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Implementation of augmented reality as a revolutionary approach in computer stores

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ABSTRACT

The adoption of augmented reality (AR) spans various fields, from education to business. Currently, many businesses utilize AR to boost customer engagement and enhance product understanding. This research focuses on developing and examining an AR application on a Solo computer store's website to improve customer engagement. Results indicate that AR significantly enhances the shopping experience, deepens product comprehension, and increases website interactions. Features like 3D product visualization and detailed information enable customers to make more informed purchasing decisions. A questionnaire with 25 respondents revealed a high acceptance rate of the AR application, averaging 92%. Additionally, AR was shown to increase customer engagement, potentially boosting sales by up to 35%, reducing operating costs by 20%, and enhancing productivity by 15%. The study also found differing preferences across age groups: older respondents (40-70 years) favored traditional website features without AR and were less comfortable with markerless technology, whereas younger consumers (18-39 years) were more attracted to AR-enhanced websites. These insights offer valuable guidance for the Solo computer store to craft innovative marketing strategies tailored to the diverse preferences and needs of their customers.

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1. INTRODUCTION

In today's digital age, a lot of business sectors facing a challenge to obtain more engagement with their customers. Computer store is a business sector that needs to follow the technology advancement to increase the customer experience and stay competitive. One of the most promising innovations the digital age is augmented reality (AR) technology [1]. This research focuses on designing and implementing AR as a feature of a computer store website to achieve two main goals such as enhancing customer interaction and enriching their shopping experience. To understand user preferences and needs, a combination of surveys and questionnaires was employed [2]. Additionally, a comprehensive literature study was conducted to gain insights into the latest advancements in AR technology and its successful applications in retail environments [3]. The model development life cycle (MDLC) framework was then utilized to guide the development of a computer store website that seamlessly integrates AR features.

The primary outcome of this research is a fully functional computer store website equipped with an innovative AR feature [4]. This feature allows customers to visualize the detail of computer specification would look like and provides better product understanding before making a purchase decision [5]. Current finding in [6] suggests that the integration of AR on the website significantly enhances customer interaction and overall shopping experience. This suggests that AR has the potential to revolutionize the computer retail industry by bridging the gap between online and offline shopping.

According to several recent studies, such as the one conducted by Samir *et al.* [7], e-commerce has been shown to have a positive impact on customer satisfaction, where product quality significantly influences customer loyalty. However, demographic details like the age of respondents were not thoroughly considered in this study. Aristantia and Liu [8] also found that AR enhances customer satisfaction and repurchase intention in e-commerce, although their study did not delve into specific aspects such as the tools used to create AR and the age of respondents. A similar issue was found in the research by Dethe and Joy [9], which highlighted the significant impact of AR on purchase decisions but again lacked details on the specific application of AR to certain products. On the other hand, the research by Rama Santo and Djumadi Sastro Wiyono at Toko Maju Jaya showed that web-based e-commerce can boost sales [10], but it has yet to leverage AR features. Meanwhile, the study by Leni Fitriani and Bayu Muhammad Fauzi in Garut designed a web-based computer store mapping system, but it has not yet incorporated AR to enhance the user experience [11].

Therefore, further exploration of AR should focus on evaluating the effectiveness of its features [12] in boosting sales and customer satisfaction. Additionally, it would be valuable to investigate the potential applications of AR in other retail sectors [13], as this technology holds promise for transforming the way consumers interact with products and make purchasing decisions [14]. With proper utilization, AR can not only significantly enhance the shopping experience but also open up new opportunities for the retail sector to adapt and grow amid increasingly fierce digital competition.

2. METHOD

The research stages can be seen in Figure 1, starting with the identification of research problems and objectives. Next, data is collected to support the development of an AR application [15]. AR application development is carried out using the MDLC method [16], [17]. which consists of the stages of concept, design, material collection, assembly, testing, and distribution. This research focuses on how AR is implemented on the website of a computer store in Solo and how it affects customer engagement and sales [18], [19].

Figure 1. Research framework

2.1. Research framework

2.1.1. Problem identification and research objectives

The problem identification in this research stems from the observation of the low utilization of AR technology in Solo computer stores. Despite its potential to enhance customer shopping experiences through interactive product visualizations, AR remains underutilized. This research aims to examine the effectiveness of implementing AR on the website of a Solo computer store to improve customer satisfaction and sales. By integrating AR, customers are expected to gain a better understanding of product specifications and features, thereby increasing their purchase intention.

In addition, this research also identifies the challenges and obstacles faced in implementing AR in Solo computer stores and seek solutions to address these issues. The findings of this research are expected to contribute to the development of the computer store business in Solo and serve as a reference for future research on the application of AR technology in the retail sector.

