyze feedback from participants to assess the impact of the proposed system compared to the experience without the system.

6) PRESENT FINDINGS

The findings that have been analyzed will then be presented and any trends and correlations that prove or disprove the hypothesis proposed will be put forward. Any other conclusionsor assessments made in the study that are outside the studies initial goals but add significant support to the research topic will be presented as well.

7) CONCLUSION

All conclusions drawn from the research will be presented in this section.

8) FUTURE ENHANCEMENT.

Factors and functions found through the study, either through feedback from participants or weaknesses in the proposed system that can further enhance the system as well as suggestions to improve research methodologies and analysis will be proposed in this section.

3.4 MEASURING INSTRUMENTS

In this study, the quantitative method of measurement will be used collect the data to address the research objectives that were proposed. This would allow for the collection of explicit results fromparticipants that can then provide a clear and focused statistical analysis of the data collected. Quantitative research uses a clear and structured exploratory method which allows for the methodsused to be easily verified and replicated, which then ensures that the data collected is dependable and less open to disputation in interpretation. Quantitative data is also perfect for collecting data from a large sample size of participants, providing higher accuracy of the data analyzed and allowing for more conclusive results to be assessed.

Research using the quantitative method have the unfortunate constraint of being focused of statistical and concrete data, which would lead to researchers missing or ignoring nuances in the responses they receive from participants, which can be at times be more valuable than the quantitative data collected.

Regardless, this constraint can be offset by creating clear and definitive exploratory methods thatensure that the data collected is both as relevant and as

3.5 VALIDITY AND RELIABILITY/ TEST AND ANALYSIS

In order for a questionnaire to be considered appropriate for study, it must hold two very significant properties, namely reliability and validity. The first tests the accuracy of the questionnaire, whereasthe latter tests the extent to which the outcomes of the questionnaire are compatible withexpectations from real world scenarios.

In this research, the significance value for each question is identified through conducting pilot tests for the questionnaire where irrelevant or difficult to understand questions can be identified and modified or removed to increase the validity in the questionnaire.

3.6 STUDY POPULATION, SAMPLE, SELECTION

For the study to reach its goal, the target sample size of participants is expected to be within

the range of 30 to 50 participants. The number of participants is kept within this range to ensure that a sufficient number of participants can be drawn from while keeping the number of participants who will be exposed to the proposed system to a manageable number.

The key demographic of the study will be participants who are either knowledgeable or have experience with the online shopping process. This will further be bolstered by participants being required to have made an online purchase within the last three months to ensure that the experienceis fresh in their minds. \special focus will be given towards finding participants between the ages of 21-34, as a study by Nielsen showed that nearly half of all participants surveyed on whether they would make an online purchase in the next 6 months were within that age group (Nielsen Inc.,2014) with the next potential age 35-49 respondents making up about 28% of those willing to makea purchase online, and age 50-64 being about 10%.

3.7 DATA COLLECTION AND ANALYSIS

3.7.1 QUESTIONNAIRES.

The primary method of data collection will through the use of questionnaires, allowing for a largerquantity of data to be collected for a more accurate assessment. Questionnaires are a commonly used data collection technique where participants are provided with surveys through eitherphysical papers or digitally through email, website links or specialized digital forms for participants to provide their feedback on a subject. Questionnaires are a low cost method of data collection and tend to be easier for all parties involved, with it being easier for participants to answer and easier for researchers to distribute, collect and analyzed quickly. Though this requiresthat the questionnaires should be designed based on the answers relevance to the study.

In addition to the proposed questionnaire, users will also be given two subjective assessment questionnaires to assess the usability and confidence of using the AR integrated online shopping platform :System Usability Scales (SUS),which is a ten items

questionnaire scored from 0 to 100, used to assess a system or functions usability and User Experience Questionnaire (UEQ), a questionnaire designed for end-users to understand

how users perceive the usability of system based on factors ranging from attractiveness, efficiency, novelty and others.

3.8 DISTRIBUTION

Due to current limitations of travel and arrangement of in person meetings, online distribution methods are the more favorable choice for this research. As such, Google forms will be chosen as the preferred method of data collection and distribution. This is primarily due to how effectivelyand how cost efficient the method of distribution is for this service. Especially since Google formsonly needs a google account to create the questionnaires and participants do not require an accountto answer the questionnaires. All that is required is that the link to the google form be shared to participants though either emails, social media posts or PMs to be answer at the participant's convenience.

Google forms allows for a number of additional functions and aids to support the questionnaires. Such as allowing for designating priority and optional questions, inserting links and comments toadditional information to further clarify questions for participants and allowing for responses collected to be represented in simple graphical outputs such as bar charts, graphs and pie charts.

3.9 QUESTIONNAIRE SAMPLES.

The following questions will be provided to the participants to collect quantitative data from theirinteractions with the system.

Section A / First section

The first section is collect data to define demographics, clarify the distribution of participants andto ensure the participants experience in current online platforms.

1) Please select your age:

Purpose: This is to create categories to be created based on age group demographics, generally based on generational divisions such as 21-34, also known as the Millennial Age

group.

2) Have you made an online purchase within the last 3 months? :

   Purpose: This is to verify that the participant has a fresh online shopping experience

3) How often do you make online purchases within a year?

   Purpose: This is to analyze the demographics that are more likely to interact with online platformsand by extension benefit from the proposed system

4) Current online shopping platforms (Amazon, EBay, Lazada) provide sufficient information for youto make an informed purchase.

   Purpose: This is to assess the current level of satisfaction an abstract presentation of products online, usually with only images and statistics available, of customers when purchasing a product.

Section B/ Second section

The second section is to collect feedback from participants on their experience in using the proposed system in a mock online platform. This questionnaire will use a scale from strongly disagree (1) to strongly Agree (7).

1) Using augmented reality had given me more information regarding the product that I wish to purchase.

   Purpose: This is to assess how effective the augmented reality system is at providing additional information to participants that they would otherwise not have from the traditional online platform.

2) Using augmented reality allowed me to assess a product in details that I would not have otherwise. (Ex how large the product might appear physically.)

   Purpose: This is to assess if the system adds additional value to the participants online purchasingexperience by providing unique information.

3) Using augmented reality allowed me to come to a decision regarding a product more

quicklythatwithout the information it provided.

Purpose: This is to assess if the system influences the decision making process of an onlinepurchase when compared to if the user had not used the system.

4) Using augmented reality increased my interest in products that would not interest me otherwise.

Purpose: This is to assess whether the novel nature of augmented reality creates interest in productsthat participants may purchase.

5) Viewing the model of the product made me more likely to choose it.

Purpose: This assesses the influence having a visual representation of a product will have on theparticipant.

Section C / Third section

The third section is to collect data on participant's interest and interactions with the augmented reality system as well asking for feedback from participants on what products they may want to use AR systems with for future enhancement.

1) I think that augmented reality is easy to use.

Purpose: This assess the participant's effectiveness when using the system.

2) I think that interacting with augmented reality product presentation is clear and understandable.

Purpose: This assesses the systems effectiveness in presenting the products of choice to the participant's purchases.

3) What products do you believe would benefit from augmented reality virtual presentation? (Ex.furniture, clothes makeup etc.)

Purpose: This is to gather novel feedback on what products participants believe would benefit from AR virtual representation, such as furniture, clothes makeup etc.

3.10 GANTT CHART OF TIMELINE

The development of this project is expected to be carried out in 14 weeks starting from 17th May 2021 and it's expected to completed and submitted by 11th August, 2021 the project timeline is highlighted in below Gantt chart. Milestones are denoted in the images by their bold lettering.

	Name	Duration	Start	Finish
1	**Milestone 1: Project proposal**	**15 days**	**17/05/21 08:00**	**04/06/21 17:00**
2	Project Concept research	2 days	17/05/21 08:00	18/05/21 17:00
3	Methodology research and design	4 days	19/05/21 08:00	24/05/21 17:00
4	Project Proposal Preparation	10 days	24/05/21 08:00	04/06/21 17:00
5	**Milestone 2: Literature review**	**21 days**	**04/06/21 08:00**	**02/07/21 17:00**
6	Prepare Problem statement	4 days	04/06/21 08:00	09/06/21 17:00
7	Prepare Research Question and Significant of the study	3 days	10/06/21 08:00	14/06/21 17:00
8	Define Scope of The Study	3 days	15/06/21 08:00	17/06/21 17:00
9	Literture Review	8 days	14/06/21 08:00	23/06/21 17:00
10	Research methodology preperation and documentation	4 days	24/06/21 08:00	29/06/21 17:00
11	Compilation of documentation	3 days	30/06/21 08:00	02/07/21 17:00
12	**Milestone 3 System development**	**24 days**	**07/06/21 08:00**	**08/07/21 17:00**
13	System Development	17 days	07/06/21 08:00	29/06/21 17:00
14	Implementation of system	2 days	01/07/21 08:00	02/07/21 17:00
15	Testing of proposed system	4 days	05/07/21 08:00	08/07/21 17:00
16	**Milestone 4: Data collection**	**12 days**	**01/07/21 08:00**	**16/07/21 17:00**
17	Create a questionaire using google form	2 days	01/07/21 08:00	02/07/21 17:00
18	Start the distribution of survey to respondents	10 days	05/07/21 08:00	16/07/21 17:00
19	**Milestone 5: Data Analysis**	**5 days**	**16/07/21 08:00**	**22/07/21 17:00**
20	Perform Analysis on The Collected Data	3 days	16/07/21 08:00	20/07/21 17:00
21	Finalize the result of the data analysis	3 days	20/07/21 08:00	22/07/21 17:00
22	**Milestone 6 : Finalize Document**	**12 days**	**23/07/21 08:00**	**09/08/21 17:00**
23	Finalization of system	6 days	23/07/21 08:00	30/07/21 17:00
24	Finalization of documentation	4 days	30/07/21 08:00	04/08/21 17:00
25	Preperation for Viva	4 days	04/08/21 08:00	09/08/21 17:00

