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SMARTLY: Smart Trolley Based on Augmented Reality as a Solution for Shopping Issues in Supermarkets

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ABSTRACTS

Indonesian society has a high interest in shopping at supermarkets. However, there are still several issues when shopping at supermarkets, such as long queues at cashier counters, discrepancies in consumer budgets, and difficulties in finding desired product locations. Therefore, there is a need for a tool that can help enhance the effectiveness of shopping activities in supermarkets, and one such solution is the creation of the SMARTLY tool. SMARTLY is a new innovation that will be applied to trolleys with a smart system based on Augmented Reality (AR). The method used in writing this article is a planned experimental method that starts with literature review, product design, prototype creation, testing, troubleshooting, and evaluation. Based on research findings, SMARTLY can provide information about product locations, prices, names, promotional quantities, and specifications, encompassing various details about the products to be purchased. Thus, this tool can act as a solution to all the problems mentioned earlier.

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1. INTRODUCTION

Indonesian society exhibits a high interest in shopping at supermarkets, as indicated by a survey of respondents totaling 76.32%, which signifies that the majority of the population prefers shopping at supermarkets over traditional markets or convenience stores (Suryani, 2017). However, there are still several issues when it comes to shopping at supermarkets, including: Firstly, the issue of shopping queues, which has become a common occurrence in all commercial areas, where the increasing number of customers leads to longer payment queues at the cashier, especially in larger-scale supermarkets (a Rocha, A.L.S and de Oliveira, M.B., 2019; Das Nair, R., Chisoro. S. and Ziba, F., 2018; Phiri, M. and Ziba, F., 2019) . According to a Visa study, 70% of consumers will leave a queue if it is too long, and 10% of queueing consumers find waiting the most frustrating part due to having to stand for a considerable amount of time (Budiyanto, 2015; Marriott, R.D., 2018; Srinivas, S., Nazareth, R.P. and Shoriat, U.M., 2021). Secondly, there is a disparity between consumers' budgets and the total amount they need to pay (Sari, 2021; Lugaresi, G. and Matta, A., 2019). Thirdly, many consumers have complained about the layout of goods, as they face difficulty in finding desired items due to the absence of clear guidance on the location of the items they want (Arifianti, 2016; Morris, T.P., White, I.R. and Crowther, M.J., 2019).

Based on a survey by the Bureau of Labor, it is reported that on average, 204 individuals spend 1.4 hours per day shopping (Budiyanto, 2015). However, due to the various shopping issues described above, there is a need for a tool that can enhance the effectiveness of the shopping and payment process in supermarkets (Phiri, M. and Ziba, F.,2019; Abd-Elwahed, M.S. and El-Baz, M.A, 2018). Solutions to the issues raised have been explored in previous research. Jamaludin and Ismail created a mobile application for supermarket users using Augmented Reality technology to identify prices and specifications in the supermarket. However, this innovation takes a considerable amount of time for scanning product's prices and generating a receipt that only displays the total price without itemized details. Additionally, research on the design of a Smart Trolley has been conducted by Jayshree, Gholap, and Yadav. This Smart Trolley uses RFID technology to identify prices and facilitate product payments in supermarkets (hishvan, M.S. and Benndorf, J., 2019; Memon, R.A., Li, J.P. and Ahmed, J., 2019; Dawabsheh, M., Hussein, A. and Jermsittiparsert, K., 2019) . However, this research has limitations in its operational process, as RFID tags need to be attached to all products and manually removed after purchase and payment, which can be time-consuming in a supermarket setting.

Based on the aforementioned prior research results, there is a need for a fresh breakthrough in the shopping process beyond mere price identification and payment. In contrast to those solutions, the proposed new innovation is an Augmented Reality-based Smart Trolley. The use of Augmented Reality enables consumers to quickly locate desired products. Additionally, the implementation of a Barcode Scanner enhances product scanning services and displays detailed pricing information through an LCD screen. Furthermore, this Smart Trolley can identify product names, promotional quantities, and specifications, encompassing various details about the products to be purchased. The product's name to be offered is SMARTLY. SMARTLY is a new innovation to be implemented in smart trolleys. The introduction of SMARTLY is expected to serve as a solution to the shopping issues highlighted above.

2. METHODS

The method used in this article is a planned experimental method that begins with literature review, product design, prototype creation, testing and troubleshooting, and evaluation. This approach is employed to design and create a prototype through the entire process of design, creation, and testing. Precise and systematic steps are implemented to achieve optimal results. This approach aims to facilitate researchers in designing, building, analyzing, and rectifying errors in the developed tool. The stages of implementation in this study are outlined in **Figure 1**.