2.1.2. Data collection

This research employs a mixed-methods approach, utilizing both qualitative and quantitative data collection techniques [20]. Qualitative data is gathered through surveys and questionnaires administered to customers, as well as direct observations conducted in computer stores. Meanwhile, the quantitative data is

obtained by analyzing the store's sales data before and after the implementation of AR, along with analyzing online reviews and customer feedback [21].

A. Surveys and questionnaires

The utilization of AR in stores is assessed through customers' feedback that aims to understanding the customers' opinions and experiences regarding to its implementation. The questionnaire design process commenced with identifying key aspects of the customer experience to be measured, such as satisfaction levels, ease of AR use, and its impact on purchasing decisions. The questionnaire incorporated a combination of closed-ended and open-ended questions to obtain comprehensive quantitative and qualitative data. Closed-ended questions are utilized to acquire measurable data on specific aspects of the AR experience. Meanwhile, open-ended questions allow the respondents to provide more detailed and nuanced feedback on their overall experiences and perceptions.

The survey is conducted to collect data from 25 computer store customers, comprising of 15 consumers with the aged 18-39 years old and 10 respondents aged 40-70 years old. The questions focus on their shopping experiences, including satisfaction levels, ease of AR use, and its influence on purchasing decisions. The questionnaire is also designed to gauge the effectiveness of AR in enhancing the shopping experience, encompassing aspects such as user-friendliness, visual quality, and the relevance of information presented. Prior to distribute the survey, the questionnaire underwent validity and reliability testing to ensure that the questions accurately measured the intended constructs and yielded consistent results. Additionally, a pilot test was conducted with a small group of respondents to identify potential issues and refine the questionnaire before the main survey [22].

A user acceptance test (UAT) was also adopted to evaluate user acceptance of the AR application before its official launch. The UAT involved potential users to directly test the AR application and provide feedback according to their experiences. The feedback is then utilized to improve the AR application before its release. The data collected from the survey and questionnaire are analyzed to identify patterns, trends, and correlations between AR usage and customer satisfaction, as well as its impact on purchasing decisions. The results of this analysis provides valuable insights into how AR can be leveraged to enhance the shopping experience in computer stores in Solo city and how this technology can assist the store in meeting the needs and expectations of their customers [23].

B. Observation

Direct observation in computer stores in Solo brings crucial aspect since it plays as a tool to understand the real-world utilization of AR. The observation process starts by examining the store layout and placement of AR devices, followed by observing customer behavior while interacting with AR technology. The focus of observation encompasses several aspects, including how customers access and utilize AR features, their reactions to the information presented, whether AR usage influences their purchasing decisions, how store staff employ AR to assist customers, and the challenges and obstacles encountered in using AR [24].

Brief interviews with customers and store staff are also conducted to gain a deeper understanding of their experiences and perceptions regarding to the AR adoption. Observation and interview data is qualitatively analyzed to identify patterns, themes, and key insights related to AR utilization in computer stores [25]. The information obtained will be invaluable in evaluating the effectiveness of AR as a revolutionary approach in computer product sales. The results of this observation are also expected to help identify potential areas for improvement and further innovation in the use of AR in Solo computer stores, as well as provide useful recommendations for store owners and AR technology developers [26].

2.1.3. AR application development

The development of the AR application in this research followed the MDLC method, as illustrated in Figure 2. This method comprises five stages namely concept, design, material collection, assembly, and testing. The first stage involves planning the application's ideas and features [27]. While the second stage focuses on creating the user interface and visual elements. The material collection stage involves gathering digital assets such as 3D models, images, and audio. The assembly stage involves integrating all elements into a functional application, and the last stage involves evaluating the application to ensure optimal functionality and performance.

The use of the quantitative analysis allows us to identify patterns and correlations between AR usage and sales figures. Overall, satisfaction and recurring issues or positive aspects of the AR experience in stores are extrapolated by analyzing online reviews and customer feedback [28]. The combination of these two data collection techniques provides a comprehensive overview of the implementation and implications of AR on the websites of computer stores in Solo.

AR is an innovative technology that transforms a number of sectors by forcing digital information into a real environment. AR provides new methods to enhance consumer engagement, product visibility, and the entire shopping experience in the retail industry [29]. The project aims to implement AR in a computer store located in Solo City, Central Java, Indonesia. The MDLC will be used to build and distribute AR applications systematically. The main objective is to evaluate the effectiveness of AR in increasing consumer engagement and increasing sales [30].