Table 3-1 Gantt Chart Overview part

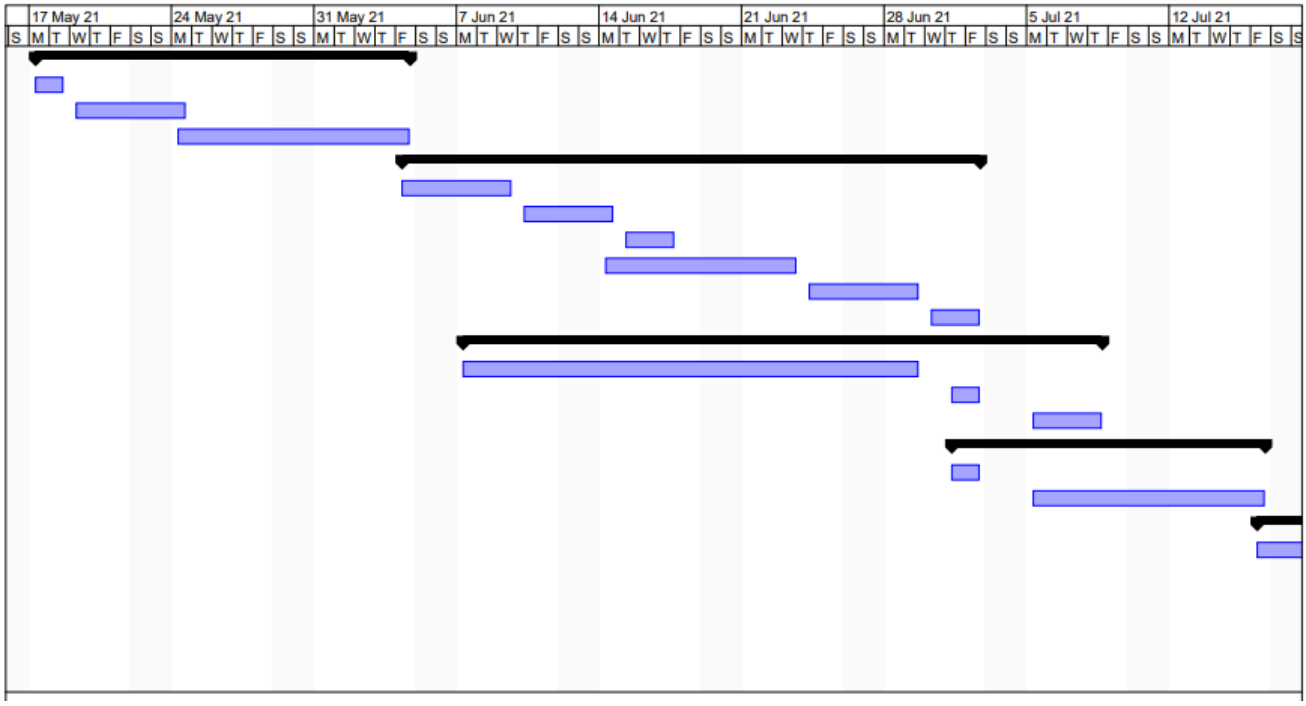

Figure 3-3 Gantt Chart Overview part 2

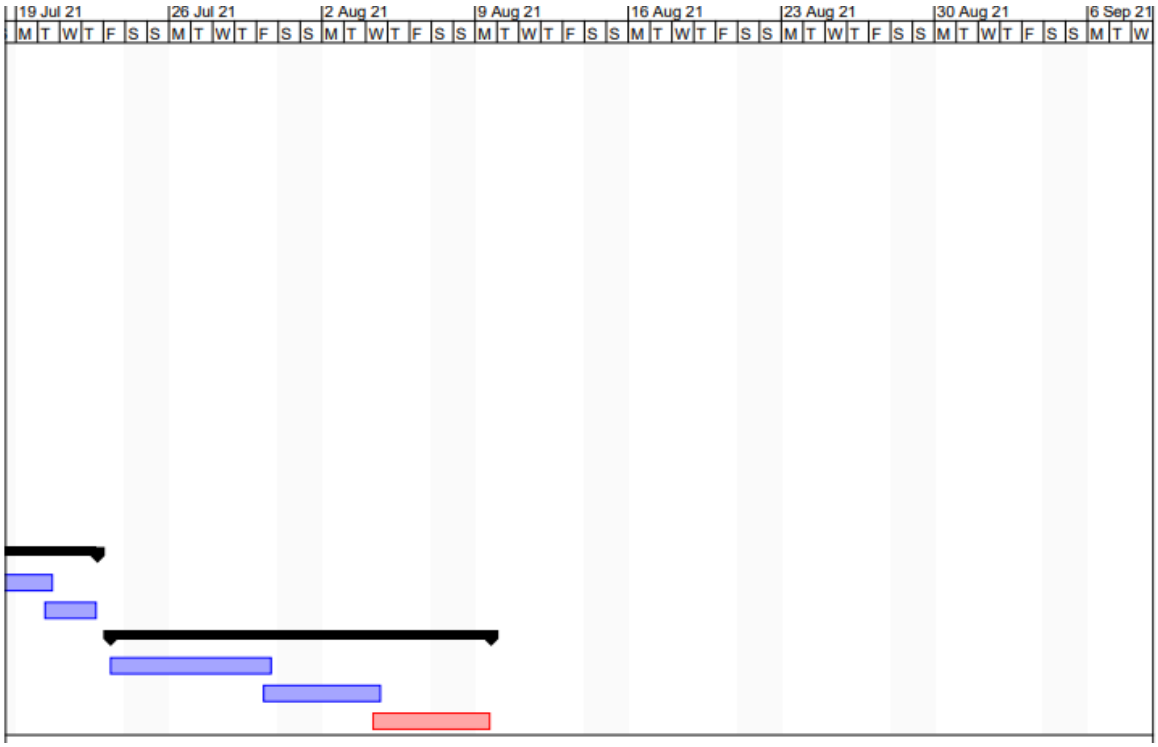

Figure 3-2 Gantt Chart Overview Lines 2

4 DATA ANALYSIS

4.1 OVERVIEW

This chapter details the analysis of the data collected through the fact finding methods proposed in the previous sections. Survey questions as well as User Experience Questionnaires will be provided to the participants along with the demonstration system and the results of the questionnaires will be presented and textually analyzed in this chapter. Through these findings, the author draws a conclusion from the analyzed data and derive from the data how effective the proposed system affects the participant's user experience.

4.2 FINDINGS AND ANALYSIS

For the data analysis of the findings for this project, the author would present the findings for the raw findings for the research and then proceed with discussions, conclusions and justifications. The analyzed aggregations of the questionnaires have been attached to the Appendix D section of the report and as part of the data analysis process, the author would present the findings in a tabular form for relevant presentation.

5 SYSTEM DESIGN

5.1 OVERVIEW

In this chapter, the author deals with the design of the test system. Unified Modeling Language (UML) diagrams are used to better represent the proposed system. This chapter also presents the user interface (UI) design of the proposed system. The UML diagrams to be used are: Flowchart, Sequence diagram and a use case diagram.

5.2 FLOWCHART

A flowchart explains the processes of the proposed system by using different shapes to define different states of the system. It represents different types of steps or actions in the process of a system. These shapes include: Beginning and Ending phases are represented by oval shapes and the processes involved in the system are represented by rectangular shapes , and finally decision points illustrating in this case the decisions made by the users, are represented by diamond shapes. Arrow lines are used to represent the flow or relationship between processes. In this flowchart, the system referenced is the cloud based augmented reality platform.

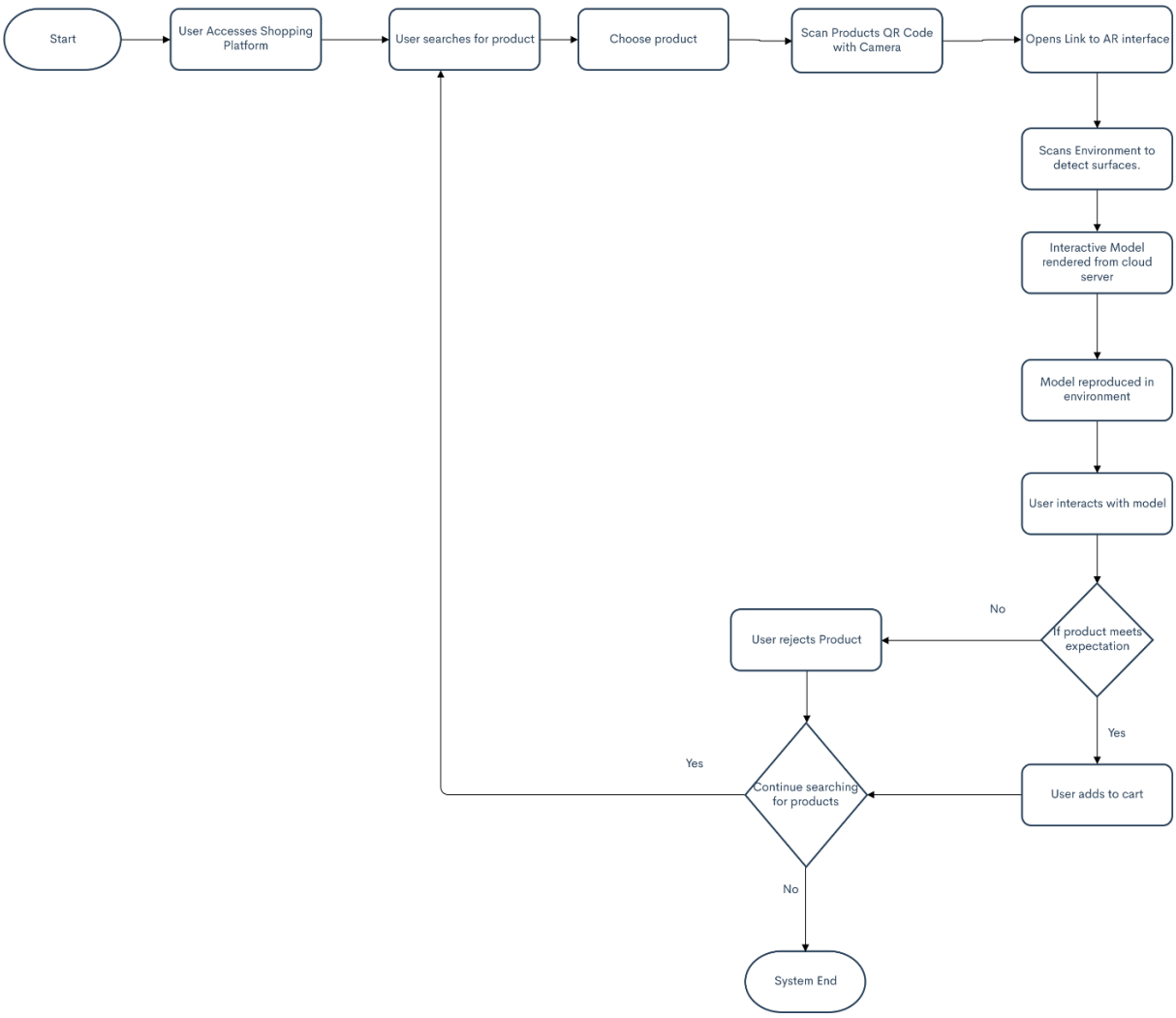

Figure 5-1 Flowchart of the Proposed System

5.3 SEQUENCE DIAGRAM

The following Sequences diagrams is used represents how actors, in this case the user of the website and the website and AR framework are expected to interact within the proposed system. It also represents how the system (website) sequentially collaborates with other aspects of the system (the cloud based AR framework) to execute its functions. It further illustrates the order of actions and interactions within the given use case for the system to execute its overall functions.

The arrows are used to denote the directions of actions and interactions within the system environment as messages between the user and the system. Furthermore, messages from the system to itself denote interactions of different components of the system interacting with each other such as calling for externally processed and stored data. These cases tend to have the actor or object send its message to itself without having to require a response or return message from other actors in the system. [28].

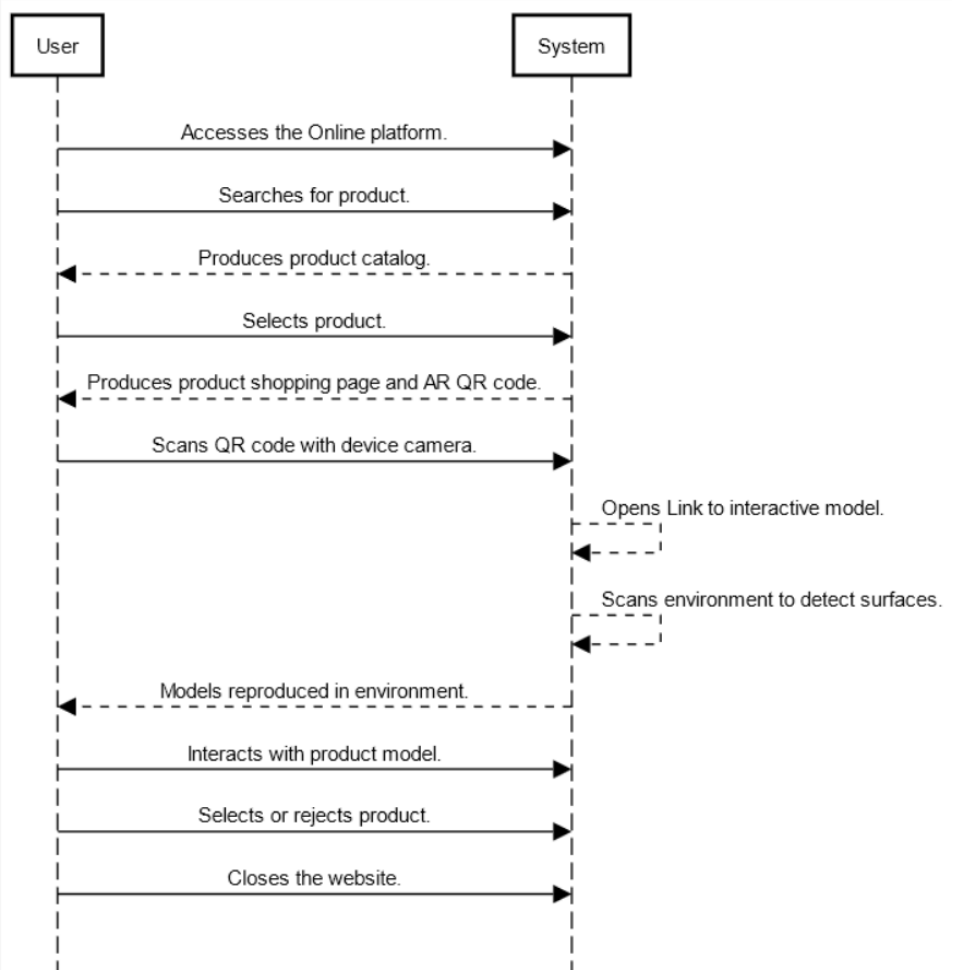

Figure 5-2 Sequence Diagram of the Proposed System

5.4 USE CASE DIAGRAM

The following use case diagram is used to show the overall functionalities of the system as well as how the user interacts with them. Use case diagrams show the actors and what they perform in a system. The stick figures in the diagram represent the actors in this case the AR system and the user. Within the oval circles are the functions and actions occurring within the system such as data calls or search queries. It may also demonstrate relationships between actors or use cases which comprise of includes where the relationships are mandatory whereas extend relationships can be optional.