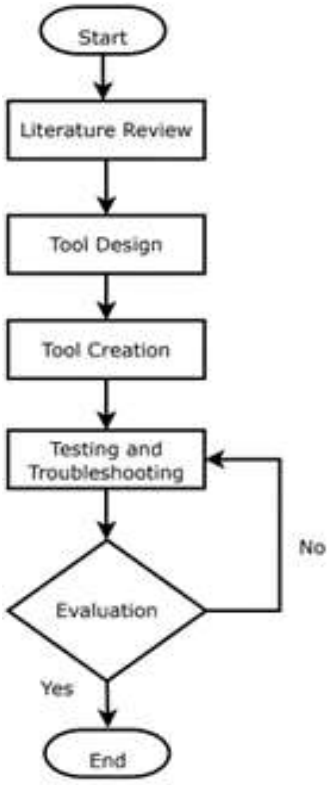

Figure 1. Implementation Phase

2.1. Literature review

The literature review is conducted by collecting relevant literature concerning the Smart Trolley as well as its functioning, such as the process of detecting prices, weights, and expiry limits of items, along with the technology to be implemented.

2.2. Tool Design

From the literature review, information about previously created devices will be obtained. From these previously created devices, their weaknesses and strengths are identified. The device design is then developed with the expectation that the outcome will be superior to what has been previously achieved. The design for SMARTLY can be seen in **Figure 2.**

Figure 2. Isometric view

The working principle of SMARTLY depicted in the flowchart of the whole trolley system is as follows in **Figure 3.**

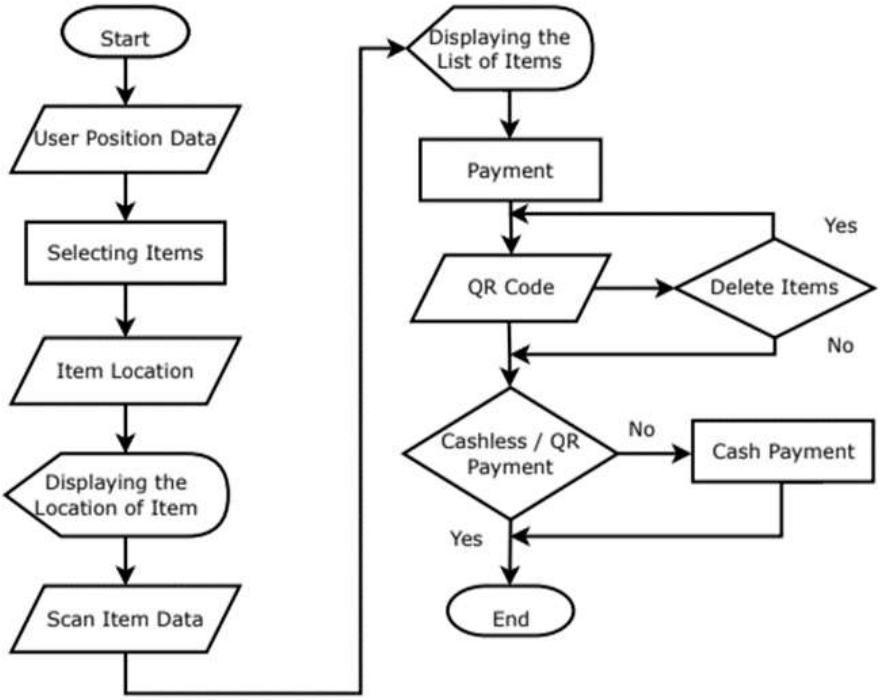

Figure 3. SMARTLY Working System Flowchart

2.3. Tool Creation

The process of creating the Smart Trolley product is carried out as shown in **Figure 4**.

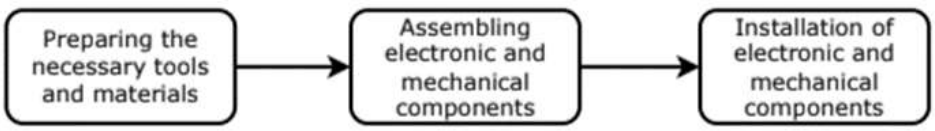

Figure 4. Tool creating process

Before making products, we prepared all the necessary tools and materials to support the manufacturing process. The required tools and materials included electronic components and mechanical assemblies. The production process of SMARTLY took approximately 60 days,

starting from the initial stages until the product evaluation phase. The product manufacturing process began with the fabrication of the trolley according to our designed specifications and using predetermined materials. Once the product was completed to our satisfaction, the next step involved the installation of electronic components and sensors.

2.4. Testing and Troubleshooting

This testing was carried out to comprehensively evaluate the functional performance of the designed system, ensuring that the tool functions as intended. In case any errors arise, troubleshooting will be conducted.

2.5. Evaluation

Evaluation is performed to measure the success outcomes and identify any shortcomings in the tool. If there are still deficiencies in this tool, further testing and troubleshooting are necessary to optimize its performance.