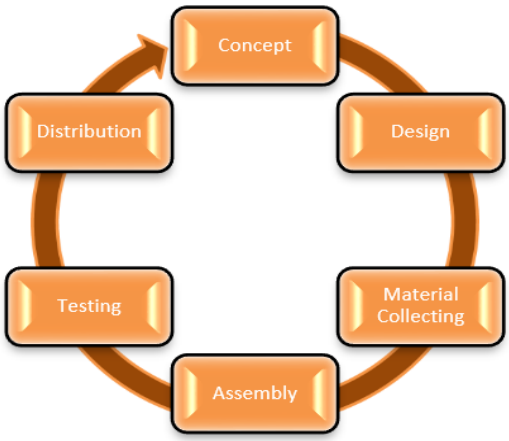

Figure 2. MDLC method

A. Concept

The concept phase of this research delves into the theoretical foundations of AR technology and its potential impact on customer engagement and operational efficiency in retail. This phase establishes the fundamental blueprint that pictures the AR application, merging traditional retail with cutting-edge digital advancements.

The designs of the AR application adopts use case diagrams, activity diagrams, class diagrams, and flowcharts to comprehensively map user interactions and system processes [31]. Additionally, this phase identifies potential challenges and limitations of AR in retail setting, such as technical issues and ethical considerations related to data privacy. By addressing these concerns, this research aims to ensure that the developed AR application is not only innovative and user-friendly but also comply the ethical issue.

– Use case diagrams

A use case diagram serves as a visual representation of the interaction between users and a system. This graphical illustration depicts the various ways users can interact with an application or system, outlining the tasks or functions they can perform [32]. Essentially, a use case diagram provides a comprehensive overview of user interaction with a system or application from the user's perspective, as can be seen in Figure 3 for an example use case.

The use case diagram illustrated in Figure 3 depicts the interaction between a user and a computer store application equipped with AR features. The user can browse the store's product catalog, select a specific category of computer tools, and view 3D objects of the selected products. Additionally, the user can access the application’s user guide and the store's contact information. The AR feature allows users to view 3D objects of the selected products, providing a more interactive and informative experience. The application usage guide helps users understand how to use the AR feature effectively, while the store's contact information enables users to contact the store if they have any questions or concerns. In Table 1 it describes the use of applications by users, that is, visitors to online computer stores. The app allows users to explore the collection of products in the store in a three-dimensional (3D) display on their devices.

The prominent feature of the app is displaying the store’s products in 3D format. This allows users to gain a deeper and more interactive experience while looking at the products offered. The 3D view can help users to understand the shape, size, and details of products better than just looking at two-dimensional images. With this feature, customers can have detailed product description and thus they are able to make more accurate purchasing decisions and feel more satisfied with their online shopping experience.

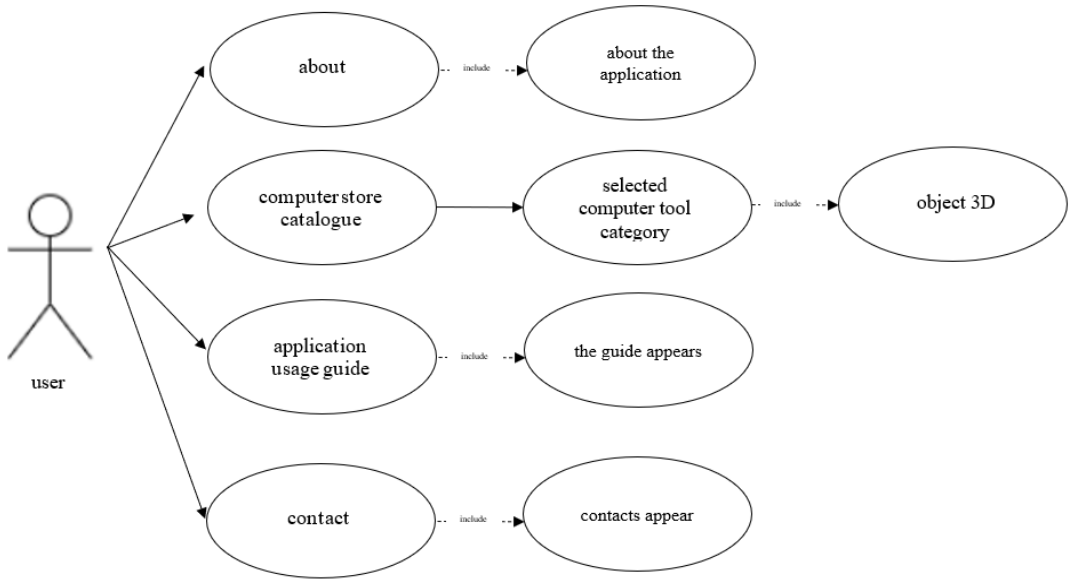

Figure 3. Use case diagram

Table 1. User application usage

User	Information
Visitors	Visitors can explore the collection of items sold on the computer store website in a three-dimensional format presented on their devices.