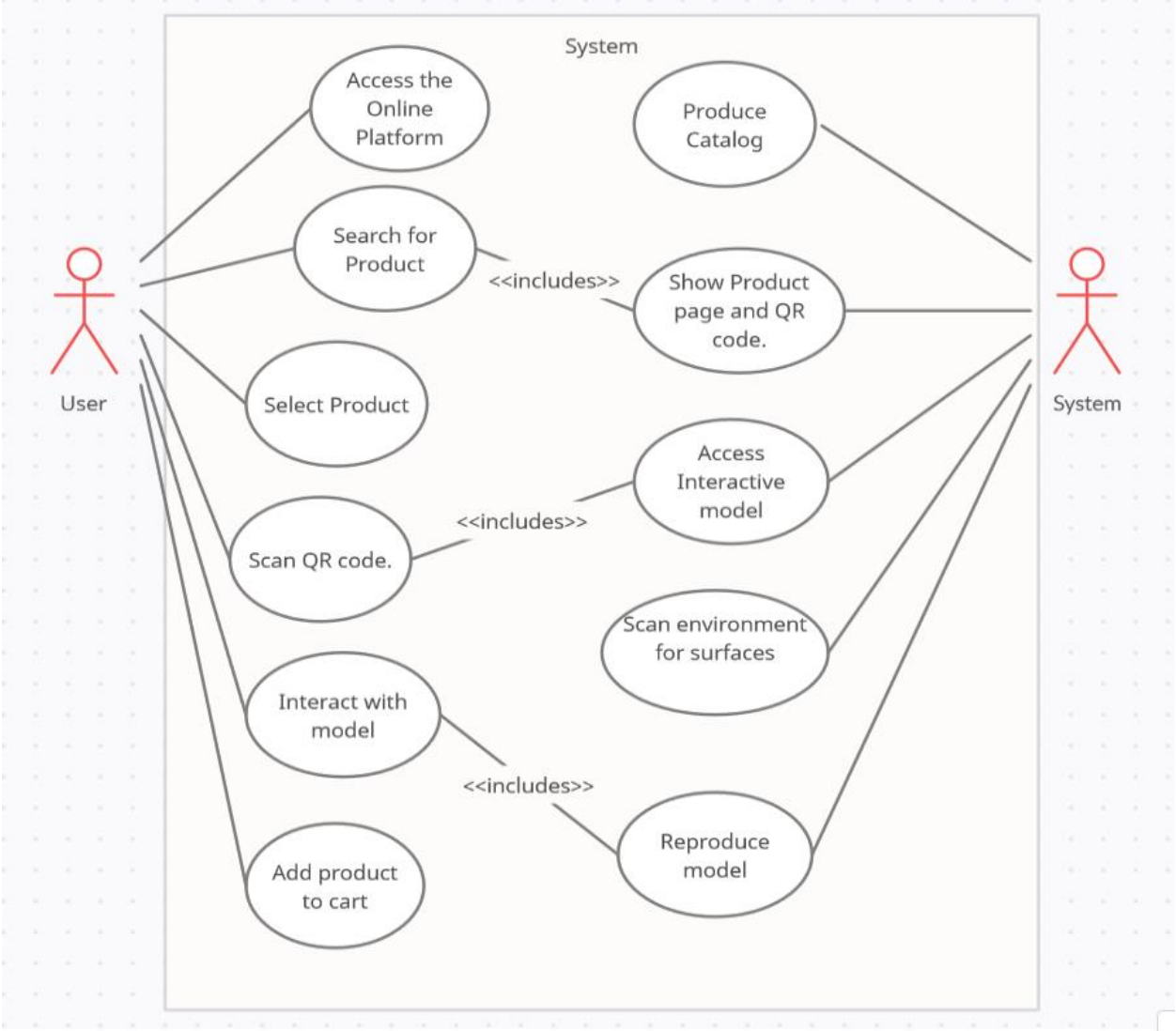

Figure 5-3 Use Case Diagram of the Proposed System

5.5 LIST OF ACTORS AND USE CASES

Actor	Use case	Description
User	Access the Online Platform	This use case represents the functionality of the user accessing the test platform. This simulates an average user accessing their choice ecommerce website.
	Search for Product	The user searches for the product that they wish to examine or purchase on the ecommerce website.
	Select Product	This use can then choose a product from the catalogue presented by the website that they would be interested in examining or purchasing.
	Scan QR code.	The user scans the products QR code to access the AR representation of the product through their preferred device.
	Interact with model	The user is able to interact with the model allowing them to rotate and scale the product at will.
	Add product to cart	The user then adds the product to the shopping cart signifying the end of their interaction with the system. It may also loop to the product search use case should the user choose to continue viewing other products.

System	Produce Catalogue	The system produces the catalogue based on the products that the users product queries or from the existing catalogue choices available in the database to emulate existing ecommerce platforms.
	Show Product page and QR code.	The website interface will then present the user with the product information including all relevant data such as price, specification and images of the products. The page will also include a QR code that allows the user to access the cloud based AR interface for the users to interact with the product.
	Access Interactive model	The system will then access the cloud based database of AR model tied to the QR code and provide a link and interface for the user to interact with.
	Scan environment for surfaces	This use case represents the system using the using the users devices camera to define the projection area by scanning for applicable surfaces.
	Reproduce model	This use case defines the system projecting the rendered AR Model into the users' environment.

Table 5-1 List of Actors and Use cases with Descriptions

6 SYSTEM IMPLEMENTATION

6.1 OVERVIEW

This chapter addresses the system development phase of the project where the details into the systems and frameworks used for the proposed system are discussed including why the proposed frameworks were chosen.

6.2 SYSTEM DEVELOPMENT BACKGROUND

The proposed system would its development focused on being deployable for mobile device users as to guarantee that a larger number of users would be able to access the delivery method of the model data, i.e. QR code scans, initial proposals had gone into creating a dedicated application for users to access AR interface. For the system implementation phase, the system would be separated into two separate components for the system development.

They would be the demo website, acting as a test ecommerce website to emulate the average customer experience. And there would be the EchoAR interface which would be the delivery platform for the interactive AR models that users would be able to access from the website. As such the website would act as a the entry point to the AR features ensuring that accessing said feature would not deviate too heavily from standard purchasing procedures. Furthermore all models are stored and deployed from EchoARs' cloud storage and delivery system, allowing for rapid modification and deployment of new models based on user feedback.

The following frameworks/ systems make up the components of the proposed system:

6.2.1 ECHO AR

Figure 6-1 EchoAR Platform Logo

EchoAR is a cloud-based augmented and virtual reality platform that allows for developers and companies to leverage the services tools and server-side infrastructure to create and deploy AR/VR applications with ease. [27]

Using its 3Dfirst content management system (CMS) as well as its delivery network and scalable Backend as a Service (BaaS) infrastructure, EchoAR allows its users to develop AR/VR applications with ease while effectively managing all backend and publishing of 3D content though an easy to use dashboard.[28]

EchoARs framework allows for both integration to existing AR enabled applications, such as those developed using Unity's AR Foundation framework as well as offering web based AR integration by handling all rendering and calculations on the cloud and delivering the render though links accessible through a user's browser, allowing for AR access on any platform.

EchoAR serves as the primary component of the AR delivery framework. As it allows for browser based AR deployment, it offers alternatives to users who are not able to access the service through an app as well as allowing for easier integration into existing ecommerce platforms as it would only require an embedded link or QR code for a user to access the AR

interface.

6.2.2 WORDPRESS

Figure 6-2 WordPress Logo

WordPress is one of the most popular open-source content management system (CMS) [29] currently in service that allows of its users to develop website quickly and efficiently with minimal to no cost depending on the users requirements. With its use of templates, drag and drop features, and extensive plugin support, it allows for users to develop their website without needing to be proficient at common website programming languages such as JavaScript, Python, or Html, while offering those who have said knowledge ample space to customize to their requirements. [30]

WordPress through its abundance of features allow its users to create any number of types of websites, such as blogs for personal use, business pages for smaller companies or organizations, online portfolios for designers, architects and experts from any number of fields, and e-commerce platforms of any size and feature. [30]

In regards to the proposed system, the demonstration website which acts as both the basic interface as well as the access point and ecommerce platform, was developed through WordPress as to deliver an authentic shopping experience for users to experience the platform.

6.2.3 PANTHEON IO

Figure 6-3 Pantheon IO Logo

Pantheon.io is a Website Management Platform for websites developed through WordPress or Drupal. It allows for the while allowing for real-time publishing and modifications of any WordPress elements with minimal backend overreach as any and all features and functions are effectively accessible through pantheons dashboard.[31]

Pantheon.io serves as the host CMS platform for the demonstration website, allowing for features and modifications to be made to the website with ease and efficiency based on user feedback and responses.

6.3 SYSTEM COMPONENTS

The following are the development ends of the two primary components of the system, the websites pantheon.io dashboard and the EchoAR model deployment dashboard.