3. RESULTS AND DISCUSSION

3.1. Use Case Diagram

A use case diagram is a diagram formed to explain or illustrate the relationship between users and the system being developed (Kurniawan, T. B., 2020). The following is a use case diagram of the SMARTLY product.

3.1.1. Use Case Diagram Admin

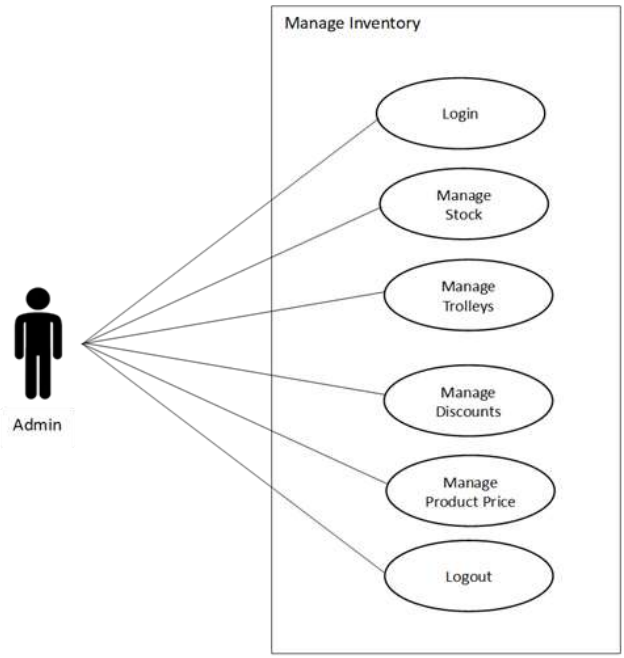

Figure 5. Use Case Diagram for Admin of the Created Software

The figure 5 illustrates that the Admin plays the role of managing the stock, trolleys, discounts, and prices of items in the supermarket. The main task of the admin is to ensure that the item data listed in the trolley corresponds to the actual conditions in the supermarket in real-time.

3.1.2. Use Case Diagram User

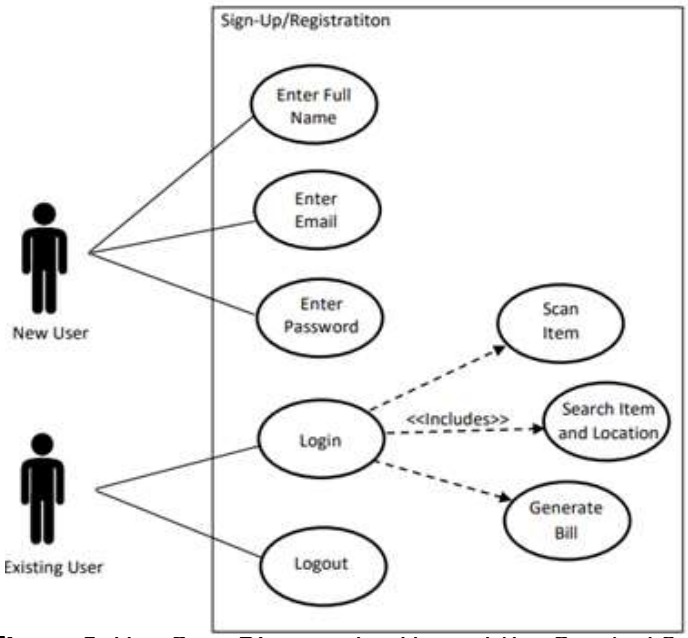

Figure 6. Use Case Diagram for User of the Created Software

The Figure 6 is provides an overview of the activity flow that a User can perform within the Application. For New Users, registration is required before using the trolley, which involves entering full name, email, and password to obtain a username. When using SMARTLY, Users can scan items using the sensor, search for items along with their locations, and scan barcodes for payment.

3.2. Design of the Application Interface

The interface design is the initial design before building a software application, and the resulting software will not deviate significantly from the designed interface (Sari et al, 2021).

3.2.1. Payment Page Interface Design

This page displays a barcode scanner for product payment, which the user has added from the product search column along with the product description and listed price. Once the user has finished selecting the products to be purchased, they can adjust the product quantity, and the total payment amount will be shown. Click on the payment menu to proceed with the payment, and a barcode will appear to determine the user's chosen payment method along with the added product's name, quantity, and post-discount price, as shown in the figure 7.

Figure 7. Product Payment Page Interface

3.2.2. Location of Product Page Interface Design

This page displays the search results for the location of product based on the type of item input by the user in the search column. The application will then show the direction to the location of the item and provide information about the shelf number in the supermarket that the user needs to go to. The following is the interface design for the location of product page in figure 8.