– Activity diagrams

In software development, activity diagrams are particularly valuable. It has function to illustrate the steps of a user takes, from the very first phase such as log in and log out. This level of detail is invaluable for identifying potential bottlenecks or areas where the user experience could be improved, ultimately leading to increased efficiency and user satisfaction. In addition, activity diagrams can be applied in various applications such as to model business processes, outline manufacturing procedures, or even plan event logistics. Their flexibility and intuitive nature make them an indispensable tool for anyone seeking to visualize and optimize complex processes.

The activity diagram shown in Figure 4 illustrates the interaction between the user and the system within a computer store application equipped with AR features. Starting with the user launching the application (start), the system displays the user's dashboard. Following that, the user can choose a product catalogue, and the user can browse the product catalog. To show the product 3D object, the user can scan an object using AR. The system proceeds to detect the object (detect objects). If the object is detected, the system immediately displays the 3D model of the object. If it is not detected, then the process returns to the object scanning stage (scan object). The diagram in Figure 4 provides a clear overview of the application's workflow, from start to finish, as well as how users interact with the AR feature to view product details in 3D.

– Class diagrams

A class diagram illustrates the structure of a system by depicting its classes, attributes, methods, and relationships between classes. The diagram shown in Figure 5 assists developers in understanding the interactions between components, identifying potential design issues, and designing a more structured system. Class diagrams also serve as a blueprint for the implementation of program code [33].

The class diagram presented in Figure 5 illustrates the structure of an online store application system. It consists of four main classes: customer, administrator, shopping cart, and order. The customer class has attributes such as name, ID, email, phone number, and address, along with methods for registration, login, and profile upload. The administrator class has attributes for ID and password, as well as a method for updating the product catalog. The shopping cart class consists of several attributes such as cart ID, product ID, and quantity, along with methods for adding items, updating quantities, viewing cart details, and placing orders. The order class contains attributes for order ID, order date, shipping date, customer ID, and status, as well as methods for viewing order details and processing payments. The relationship between the classes indicates that one administrator can manage multiple customers, one customer can have one shopping cart and multiple orders, and one shopping cart can result in one order.