6.3.1 PANTHEON WORD PRESS WEBSITE

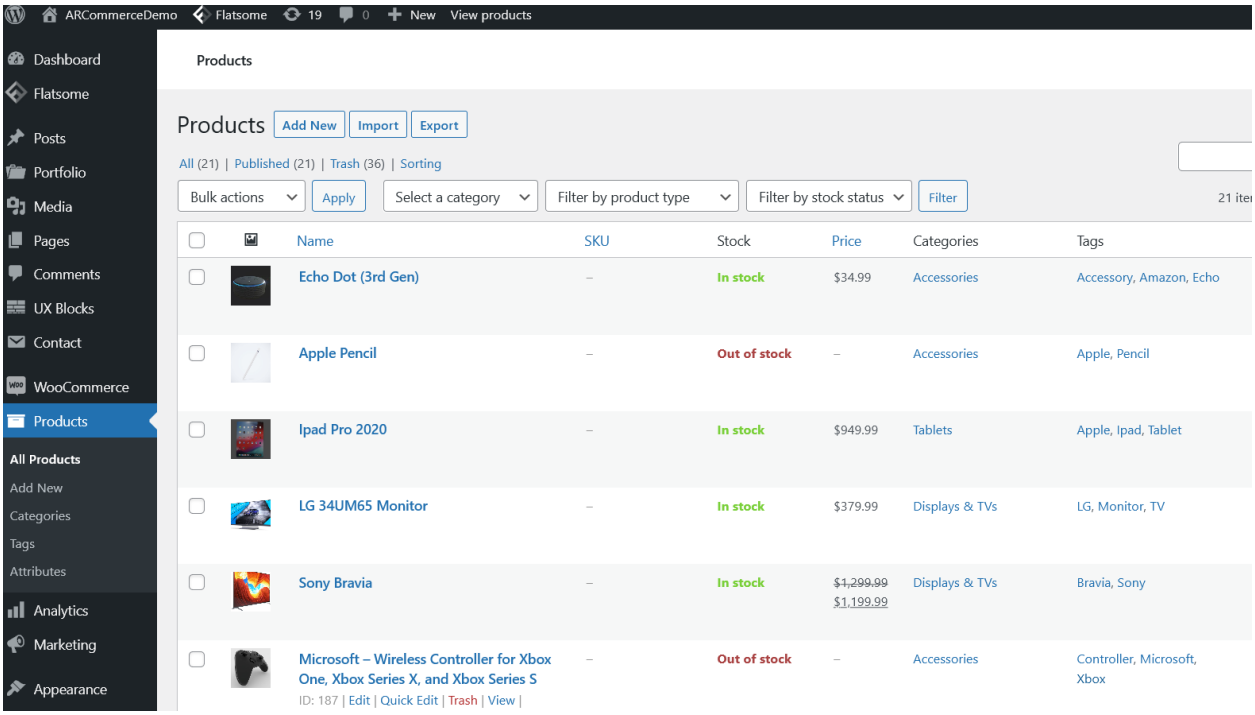

Figure 6-4 Pantheon.io WordPress Product Management Dashboard

Through this platform, new products can be added to the catalog of the website for users to access. The QR links are also configured through this dashboard. Real time changes can be made to the website from this dashboard, from inventory and product changes to modification of website interfaces.

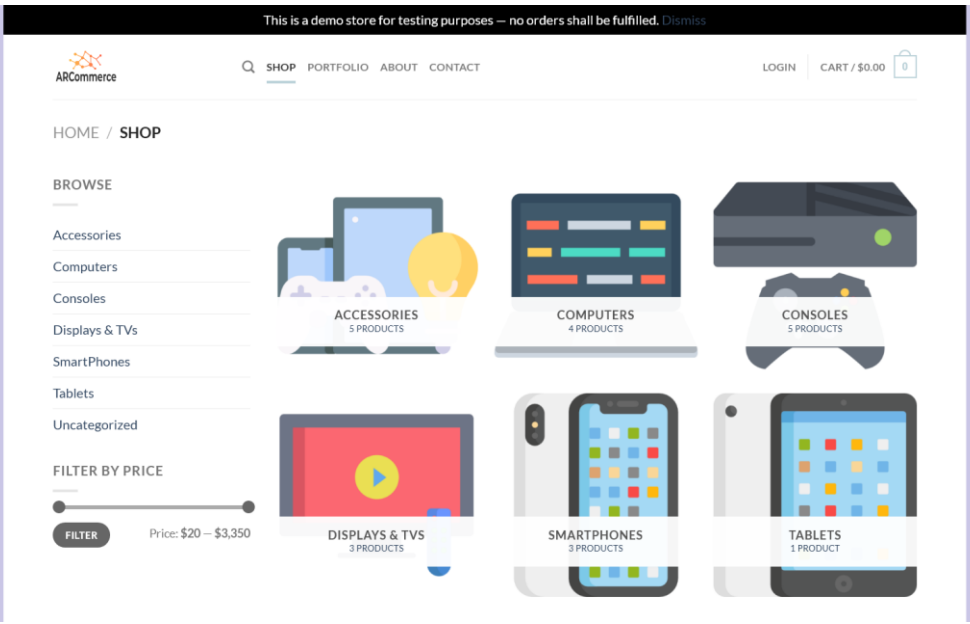

Figure 6-5 Demo Website Homepage

This demo home page (https://dev-ar-ecommerce.pantheonsite.io/shop/) acts as the initial starting point of the system, providing users with a number of products, each with their own 3d AR enabled model for the user to interact with. From here, a user can select from the list of available products to assess interest in the product after viewing the products 3d representation.

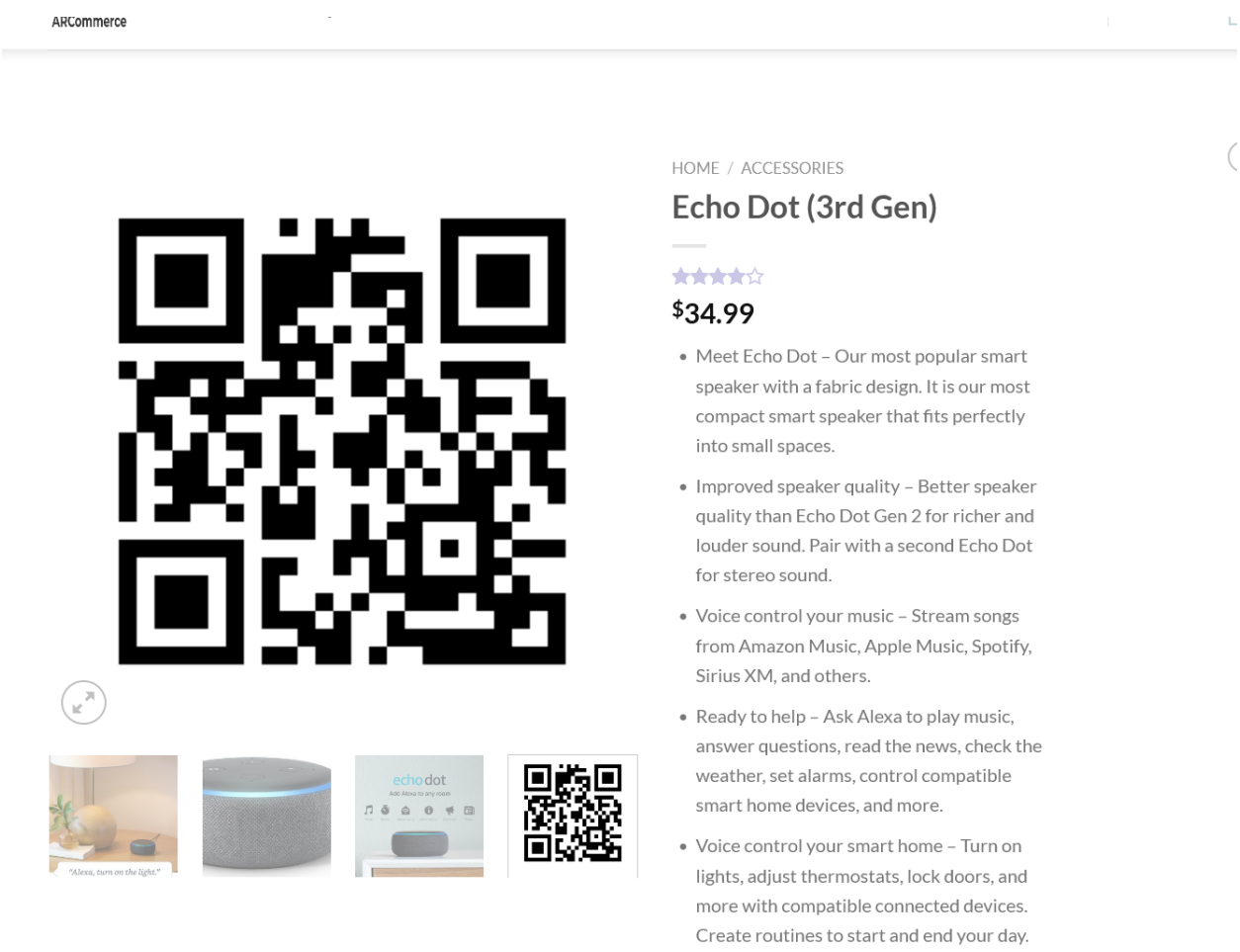

Figure 6-6 Demo Website QR integration

Once users access their chosen product, the product page will display all relevant information pertaining to a product, to best simulate existing e-commerce platforms as well as integrating the AR QR code, enabling users to access the function by simply scanning the code from the website using their preferred AR enabled device.

6.3.2 ECHO AR DASHBOARD

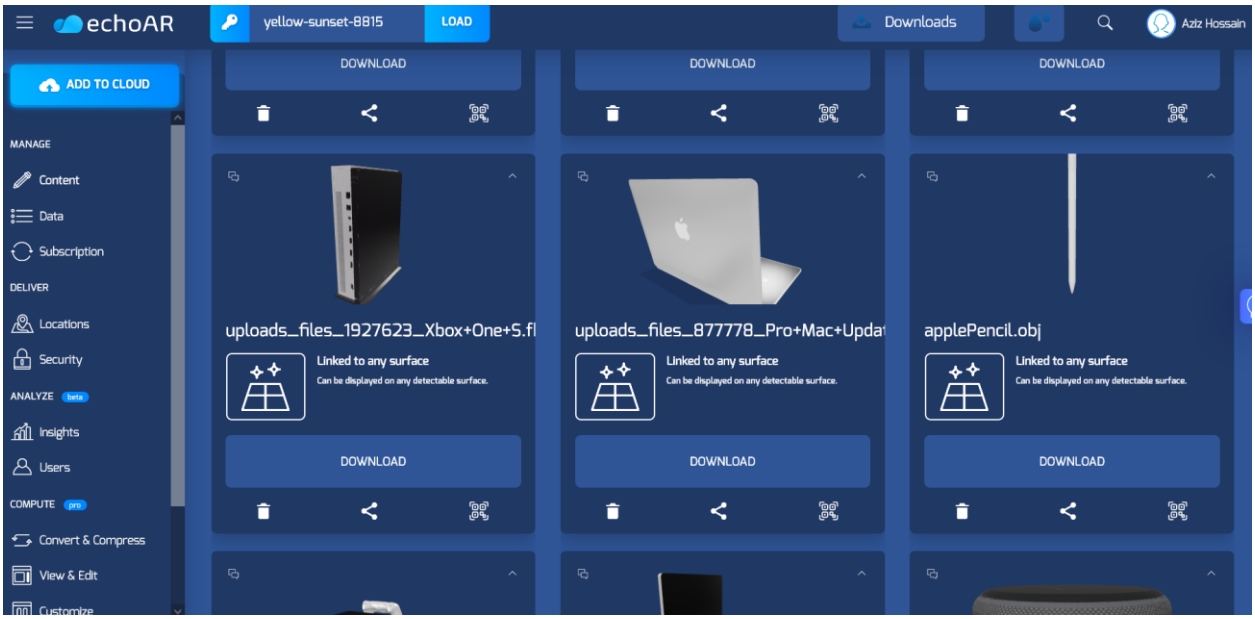

Figure 6-7 EchoAR dashboard

The EchoAR dashboard in figure 6.2 demonstrates the interface though which new models based on products can be added modified or removed. Furthermore, it also allows for the generation of QR codes that link to the rendering interface of the platform. Any models that are uploaded are then converted to an AR friendly models that can have its parameters modified through metadata configuration, such as spawning all models at specific scales, having them rotate in place or only allowing models to be generated in specific locations or from specific images.

For the purposes of the system, the primary deployment method would have the framework project the AR model onto any applicable surface that the user has their device pointed towards.