Figure 8. Location of Product Page Interface

3.3. Design of 3D Case

The process of creating the hardware system begins with the creation of a 3D case design using the Tinkercad application, considering the size and shape according to its function. This 3D modelling application aids in visualizing the created design, showing how everything will look and interact. The 3D case design includes a compartment or space to hold the smartphone and accommodate electronic components. The 3D case design can be seen in the figure 9.

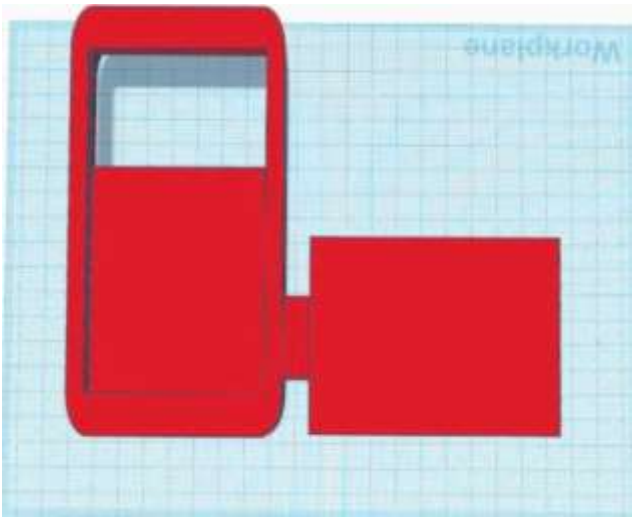

Figure 9. 3D Case Design

The created case design is then printed with 3D printing using PLA+ (Polylactic Acid Plus) plastic material, chosen based on the object's requirements, considering appearance, strength, and flexibility. Following that, the hardware assembly takes place, involving soldering of components and their attachment onto the case.

3.4. Payment System Design

The design of the payment system involves the use of Internet of Things (IoT) hardware and Arduino IDE, which constitutes the integration of microcontroller technology, sensors, and communication modules to create an efficient and smart payment solution. In this process, Arduino IDE serves as a tool for programming and controlling the hardware components involved in the payment system. This encompasses initializing components, such as sensors and displays, as well as setting up the necessary logic for the payment system. Sensors like RFID sensors are employed to detect payments or product prices.

3.5. Augmented Reality Design

3.5.1. Software System Design

The process of designing the software system is carried out using two applications, namely Blender and Unity Engine 2022. These two applications are used as platforms for creating the required 3D supermarket modelling. After successfully modelling the objects, the next step is to apply specific colors and images to the object surfaces to make them look more realistic, a process known as texturing (Syahputra & Sahrin, 2020). The following is an image of the 3D supermarket modelling that has been created.

Figure 10. 3D Supermarket Modelling

3.5.2. AR Technology Design

The process of designing AR technology is carried out using three applications: ArCore, Vuforia Engine, and XR Plugin. Essentially, these three applications serve the same purpose, which is to bridge the gap between the virtual world and the real world. The main goal is to make the virtual 3D supermarket objects created in the previous step appear as if they are seamlessly integrated with the real world. The motion tracking technology in the ArCore application is integrated with the camera on Android phones using the XR Plugin application (Al-Ghifari & Rizqi, 2020; Dźwigoł, H. and Dźwigoł-Barosz, M.,, 2018). This combined technology is then used to identify key points of objects and analyze their real-time

movements. Additionally, the object scanner function in the Vuforia application enables the AR system to detect and track physical 3D objects in the real world, allowing the objects to be recognized by the system (Mandarani et al, 2021).

3.6. The Integration of Software with Hardware

The designed software will then be integrated with the hardware to achieve synchronization between the two. The integration of software with hardware involves connecting the functionalities of the software to the physical components of the hardware. This ensures that the software can control and interact with the hardware effectively. In the context of our project, the software developed to manage the SMARTLY features, such as barcode scanning, location tracking, and payment processing, needs to be seamlessly integrated with the hardware components of the trolley, including sensors, display screens, and communication modules. This integration ensures that the software commands are executed accurately by the hardware, resulting in a fully functional and efficient system. The prototype will be assembled according to the designed casing and then installed on the trolley.

4. CONCLUSION

SMARTLY is a new innovation that will be applied to a smart trolley using Augmented Reality technology. The use of Augmented Reality allows consumers to quickly locate and identify the products they are looking for, providing detailed information about the products through virtual markers. This significantly reduces the time needed for shopping and eliminates the frustration of searching for desired products. Moreover, the Smart Trolley can identify product names, promotional offers, and product specifications, encompassing a variety of information about the items to be purchased. The incorporation of a Barcode Scanner enhances the scanning service and displays price details. The payment system is designed using Internet of Things (IoT) hardware and Arduino IDE. With the implementation of SMARTLY, it offers a positive outlook on utilizing technology to address shopping challenges and enhance the supermarket shopping experience through the utilization of Augmented Reality.

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