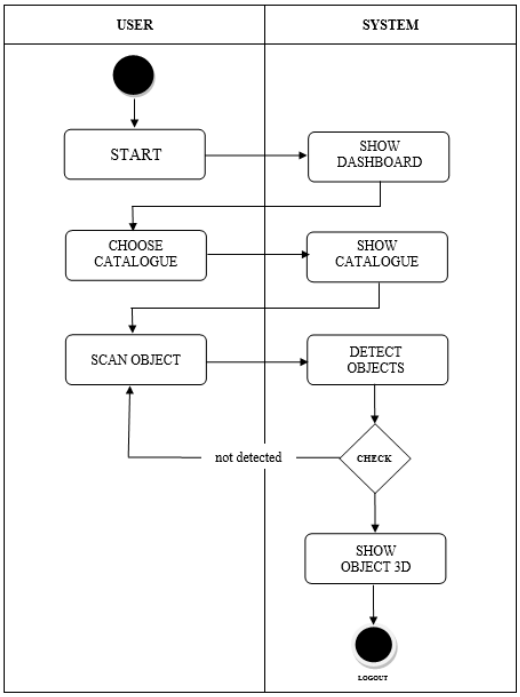

Figure 4. Activity diagram

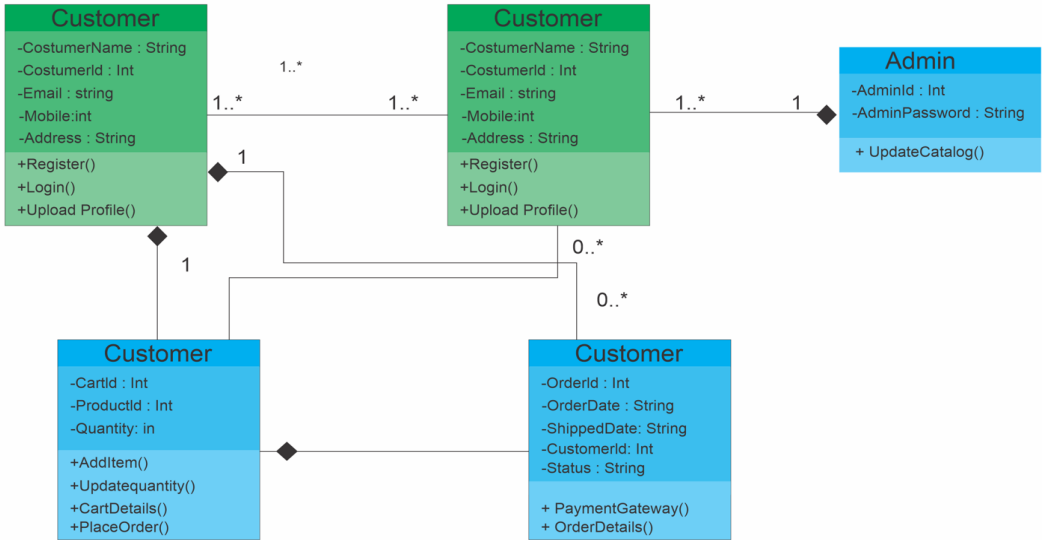

Figure 5. Class diagrams

– Flowcharts

The flowchart in Figure 6 illustrates the workflow of an online store system equipped with AR features. The process begins when either the user or the admin launches the application. In case a user is not registered to the system then they need to register and create an account before they can log into the system. Upon successful login, users can browse and search all the products, view the product details, and add them to their shopping cart. The payment process can be completed either online or through cash on delivery (COD). Once the payment is successful, the order is placed. Users can then log out of the system after completing their shopping.

Meanwhile, the system administrator (admin) has access to manage various aspects of the online store. The admin can add new product categories, add products to the catalog, manage incoming orders, and handle payments. Additionally, the admin can review customer feedback and generate reports for further analysis. This flowchart in Figure 6 provides a clear overview of how users interact with the online store,

from searching for products to completing payment. Furthermore, it also demonstrates the admin's role in managing the online store, including product management, order management, payment processing, and customer feedback management.

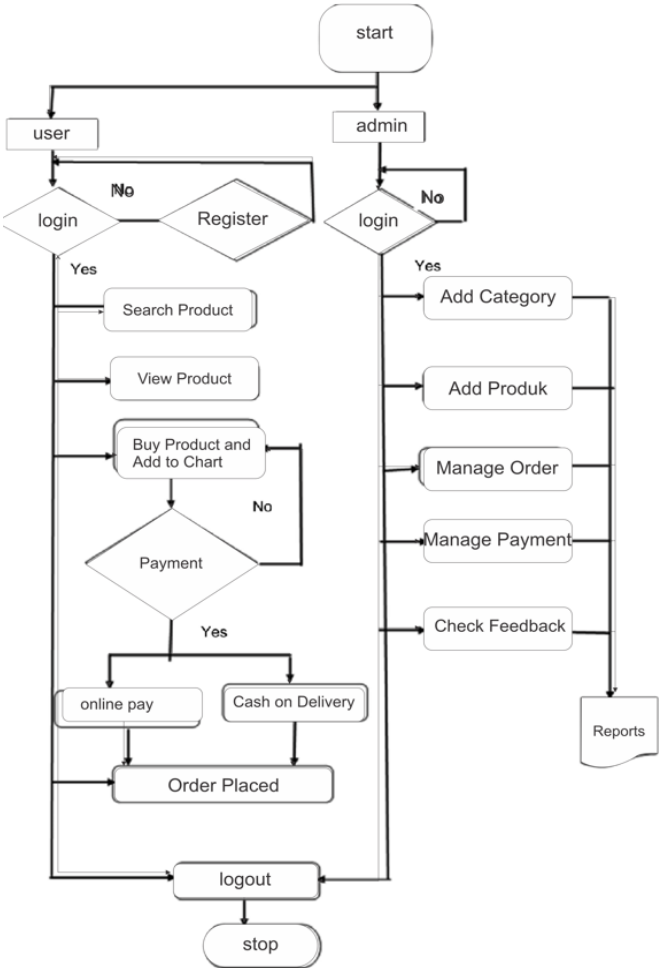

Figure 6. Flowchart of system

B. Design

The multimedia product design phase is the foundation for creating an optimal user experience. This phase includes creating storyboards for the narrative flow, wireframes for layout, and UI design that is both visually appealing and intuitive. The selection of colors, typography, and multimedia assets is done meticulously. Interactivity is enhanced with responsive buttons, menus, and animations [34]. Collaboration between designers and developers results in a comprehensive blueprint for further development.

C. Material collecting

The Material Collecting phase is the process of gathering all necessary materials for a multimedia project, including text, images, audio, and video. These materials are collected from both internal and external sources, carefully selected based on relevance and quality to meet the project's requirements. This phase is crucial to ensure the project has all the elements needed to effectively convey its message and achieve its objectives.