6.3.3 ECHOAR QR CODE

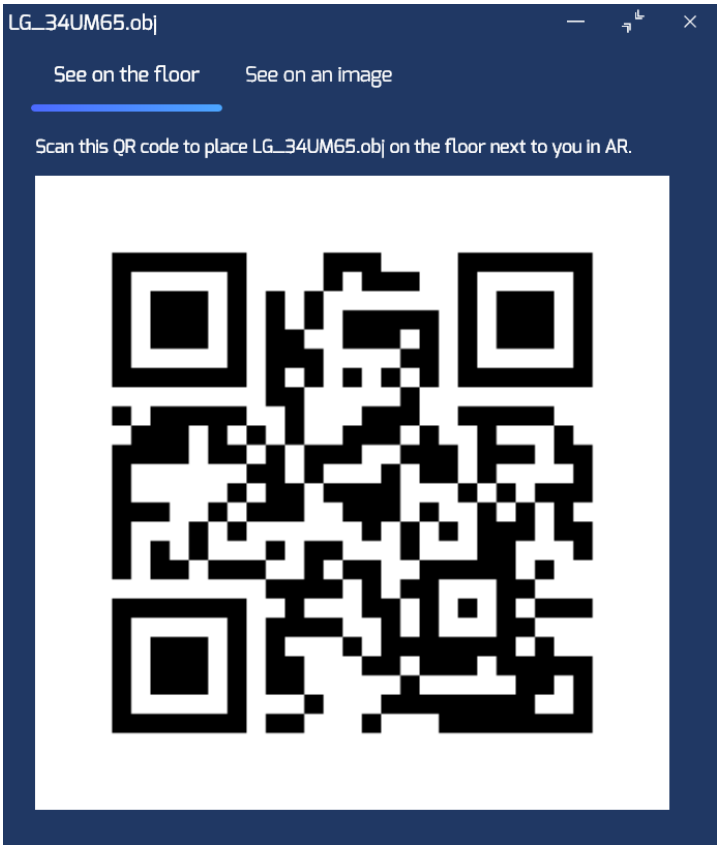

Figure 6-8 EchoAR model QR

Figure 6.3 displays the unique QR code assigned to each model uploaded to the database. The QR codes link to web links tied to EchoARs web based AR system. It also allows for the code to be embedded into images should the need arise for it.

6.3.4 ECHOAR WEBVIEW

Figure 6-9 EchoAR WebAR interface.

In figure 6.4, the initial interaction screen is displayed. Through this screen, a user is able to view the model before the AR projection, giving them an interactive 3d representation of their chosen product to view, providing the user with more information about their product even if they use a device that would not allow for AR projection. The screen will also allow for the transition into AR mode by prompting the user to select the “See in AR” option. This will request the user to provide their choice browser to allow for camera access for the successful scanning of any applicable surfaces for projection.

Figure 6-10 Model projected into the world.

Figure 6.5 shows the projected model in the scanned environment. Once the user chooses the "See in AR" option, the browser will then open an instance of the AR interface.

The user will then be required to provide access to the devices camera for scanning and once

the system is properly initialized, they will then be asked to scan a nearby surface for object projections.

Once the model is projected the user is then able to manipulate it however they wish to, from viewing it to scale, to manipulating its scale and rotation. They may also recalibrate the object to any other surface they wish to try. This then will give them a more informed view of the product that they had chosen.

7 SYSTEM TESTING

7.1 OVERVIEW

To ensure that the proposed system is able to optimally deliver its promised functions, system testing is a crucial phase for the development process. System testing helps ensure that the systems is able to deliver on user satisfaction while allowing for in depth assessment of the systems quality. [24].

While the initial test plan was proposed to be performed though in person test with a wider sample size of users on test devices ensuring that instant feedback on issues with the system could be given on the systems usability and accessibility without concerns of device incompatibility or other external issues, serving as a key beta testing phase to ensure that any critical issues could be addressed quickly and efficiently as well as the usage of multiple testing systems such as the System Usability Scale to collect test data from a sizable sample size to cover larger demographics of users. Unfortunately, as of this report, any such testing system would be impossible due to travel and gathering restrictions, social distancing requirements and mask mandates in most Malaysian states in the current MCO lockdown [26], necessitating that any such test would require arranging online meetings with testers as in person testing may put the author as well as any beta testers at risk, restricting the effectiveness of data gathering and effective support. As such, the author had to limit testing to a far smaller number of users as well as perform a large amount of the testing themselves, though the author had insured that any testable feature of the system had been assessed and scrutinized deeply.

7.2 TEST PLAN

The following test plan consists of the main features to be tested to ensure that all components within the system are fully functional and effective. From the testing of these components, a number of test cases can be derived and usability and functionality can be executed.

Within the tests the demonstration website will act as the interface for the user, emulating the average ecommerce shopping experience while the Augmented Reality aspect will deliver through the EchoAR framework. These components may be tested together, referred to as the system, as well as individually when needed, referred to as the platform and the AR framework respectively.

The test plan will also describe the risk levels for each component test based on the impact to the systems functionality should they fail during operations. High risk levels denote any system critical features or functionality which may lead to complete system failure should they not be functional or fail during operations. Medium risk level denote functionality aspects where the proposed system is able to perform its functions but at the cost of usability, accessibility and/or stability to the user or the system. Finally Low risk level, are the low priority functionalities within the system that exist to add to the system, while not being necessary for function delivery. [25].

The following table lists the test cases performed on the proposed system as well as the results of each test case.

Test Object ID	**Object Name**	**Risk Level**
HP00	Website Home Page (GUI)	High
SF00	Search function	Medium
QR00	QR code accessibility	Medium
EWA00	EchoAR WebAR Access	High
EAP00	EchoAR AR Projection	High
EMM00	EchoAR model Manipulation	Low
ES00	Exiting the System	Low

Table 7-1 Features and Functionalities to be tested.

7.3 TEST CASES

7.3.1 WEBSITE HOME PAGE (GUI)

Test Case ID	HP00
Test Objective	1. To validate the functionality in the home page including display of categories of products.
Prerequisites	Homepage link to be accessed. Website Published. Internet browser. Active Internet Connection.
Test Data	Website link: https://dev-ar-ecommerce.pantheonsite.io/shop/.
Test Procedure	1. Open preferred internet browser. 2. Type "https://dev-ar-ecommerce.pantheonsite.io/shop/" and press enter
Expected Result	1. The browser should take the user to the website. 2. The website should display the product categories available on the website.
Actual Result	The website was opened and the expected page was loaded. The page displays the category of products including the numbers of products available.
Status	Pass

Table 7-2 WEBSITE HOME PAGE (GUI) TEST CASE

7.3.2 SEARCH FUNCTION

Test Case ID	SF00
Test Objective	To test the functionality of the search feature based on keywords or tags.
Prerequisites	The website has been accessed and user is on the homepage. The user has selected the search bar.
Test Data	T1: The text “Xbox” to be entered in the search bar. T2: The text “Nokia” to be entered in the search bar.
Test Procedure	T1: The text in T1 is keyed in and enter is pressed. T2: The text in T2 is keyed in and enter is pressed.
Expected Result	As there are 3 products with the “Xbox” tag, three products should be returned. T2: As no Nokia products are in the database, no product should be returned.
Actual Result	T1: The website filters and displays 3 Xbox products in the product catalog. T2: The website shows a blank screen and an error text that shows “No products were found matching your selection.”
Status	Pass

Table 7-3 SEARCH FUNCTION TEST CASE

7.3.3 QR CODE ACCESSIBILITY

Test Case ID	QR00
Test Objective	1. To validate that the embedded QR codes are successfully displayed.
Prerequisites	1. The website has been accessed. 2. A product has been chosen. 3. The products QR code has been embedded.
Test Data	QR code of the product "**Echo Dot (3rd Gen)**".
Test Procedure	1. User scrolls through product image carousal. 2. User selects QR code thumbnail in carousal.
Expected Result	The product carousal should display product images as well as the QR code at the end of the images. Once selected, the QR code should replace the large product image for easier scanning.
Actual Result	Product webpage successfully loads. The carousal displays all product images. User is able to scroll and/or drag through all 5 images. QR code is prominently displayed when selected.
Status	Pass

Table 7-4 QR CODE ACCESSIBILITY TEST CASE

7.3.4 ECHOAR WEBAR ACCESS

Test Case ID	EWA00
Test Objective	To validate that the QR code scans access the EchoAR WebAR screen.
Prerequisites	1. Device tested is AR capable. 2. The website has been accessed and the product page has been loaded.
Test Data	QR code of the product "**Nintendo – Switch 32GB Console**".
Test Procedure	1. The product QR code has been scanned though the devices camera. 2. The WebAR interface link has been clicked...
Expected Result	The EchoAR WebAR interface has been accessed. The Model should be displayed in the test devices browser. The model should be interactive allowing for user manipulation.
Actual Result	EchoARs WebAR interface is displayed. The model of the scanned product is projected into the virtual space. The model is fully interactive, allowing for users to access a preview of the product and allowing for rotating and scaling of the product. The option of viewing the product in AR is presented with an option "See in AR" on the top right of the view.
Status	Pass

Table 7-5 ECHOAR WEBAR ACCESS TEST CASE

7.3.5 ECHOAR AR PROJECTION

Test Case ID	EAP00
Test Objective	To validate the system AR capability to project the model in the users space.
Prerequisites	1. Device tested is AR capable. 2. The system has been started and the product page has been loaded. 3. The product QR code has been scanned the WebAR interface has been loaded.
Test Data	QR code of the product "**Apple iMac**".
Test Procedure	1. The WebAR interface link has been clicked. 2. The "See in AR" option is selected. 3. The camera is used to scan a preferred surface for the product to be projected on.
Expected Result	The device should display the product on the surface scanned through the device. The model projected should be the product based on the product selected by the user. The device should be able to detect the surface scanned and place the model virtually on it.
Actual Result	The model projected is displayed. The model projected is placed directly on the surface scanned. The model was not to direct scale, but at a rough estimate based on the models dimensions uploaded. The model can then be interacted with based on user's gestures.
Status	Pass

Table 7-6 ECHOAR AR PROJECTION TEST CASE

7.3.6 ECHOAR MODEL MANIPULATION

Test Case ID	FD03
Test Objective	To test the manipulation capabilities of the model projections when the model is loaded in the AR environment.
Prerequisites	1. Device tested is AR capable. 2. The system has been started and the product page has been loaded. 2. The product QR code has been scanned the WebAR interface has been loaded. 4. The devices AR camera has been accessed and the model has been projected.
Test Data	User selects test product page "**Echo Dot (3rd Gen)**".
Test Procedure	1. Load model in projected space. 2. Rotate the model by performing a drag gesture with one finger. 3. Scale the model by performing a pinch gesture with two fingers. 4. Pan the model Drag gesture by per with 2 fingers.
Expected Result	The user should be able to manipulate the model through gestures such as scaling, panning and rotating the model.
Actual Result	The user is able successfully scale the model and rotate the model through the specified. Panning, while successful is less intuitive and may lead to accidental scaling or miss placement of model.
Status	Pass

Table 7-7 ECHOAR MODEL MANIPULATION TEST CASE

8 RECOMMENDATIONS, CONCLUSION AND PERSONAL REFLECTIONS

8.1 OVERVIEW

This is the final chapter of this report in which the recommendations by the author, the conclusions and the personal reflection of the author during the project duration are discussed and elaborated. Recommendations include the factors that affect the performance of the proposed system, limitations of the developed system and suggestions of enhancements and modifications that could be implemented in the future to improve the effectiveness of this project. And finally, the research results are summarised in the conclusion with the personal reflections discussing what the author had discovered in producing this project as well as the skills and experiences developed in terms of soft and hard skills.

8.2 LIMITATIONS AND RECOMMENDATIONS

While there are more AR capable devices available [32] for most online shopping customers, there will still be a sizable number of users whose preferred devices would not be AR capable, limiting the usability of the proposed system. They may be able to view and interact with the WebAR view model to gain more information regarding their product, they would not be able to take full advantage of the AR functions provided, thus removing key information such as how the product would relate to their current surrounding. Furthermore, the age and power of the device may have an effect of the accessibility of the AR models, as older devices using older AR frameworks may take longer to project models, thus increasing user frustration.

Another limitation would be that due to the web based nature of the platform, as to remove the need for users to install additional applications outside their preferred ones, the amount of interaction users can have with their products is heavily limited to what can be provided. As such, if decisions would be affected based on how products scale against a user's own property or how certain products may look in different colors.

Future endeavors may look into focusing more on creating a app based ecommerce platform and integrating AR into said platform, as development using AR frameworks such as Unity's AR

Foundation that would allow for more options for users to interact with the AR projections, such as allowing for life-size scaling by measuring objects around the user [33], AR projection on the user themselves for products such as smart phones or smart watches [34] and other features.

8.3 CONCLUSION

It is in this authors opinion that as more people rely on ecommerce for their purchasing needs, Traditional e-commerce systems face limitations in how they are able to provide direct enough direct information to their customers, especially with products that are more reliant on their dimensions for informed purchasing decisions such as with products like furniture, clothing, electronics, accessories, and other decorative products.

In aiming to address this limitation, this study focused on the development an AR e-commerce system and study how AR implementation would enhance a user's experience and purchasing confidence. As such a formal usability study was developed and conducted with the developed ecommerce system.

It is from these study results, that assertions could be made that an AR integrated e-commerce system could be effectively used to provide more direct information to customers that would normally only be available in traditional shopping experiences and thereby help them make more informed and confident decisions when purchasing products. Furthermore, in the study, users were seen to prefer the web based AR integration over having to install a separate application due to its direct and ease of use.

Finally while the AR integrated e-commerce platform was able to provide users with a more informed and interactive shopping experience than with other traditional ecommerce platforms, the proposed method comes with its own limitations in regards to its usability such as inaccessibility on older devices as well as lesser interactive options compared to app based AR devices. Further enhancements may see the focus of AR integration being targeted towards shopping apps, which would allow for greater access to an AR capable devices camera and scanners and allow for more advanced model interactions.

8.4 PERSONAL REFLECTIONS

Throughout the research and development phase of the project the author had become exposed to numerous methods and technologies used to deliver AR systems to users hands. From apps with integrated AR features supported by Unity's AR foundation framework or Vuforia AR systems to web based AR frameworks such as AR.js and the employed EchoAR Platform. Every choice made to the project regarding the engine used was made to ensure that the users would have the most intuitive and least obstructive path to access the AR system on the demo website. This also necessitated the author to expand their knowledge on these systems in order to better understand the scope benefits and weaknesses of each as well as deepening their knowledge of app and website development which the author found to their benefit.

In regards to the non-technical aspect of the project, the author strove to improve their interpersonal skills through the execution of this project especially in the data collection phase.

Furthermore the guidance provided by their project supervisor through their guidance, observation and care served as a driving force for the project ensuring that the author aimed to deliver the best possible outcome for the research.

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APPENDIX A: PROJECT PROPOSAL

INTI International University

Master of Information Systems/Information Technology PRJ6999

Initial Research Paper Proposal

STUDENT NAME & ID NO	Aziz Hasan Hossain I13002999
BROAD AREA	Augmented Reality; E-commerce
Concise Title	User interaction enhancement for Online Marketing Platforms through Augmented Reality systems
Problem Definition	This research aims to address the issues faced by customers wishing to purchase products online but are unable to make a confident decision in a product due to uncertainty caused by a lack of sufficient information, such as a proper representation of the dimensions of a product or how the product may appear in their environment. To achieve a greater impact or outcome, this research aims to focus on the importance of the user's confidence as well as study the user's engagement and interest in purchasing when using the Augmented Reality features in an online shopping environment.
Research questions or Research Objectives	RQ1: How does uncertainty affect a customer's commitment to purchase a product such as electronic devices on an online purchasing platform?

	RQ2: Does the implementation of Augmented Reality in an online purchases platform improve user's confidence in choosing an item? RQ3: Does the implementation of augmented reality technology provide a novel and informative experience for users in an online shopping that they may not otherwise have, such as a visualization of the dimensions of a product?
Scope of Study	The finding from this study will contribute to the field of academia in that it would illustrate the correlation between the implementation of new advanced technologies, in this case augmented reality into existing platforms, such as the online purchasing experience and how it affects consumer confidence and satisfaction. For researcher this adds to the current body of research into augmented reality and online platform interactions. The expectation from this research is to add to the current body of research regarding the implementation of augmented reality technology in the online commercial platform. This in turn may be used to further improve on research conducted by other bodies on the implementation of said technology in future platforms.
Significance of Research	By implementing AR technologies in their current systems, it can assist its customers in making better decisions in the products they wish to purchase as well as giving the companies an edge over their competitors by allowing its customers to interact directly with the products, presenting their products with a representation of products as if they were purchasing them in a physical retail store, f By implementing AR technologies in their current systems, it

	can assist its customers in making better decisions in the products they wish to purchase as well as giving the companies an edge over their competitors by allowing its customers to interact directly with the products, presenting their products with a representation of products as if they were purchasing them in a physical retail store, from the comfort of their own homes, At the moment though, AR has only seen experimental usage in retail marketing and as mostly been used in promotional campaigns, though they have seen mostly positive engagement from their market base. From this we can conclude that AR has the potential to attract customers to interact with a company's products and increase their interest in purchasing them. This engagement has the added benefit of creating a positive engagement between brands and customers by allowing customers to interact with their products in novel ways. Also by creating product catalogues and displaying information on products such as complete descriptions and specifications of goods that can be accessed by AR systems, it can assist customers in decisions regarding the products they would like to purchase. from the comfort of their own homes, At the moment though, AR has only seen experimental usage in retail marketing and as mostly been used in promotional campaigns, though they have seen mostly positive

	engagement from their market base. From this we can conclude that AR has the potential to attract customers to interact with a company's products and increase their interest in purchasing them. This engagement has the added benefit of creating a positive engagement between brands and customers by allowing customers to interact with their products in novel ways. Also by creating product catalogues and displaying information on products such as complete descriptions and specifications of goods that can be accessed by AR systems, it can assist customers in decisions regarding the products they would like to purchase.

APPENDIX B: INITIAL DECLARATION FORM

DECLARATION BY APPLICANT

(i) I undertake, to the best of my ability, to abide by accepted ethical principles in carrying out the study.

(ii) I undertake to explain the nature of the study and all possible risks to potential participants, to the extent required to comply with both the letter and the spirit of my replies to the foregoing questions.

(iii) Data relating to participants will be handled with great care. No data relating to named or identifiable participants will be passed on to others without the written consent of the participants concerned, unless they have already consented to such sharing of data when they agreed to take part in the study.

(iv) All participants will be informed **(a)** that they are not obliged to take part in the study, and **(b)** that they may withdraw at any time without disadvantage or having to give a reason.

Where the participant is a minor or is otherwise unable, for any reason, to give full consent on their own, references here to participants being given an explanation or information, or being asked to give their consent, are to be understood as referring to the person giving consent on their behalf.

(v) All personal data that is collected will be protected and kept for 2 years.

Enter your name here: Aziz Hasan Hossain Date 17-05-2021

If you are a member of staff, please obtain the signature of your line manager to indicate their agreement to this application:

....

(Signature) (Name in BLOCK CAPITALS and position within the School)

DECLARATION BY SUPERVISOR

I confirm that the proposed study has been appropriately vetted within the Faculty in respect of its aims and methods as a piece of research. I accept responsibility for guiding the applicant so as to ensure compliance with the terms of the protocol and with any applicable ethical code(s).

Enter your name Ts. DR. RAJERMANI THINAKARAN Date 17-05-2021

APPENDIX C: PROJECT LOG

PROJECT PAPER LOG

This is an important document, which is to be handed in with your dissertation. This log will be taken into consideration when awarding the final mark for the dissertation.

Student Name:	Aziz Hasan Hossain
Supervisor's Name:	Dr. Rajermani Thinakaran
Dissertation Topic: User interaction enhancement for Online Marketing Platforms through Augmented Reality systems	

SECTION A. MONITORING STUDENT DISSERTATION PROCESS

The plan below is to be agreed between the student & supervisor and will be monitored against progress made at each session.

Activity	**Milestone/Deliverable Date**	
	Item	Date
Meeting 1	Progress proposal	4-6-2021
Meeting 2	Chapter 1-3	25-6-2021
Meeting 3	Chapter 1-3 amended	3 July 2021
Meeting 4	System demonstration	29 July 2021
Meeting 5	Chapter 4-6	6-8-2021
Meeting 6	Final documentation	15-8-2021
Meeting 7	Final documentation	22-8-2021

SECTION B. RECORD OF MEETINGS

The expectation is that students will meet their supervisors up to seven times and these meetings should be recorded.

Meeting 1

Date of Meeting	4-6-2021
Progress Made	Project proposal shown and discussed.
Agreed Action	Project proposal Submission Gantt chart submission, Chapter 1-3 draft submission
Student Signature	Aziz Hasan Hossain
Supervisor's Signature	Ts. DR. RAJERMANI THINAKARAN rajer

Meeting 2

Date of Meeting	25-6-2021
Progress Made	Chapter 1-3 submitted for review. Gantt chart Submitted Proposal submitted. System Development started.
Agreed Action	Chapter 4 Preparation Chapter 5 Preparation System Demonstration.
Student Signature	Aziz Hasan Hossain
Supervisor's Signature	Ts. DR. RAJERMANI THINAKARAN rajer

Meeting 3

Date of Meeting	3 July 2021
Progress Made	Chapter 1–3 amendments suggested for revision. Initial system development in progress and local testing initiated.
Agreed Action	Chapter 1-3 amendments to be followed and submitted for final review. Progress with system development and preparation of data collection.
Student Signature	Aziz Hasan Hossain
Supervisor's Signature	Ts. DR. RAJERMANI THINAKARAN rajer

Meeting 4

Date of Meeting	29 July 2021
Progress Made	Chapter 1-3 completed. Testing of App based AR platform showing limitations due to device compatibility. Proposal to adjust current system to utilize web based AR as a solution to the device limitation.
Agreed Action	Investigate and Implementation of Web based AR platform for device compatibility. Complete
Student Signature	Aziz Hasan Hossain
Supervisor's Signature	Ts. DR. RAJERMANI THINAKARAN rajer

Meeting 5

Date of Meeting	6-8-2021
Progress Made	Demonstration of revised system. Switch to Web based AR platform. Chapter 4 incomplete Chapter 5 completed. Chapter 6 completed
Agreed Action	Advancement of new system Completing chapter 4 Proceed with chapter 7
Student Signature	Aziz Hasan Hossain
Supervisor's Signature	Ts. DR. RAJERMANI THINAKARAN rajer

Meeting 6

Date of Meeting	15-8-2021
Progress Made	Completion Of all chapters. Demonstration Platform prepared. Viva Date and time arranged
Agreed Action	Preparation and submission of Final documentation. Preparation of presentation materials. Preparation of presentation slides.
Student Signature	Aziz Hasan Hossain
Supervisor's Signature	Ts. DR. RAJERMANI THINAKARAN rajer

Meeting 7

Date of Meeting	22-8-2021
Progress Made	Completion Of all chapters. Demonstration Platform prepared. Viva Date and time arranged
Agreed Action	Preparation and submission of Final documentation. Preparation of presentation materials. Preparation of presentation slides.
Student Signature	Aziz Hasan Hossain
Supervisor's Signature	Ts. DR. RAJERMANI THINAKARAN rajer