D. Assembly

The assembly stage is the step where all the elements are integrated into a multimedia application as we see in Figure 7. Technical development commences, encompassing programming, arrangement of design elements, and functionality testing. Unity 3D is a software designed to create graphics, audio, input, and other multifunctional elements, not limited to game creation [35]. The primary advantage of Unity 3D is its

game engine that makes ease of use and its capacity to produce games in both 2D and 3D formats [36]. Markerless AR, as the name suggests, does not require any specific physical markers, unlike tracking technologies that rely on black and white markers. However, in this system, the markers used must be pre-registered within the Vuforia platform to be recognized by AR devices.

Figure 7. Assembly

E. Testing

Testing phase plays an important role since it determines the success of the application. In this step the multimedia application is tested to ensure that everything runs as it is designed. Testing includes error checking (debugging), ensuring that the application works on various devices and platforms, and ensuring that the application meets user needs and project objectives [37]. In this testing phase, an evaluation is conducted to ensure the system functions optimally. All aspects of the system are checked to verify compliance with requirements and plans. The testing involves thwo types of softrware testing namely Black-box testing and UAT. The black-box evaluation is focusing on the end results of the system as seen in Table 2. Where the developer conducting test to its application. In contratry, UAT is conducted by the users to ensure the developed system meets the user expectations.

Table 2. Black-box testing

No	Feature tested	Test feature	Expected result	Test result	Status	
1	Home Page	Computer Store Website	Initial display opens for 5 seconds	Verified	Successful Failed	☑ ☐
2	Main Menu Page	Menu Feature - Computer Store Website	Displays a list of products and item variations sold at the Computer Store according to brand	Verified	Successful Failed	☑ ☐
3	Dashboard Page	User Dashboard Feature - Computer Store Website	Displays a list of products and item variations sold and purchased at the Computer Store	Verified	Successful Failed	☑ ☐
4	Navigation in AR	AR Navigation	Smooth navigation in AR	Verified	Successful Failed	☑ ☐
5	Displaying Product	AR Product Display	Product appears clearly	Verified	Successful Failed	☑ ☐
6	Product Ordering	Computer Store Website - Purchase	Order successfully made	Verified	Successful Failed	☑ ☐
7	Payment Integration	Computer Store Website - Payment	Successful payment	Verified	Successful Failed	☑ ☐
8	User Interaction	AR User Interaction	Responsive to user input	Verified	Successful Failed	☑ ☐
9	Database Integration	AR Database Integration	Data synchronization with database	Verified	Successful Failed	☑ ☐
10	System Performance	AR System Performance	Optimal system performance in AR mode	Verified	Successful Failed	☑ ☐

– User acceptance testing (UAT)

User acceptance testing (UAT) ensures the conformity of features to the user needs after the development phase. It is a crucial stage before release, aimed at guaranteeing the application's readiness to effectively solve problems for users. This process typically begins by establishing a weighting scale table such as in Table 3 based on a previously determined structure, allowing for the prioritization of various aspects and functionalities. The UAT process involves a series of carefully designed tests that simulate real-world scenarios and user interactions [38]. This testing phase helps uncover potential issues, such as bugs, usability problems, or unmet requirements. By incorporating feedback from actual users, developers can make necessary refinements and adjustments, ensuring a smoother and more successful final product. The goal of UAT is to deliver a high-quality application that aligns with user expectations and delivers a seamless user experience.

Table 3. Weighting

Scale	Description	Score	Percentage
SD	Not Good / Not Easy / Not Suitable / Not Clear	1	0 – 25%
D	Less Good / Less Easy / Less Suitable / Less Clear	2	26 – 50%
A	Good / Easy / Suitable / Clear	3	51 – 75%
SA	Very Good / Very Easy / Very Suitable / Very Clear	4	76 – 100%

The following is a formula to calculate the percentage of each given answer:

$$P = \frac{\mathrm{f}}{\mathrm{n}}\ x\ 100\ \%$$

Explanation:
P = Percentage.
f = Frequency of answers.
n = Number of respondents.

The evaluation of the test results is conducted by considering various indicators listed in Table 4. These indicators provide a clear picture of the level of quality that occurred during the testing process. In this analysis, each category is detailed, thus allowing us to understand the specific aspects that have changed.

Assessment indicators in Table 4 serves as the primary reference for identifying and assessing the extent to which this degradation affects the overall test results. This evaluation process is crucial to ensure that each component is tested thoroughly and the results are analyzed comprehensively. Thus, Table 4 not only becomes a tool in the evaluation but also forms the basis for further decision-making related to the necessary improvement steps. This evaluation provides deep insights into the performance and resilience of the tested components.