Section D. Comments on Management of Project

Student Comments

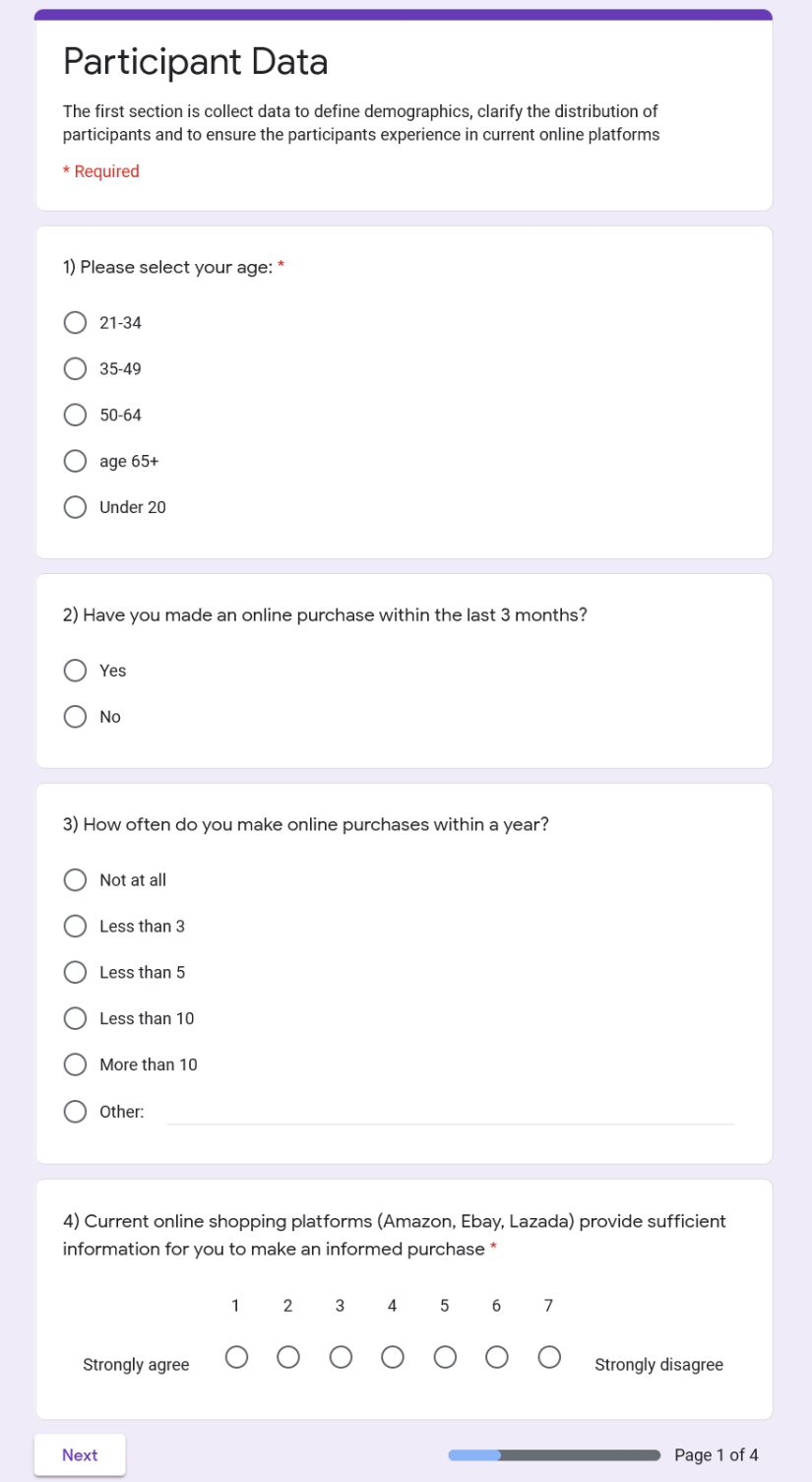
The project, while numerous challenges were met, was completed with all goals met. Adjustments had to be met to meet changes based on feedback on the project system, but were successfully implemented. It was a pleasure having Dr. Rajermani as my supervisor as her guidance, support and understanding allowed me to progress effectively with my project.

Supervisor Comments

The student able to complete the project objective on time.

Signature of Student AHH	Date:27 Aug 2021
Signature of Supervisor rajer	Date: 27/8/2021
Ethics Confirmed	Date:

APPENDIX D: QUESTIONAIRE TEMPLATE



Participant Data

The first section is collect data to define demographics, clarify the distribution of participants and to ensure the participants experience in current online platforms

* Required

1) Please select your age: *

- 21-34
- 35-49
- 50-64
- age 65+
- Under 20

2) Have you made an online purchase within the last 3 months?

- Yes
- No

3) How often do you make online purchases within a year?

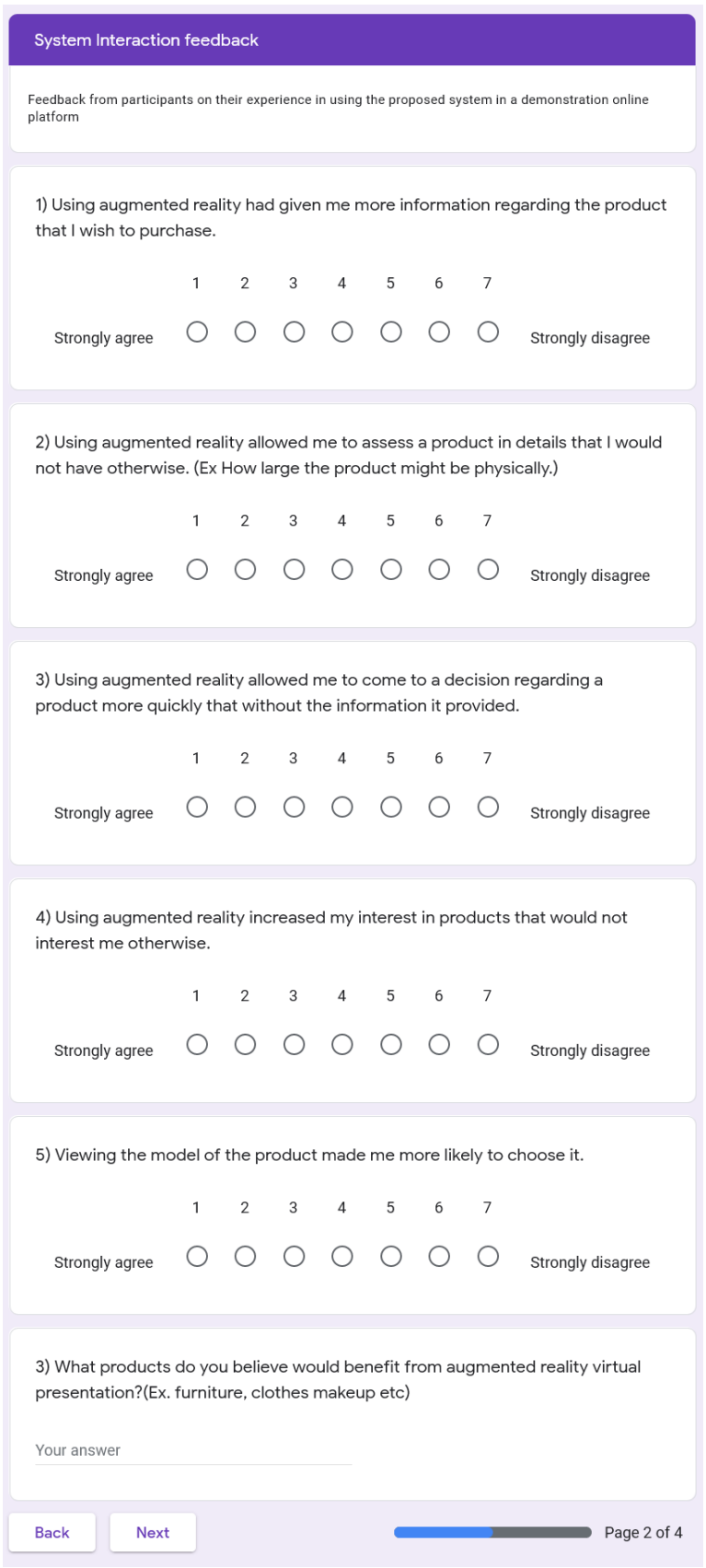
- Not at all
- Less than 3
- Less than 5
- Less than 10
- More than 10
- Other:

4) Current online shopping platforms (Amazon, Ebay, Lazada) provide sufficient information for you to make an informed purchase *

	1	2	3	4	5	6	7	
Strongly agree	○	○	○	○	○	○	○	Strongly disagree

Next

Page 1 of 4



System Interaction feedback

Feedback from participants on their experience in using the proposed system in a demonstration online platform

1) Using augmented reality had given me more information regarding the product that I wish to purchase.

	1	2	3	4	5	6	7	
Strongly agree	○	○	○	○	○	○	○	Strongly disagree

2) Using augmented reality allowed me to assess a product in details that I would not have otherwise. (Ex How large the product might be physically.)

	1	2	3	4	5	6	7	
Strongly agree	○	○	○	○	○	○	○	Strongly disagree

3) Using augmented reality allowed me to come to a decision regarding a product more quickly that without the information it provided.

	1	2	3	4	5	6	7	
Strongly agree	○	○	○	○	○	○	○	Strongly disagree

4) Using augmented reality increased my interest in products that would not interest me otherwise.

	1	2	3	4	5	6	7	
Strongly agree	○	○	○	○	○	○	○	Strongly disagree

5) Viewing the model of the product made me more likely to choose it.

	1	2	3	4	5	6	7	
Strongly agree	○	○	○	○	○	○	○	Strongly disagree

3) What products do you believe would benefit from augmented reality virtual presentation?(Ex. furniture, clothes makeup etc)

Your answer

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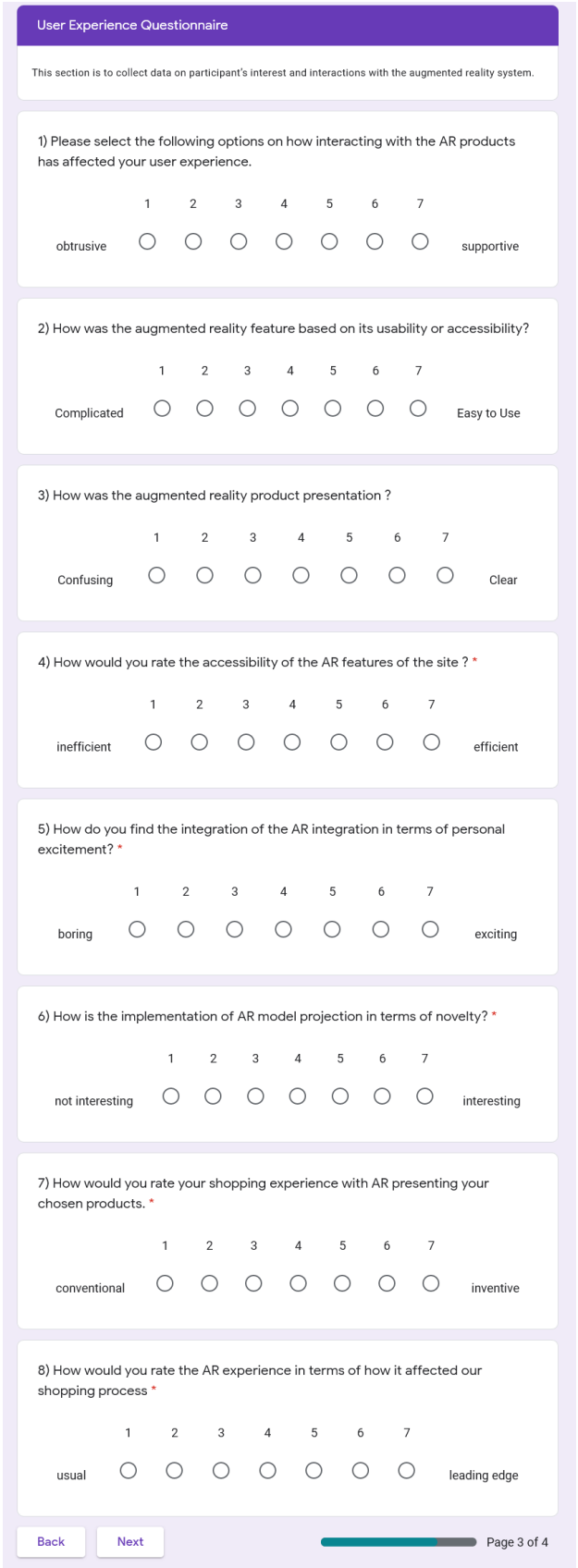

User Experience Questionnaire

This section is to collect data on participant's interest and interactions with the augmented reality system.

1) Please select the following options on how interacting with the AR products has affected your user experience.