Table 4. Assessment indicators

Category	Description P value
Very bad	0 – 40%
Bad	41 – 60%
Good	61 – 80%
Very good	81 – 100%

The evaluation results of the UAT conducted by 25 participants are presented in Table 5. This evaluation provides an overview of how well the system has been received by the end user, which is an important step in measuring the quality and readiness of the product.

There are several ways to ensure the validity and reliability of a questionnaire, one of which is by using statistical validation and reliability methods. However, there is no standard rule regarding the number of respondents, although most studies use more than 20 participants. This can be an obstacle when the research is conducted on a small population. Therefore, this study aims to describe how to properly conduct validity and reliability tests using various numbers of respondents.

Table 5. UAT test results

	Question	Strongly disagree (1 point)	Disagree (2 point)	Agree (3 point)	Strongly Agree (4 point)
Q1	How do you assess the quality of the User Interface (UI) display of E-Commerce with the addition of AR technology?	0	2	5	18
Q2	Does the UI design provide an attractive visual impression and is it in line with the E-Commerce / computer store website theme?	0	1	4	20
Q3	How easy is it to navigate the E-Commerce user interface with the addition of this AR technology according to you?	0	2	8	15
Q4	Is the navigation system in this application considered intuitive and easy to understand by you?	0	2	5	18
Q5	How easy is it for you to understand and use the application features, such as navigation, photo gallery, and product description?	0	1	3	21
Q6	What is your opinion on the clarity of using AR technology to view items for sale on the computer store website in three dimensions?	0	1	4	20
Q7	How comfortable are you using markerless technology on the Android platform to run this application?	1	1	15	8
Q8	Is the process of viewing and checking the details of items for sale on the computer store website considered easy and provides a satisfying experience?	0	2	4	19
Q9	How easy is it for you to understand information related to the color, texture, and specifications of items for sale presented on the computer store website?	0	2	1	22
Q10	To what extent do you feel this application provides a very easy solution to overcome obstacles in shopping for items in the computer store online, especially related to accurate product inspection?	0	1	3	21
Q11	Do you feel that this application provides a satisfying overall shopping experience?	0	0	8	17
Q12	What is your opinion on the responsiveness of the E-Commerce / computer store website to user commands?	0	0	6	19

– Validity test

The following table presents the results of the validity test of the questionnaire used in this study. The validity test was conducted by calculating the Pearson correlation coefficient (r calculated) between the score of each question and the total score. The r calculated value was then compared with the critical r table value (df = 23) at a significance level of 5%. A question is considered valid if the r calculated value is greater than the r table value. The analysis results show that all questions in the questionnaire have an r calculated value greater than the r table value, indicating that all questions are valid and can be used to measure the intended variable. Referring to the Table 6, it can be concluded that all questions (Q1-Q12) in the questionnaire are valid, since the count r value for each question is greater than the table r value.

Table 6. Test the validity of the questionnaire

Question	r count	r table (df = 23)	Description
Q1	0.999401	0.396	Valid
Q2	0.997074	0.396	Valid
Q3	0.984191	0.396	Valid
Q4	0.999401	0.396	Valid
Q5	0.992851	0.396	Valid
Q6	0.997074	0.396	Valid
Q7	0.552358	0.396	Valid
Q8	0.99664	0.396	Valid
Q9	0.979657	0.396	Valid
Q10	0.992851	0.396	Valid
Q11	0.9887	0.396	Valid
Q12	0.999268	0.396	Valid

– Reliability test

The reliability test of a questionnaire is performed to measure the internal consistency of questions in measuring the same structure. In this study, reliability is measured using Cronbach's Alpha, which yielded a value of 0.989. This value is very high and it indicates that the questionnaires have excellent reliability. It also indicates that the questions in the questionary consistently measure the same structure, thus, it is reliable to use in this study.

F. Distribution

The distribution phase includes the implementation of the AR application in a particular computer store in Solo City. This phase also includes training sessions for the employees of the store that aims to ensure they have adequate knowledge and skill to the current technology. The successfulness of this phase is determined by the smooth integration of AR into daily operations and improved relationship with customers.

3. RESULTS AND DISCUSSION

In this section, we discuss the development of AR applications that are implemented on the computer store website in Solo City. According to the obtained respondent data, we have been able to provide a complex picture of consumer preferences and behavior.

Figure 8 shows an intuitive and informative user dashboard. This dashboard is designed considering user needs, presenting important information concisely and easy to understand. Through this dashboard, users can quickly access relevant data, monitor the latest developments, and make decisions based on accurate information. The attractive and interactive visual display on this dashboard also enhances the user's experience in interacting with the system.