	1	2	3	4	5	6	7	
obtrusive	○	○	○	○	○	○	○	supportive

2) How was the augmented reality feature based on its usability or accessibility?

	1	2	3	4	5	6	7	
Complicated	○	○	○	○	○	○	○	Easy to Use

3) How was the augmented reality product presentation ?

	1	2	3	4	5	6	7	
Confusing	○	○	○	○	○	○	○	Clear

4) How would you rate the accessibility of the AR features of the site ? *

	1	2	3	4	5	6	7	
inefficient	○	○	○	○	○	○	○	efficient

5) How do you find the integration of the AR integration in terms of personal excitement? *

	1	2	3	4	5	6	7	
boring	○	○	○	○	○	○	○	exciting

6) How is the implementation of AR model projection in terms of novelty? *

	1	2	3	4	5	6	7	
not interesting	○	○	○	○	○	○	○	interesting

7) How would you rate your shopping experience with AR presenting your chosen products. *

	1	2	3	4	5	6	7	
conventional	○	○	○	○	○	○	○	inventive

8) How would you rate the AR experience in terms of how it affected our shopping process *

	1	2	3	4	5	6	7	
usual	○	○	○	○	○	○	○	leading edge

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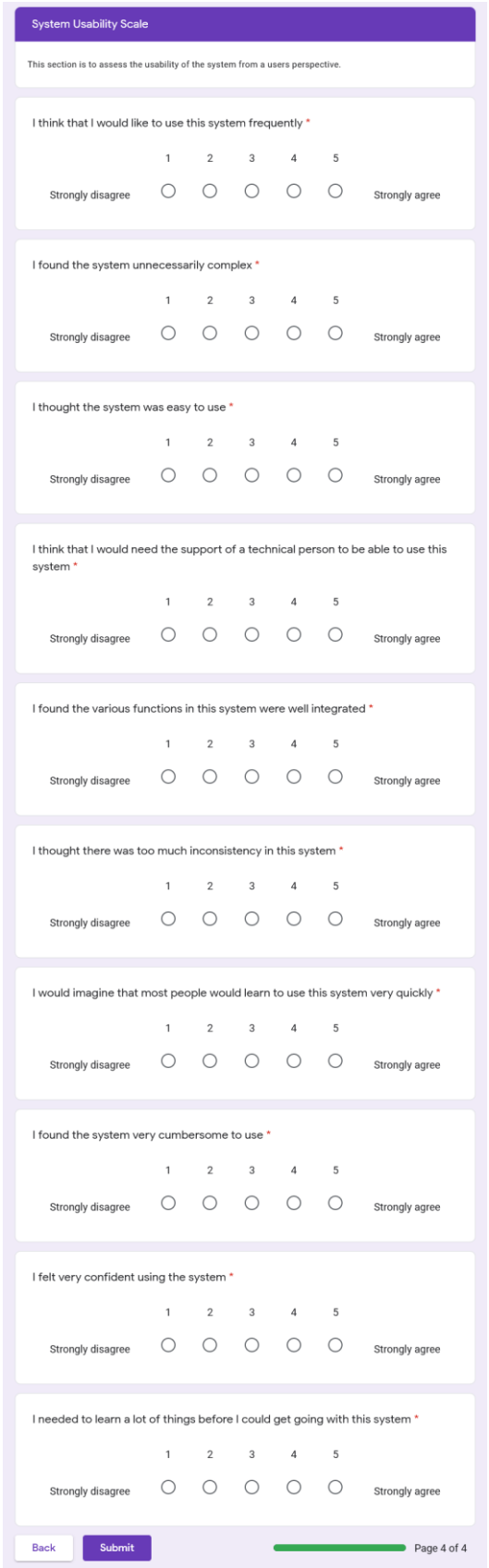


System Usability Scale

This section is to assess the usability of the system from a users perspective.

I think that I would like to use this system frequently *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I found the system unnecessarily complex *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I thought the system was easy to use *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I think that I would need the support of a technical person to be able to use this system *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I found the various functions in this system were well integrated *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I thought there was too much inconsistency in this system *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I would imagine that most people would learn to use this system very quickly *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I found the system very cumbersome to use *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I felt very confident using the system *

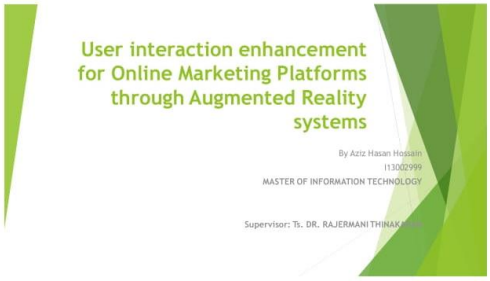
	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

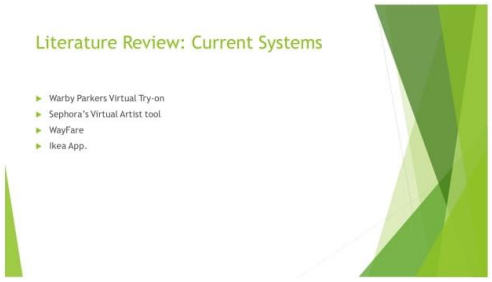
I needed to learn a lot of things before I could get going with this system *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

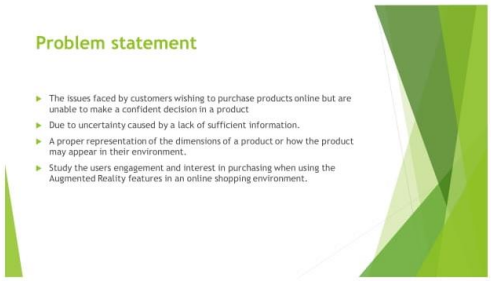
Back Submit Page 4 of 4

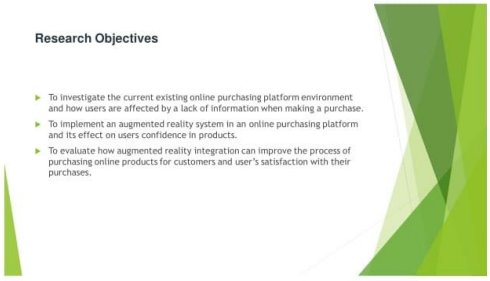
APPENDIX E: PRESENTATION SLIDES

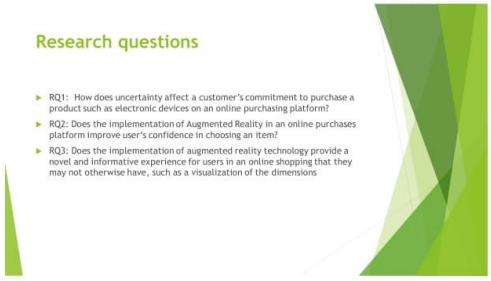





Proposed System
Users are not completely confident in their purchase due to inability ability to visualize their product in their environment, or how it may interact with it.
Customers may buy these products without confidence that the product will match expectations .
Integration of AR technologies into the online shopping experience will offer the means to overcome these major issues.
As such the proposed system aims to introduce an augmented reality framework for an online platform through the use of mobile devices.
Allow for a representation of a product to be projected into a user's real space
The application will also allow the user to train represented scales in their environment to more accurately display the size of the product
3d representations of products to assess and deliberate on factors such as the dimensions and characteristics of a product


Problem statement
The issues faced by customers wishing to purchase products online but are unable to make a confident decision in a product
Due to uncertainty caused by a lack of sufficient information.
A proper representation of the dimensions of a product or how the product may appear in their environment..
Study the users engagement and interest in purchasing when using the Augmented Reality features in an online shopping environment.

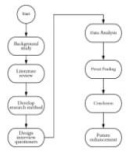

Research Objectives
To investigate the current existing online purchasing platform environment and how users are affected by a lack of information when making a purchase.
To implement an augmented reality system in an online purchasing platform and its effect on users confidence in products.
To evaluate how augmented reality integration can improve the process of purchasing online products for customers and user's satisfaction with their purchases.


Research questions
RQ1: How does uncertainty affect a customer's commitment to purchase a product such as electronic devices on an online purchasing platform?
RQ2: Does the implementation of Augmented Reality in an online purchases platform improve user's confidence in choosing an item?
RQ3: Does the implementation of augmented reality technology provide a novel and informative experience for users in an online shopping that they may not otherwise have, such as a visualization of the dimensions

Hypothesis

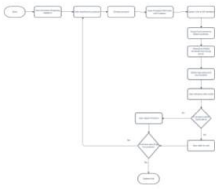
- H1: Uncertainty does have a significant effect a customer's commitment to purchase a product on an online purchasing platform.
- H2: The implementation of Augmented Reality in an online purchases platform can improve user's confidence in choosing an item.
- H3: The use of augmented reality technology does provide a novel and informative experience that is able to match the customers' expectations and provide satisfaction

Research design Framework

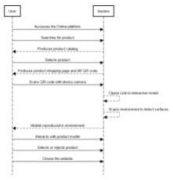


- This study aims to use the quantitative method of data collection and analysis.
- Allows the collection of definitive data from participants to ensure ease of data collection, data analysis and verification and validation.
- Develop a prototype augmented reality system for a mock online purchasing platform
- Participants will experience a number of purchasing scenarios
- The study will aim to have about 20-40 participating respondents.
- The study will use the Google forms applications to collect data

System Flowchart Diagram



Sequence Diagram



Use Case Diagram

Use case Actors

Actor	Use cases
User	Access the Online Platform
	Search for Product
	Select Product
	View QR code
	Interact with model
	Add product to cart
System	Product Catalogue
	View Product page and QR code
	Access interactive model
	Scan environment for surfaces
	Reproduce model

System Implementation

- Development focused on being deployable for mobile device users.
- Guarantees that a larger number of users are able to access the AR system.
- delivery method of the model data through QR code scans and Web based AR.
- Web based AR removes the need for users to need to install external apps.
- Demonstrations system uses website as basic interface, EchoAR as the AR framework.

Development Background

- Cloud-based augmented and virtual reality platform
- Allows for developers and companies to create and deploy AR/VR applications with ease.
- Allows for both integration to existing AR enabled applications,
- As offering web based AR integration for existing website interface.

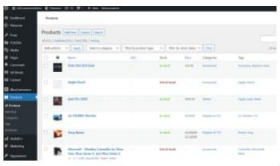
Development Background

- WordPress is one of the most popular open-source content management system (CMS)
- Allows of its users to develop website quickly and efficiently with minimal to no cost depending on the users requirements.
- Allow its users to create any number of types of websites, such as blogs , business pages , online portfolios and e-commerce platforms of any size and feature.
- website which acts as both the basic interface as well as the access point and ecommerce platform
- deliver an authentic shopping experience for users to experience the platform

Development Background

- Pantheon.io is a Website Management Platform for WordPress.
- It allows for the while allowing for realtime publishing and modifications of any WordPress elements
- Minimal backend overreach as any and all features and functions via pantheons dashboard.
- Allows for features and modifications to be made to the website with ease and efficiency based on user feedback and responses.

System Components: Website Backend



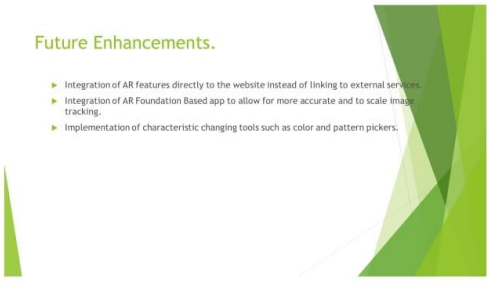
System Component :Website Interface

System Components: Product Page

System Components: EchoAR Dashboard

System Demonstration

- https://dev-ar-ecommerce.pantheonsite.io/


Future Enhancements.
Integration of AR features directly to the website instead of linking to external services.
Integration of AR Foundation Based app to allow for more accurate and to scale image tracking.
Implementation of characteristic changing tools such as color and pattern pickers.