Figure 8. Dashboard user

As for the information display of the product sold on the computer store website, it appears in Figure 9. This view provides more detailed information related to a particular product, including larger and clear product images, complete descriptions, technical specifications, stock availability, customer reviews, and purchase options. These displays are designed to provide comprehensive information to prospective buyers, helping them make the right purchase decisions. In addition, interactive features such as image zoom and product comparison can improve the online shopping experience.

Figure 9. AR product display with its detail information

In addition, Figure 9 also shows the AR visualization of a selected product on the computer store website. The AR feature displays photos of the computer device available on the computer store website and a detail explanation of each device. In this example, we only display one item from the computer store website. The following figure shows several pages that display information and each item. By pressing the AR button, customers can activate the AR feature and camera.

The development of an AR application on the computer store website has been successfully carried out. This application has been implemented and tested with very satisfying results. The intuitive and informative application display, with easy navigation and attractive design, makes it easier for customers to explore products and find the information they need. The interactive AR feature, which allows customers to virtually see products in their own environment, has proven to significantly enhance the customer's shopping experience.

Test results show that customers find it easier to understand the products in the store using the AR feature. They can virtually view products from various perspectives, enlarge images to see clearer details, and read detailed information about the product, including technical specifications, features, and customer reviews. This helps them make more accurate purchasing decisions and reduces the risk of errors in choosing products that do not suit their needs.

In addition, the AR feature has also proven to increase customer interaction with the computer store website. Customers are more interested in exploring products and spend more time on the website because the AR feature provides a more interesting and interactive experience. This can increase sales opportunities because more engaged customers tend to make purchases. In addition, a positive shopping experience can also increase customer loyalty, encouraging them to shop at the store again in the future.

As shown in Table 7, there are clear differences customers' viewpoints toward the products on the computer store website. We found that 10 respondents aged 40–70 years old are more appreciating traditional website features i.e., without embedding AR on it. On the other hand, 15 younger consumers aged 18–39 years old are more interested to the adoption of AR in store website since it is more interactive and they consider it as innovative solutions. This generation gap presents obvious challenges and opportunities for the store marketing strategy.

Table 7. Results of respondent processing analysis

Q	f value	P value	Category
Q1	91	91%	Very good
Q2	94	94%	Very good
Q3	88	88%	Very good
Q4	91	91%	Very good
Q5	95	95%	Very good
Q6	94	94%	Very good
Q7	80	80%	Good
Q8	92	92%	Very good
Q9	95	95%	Very good
Q10	95	95%	Very good
Q11	92	92%	Very good
Q12	94	94%	Very good

Table 7 presents the results of the analysis of respondents' responses to the questions in Table 5. Overall, the analysis shows an excellent acceptance rate for most statements, with percentages P values ranging from 80% to 95%. The majority of questions (Q1, Q2, Q3, Q4, Q5, Q6, Q8, Q9, Q10, Q11, and Q12) get a "very good" rating from respondents, with a percentage score of more than 91%. This value indicates a high level of satisfaction and agreement with such question. Only one question Q7 obtains a "good" rating with an 80% value that is dominated by the ages of 40 to 70 years. Although the question Q7 indicates a positive response to the AR application, there is a room for improvement. Overall, the results of the analysis in Table 7 showed that respondents provide a very positive statement. It further reflects that a high level of satisfaction and agreement with the issues of adopting AR technology in store could improve better product understanding for younger customers.

4. CONCLUSION

The research successfully developed and implemented AR applications on computer store websites in Solo City. Test results indicate that AR significantly provides customer shopping experiences, provides better product understanding, and provides customer interaction with websites. Interactive AR features, such as 3D product visualization and detailed information, help customers make better purchasing decisions. This

is supported by questionnaire results that showed an excellent acceptance rate for the application, with an average score of 92% of the 25 respondents. In addition, AR has shown to increase customer engagement and potentially improve sales and customer loyalty, as seen by sales increases of 35%, operating costs reductions of 20%, and productivity increases by 15%. The study also found that there are differences in preferences between different age groups. Older respondents (40-70 years old) prefer a store website without AR application, while younger consumers (18-39 years old) are more interested to the presence of AR application in store website.

Overall, this study shows that there is a huge potential of AR technology in improving online shopping experiences and providing added value for computer store customers. It also suggests that AR application can increase customers understanding to the products and persuade them to better buying decision. Further research is needed to explore the long-term impact of AR on sales and customer satisfaction, as well as to identify the best way to optimize AR usage in various retail sectors.

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