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Smart Shopping Cart Calculator using Barcode Scanner for Supermarkets in Kuching, Sarawak

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ABSTRACT

Nowadays, Supermarkets encountered a substantial increase in customer flow. Traditional shopping in crowded malls and supermarkets often involves time-consuming processes like selecting products, navigating heavy shopping carts, waiting in long checkout lines, and sometimes overspending. Despite online shopping's rise, many still prefer in-store shopping for product assessment. However, estimating costs and overspending are common issues. Introducing a smart shopping cart with a built-in calculator can enhance the shopping experience by enabling users to easily estimate their total expenses. This feature serves as a financial reminder, prompting shoppers to make informed decisions as they add items to their cart. It encourages thoughtful choices, reducing overspending and waste. This innovation can indirectly alleviate the issue of waste in low-income households. A survey in Kuching, Sarawak, found 90% of customers and management favoured introducing such technology, showing a demand for enhanced shopping experiences.

1. Introduction

As of 2021, with the development of the national economy and the improvement of people's consumption level, passenger flow of supermarket will increase day by day [1-3]. Shopping typically entails visiting crowded shopping malls or supermarkets, selecting and assessing products, placing them in a shopping cart, manoeuvring this often-heavy cart to the checkout counter, and waiting in long lines for the items to be scanned and billed. This process results in a significant loss of customers' time.

Even with the substantial influence exerted by online shopping platforms like Amazon, Flipkart, Nykaa, and various others, still many people prefer traditional shopping spree [4]. Shopping malls offer a real-time experience by providing customers with the products they desire, along with the opportunity to personally assess the quality of those products. Internet of Things (IoT) is one of the keys for IR4.0 which uses a network of interconnected devices to deliver data via the Internet [5].

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This revolutionary concept involves linking everyday objects to the internet, enabling them to interact and perform various tasks [6].

Frequently, users find it challenging to estimate the total cost of items added to their cart while shopping, as they tend to prioritize wants over needs. This behaviour can ultimately lead to overspending too. In addition, shopping malls experience significant traffic during holidays, festivals, and other special events. Using barcode reading techniques in such situations is inefficient, as consumers have to wait for the scanner to scan all the items [7].

The key issue during shopping revolves around the worry of not having enough money to buy all the desired items [8]. Often, it's only at the end of the shopping process that individuals realize their bill exceeds their budgeted amount, leading to difficulties in deciding which products to remove [9, 10]. In certain cases, the consumer is not aware that the total purchased amount exceeds the limited budget [11].

With the expanding dependability and cost adequacy of Internet of Things (IoT) [12] associated keen things in the field of shopping applications, it bodes well to guarantee such innovations that are put to use to remove the everyday worries of the average person. when shopping, shopping carts are needed and very helpful for the consumer to carry products. Nowadays, many supermarkets offer convenience for shopping, one of which is a shopping trolley. It is used by customers inside the store to transport goods to the cashier during shopping and designed not to leave the store [13].

A smart shopping trolley for smart world; providing faster and convenient shopping experience [14]. So, attaching a smart trolley calculator to it can greatly ease the user's ability to estimate the total price of the products in the cart is necessary. This serves as an alert to remind shoppers to make thoughtful financial decisions as the prices of items add up in the shopping cart. This function encourages shoppers to consider their choices before adding or removing items. With this feature accessible, individuals can not only prevent overspending but also reduce wastefulness. Indirectly, it can help address the pressing problem of waste in low-income households, which is currently a significant concern.

Based on a survey carried out at 5 supermarkets in Kuching, Sarawak, it was found that they are still employing traditional trolley carts. A significant majority, comprising 90% of both customers and management, expressed a desire for the introduction of smart Cart calculators to ease their shopping experience.

2. Related Works

Shopping malls in Kuching, Sarawak continue to rely on traditional trolley carts as their primary means of assisting customers with their shopping needs. However, this approach presents some challenges for both shoppers and the overall shopping experience. Many items lack displayed prices, requiring customers to use price checker and manually estimate their cart's total cost. This manual process often leads to longer checkout queues and inconvenience for shoppers [9].

Several research studies on improving customers' shopping experience have been released in the last few years [11]. Most of proposed technique [7,15-18] are a model for a customer-friendly shopping experience that uses RFID technology to read product information from RFID tags placed on products. The read data is displayed on an LCD screen placed on the trolley, providing visual assistance to the customer for calculating the total bill amount and understanding product information.

Jain’s Approach [15] is a Secure and Smart Trolley Shopping System based on IoT Module. It includes an intelligent shopping cart equipped with an RFID tag, an RFID reader, a MAX232, a GSM module, and an LCD. The system uses RFID technology to track items in the cart and provide real-

time updates on the customer's budget and the store's inventory. The GSM module allows for remote communication with the store's database, enabling seamless checkout and reducing waiting times.

Kowshika's approach is an IoT-based Smart Shopping Trolley with RFID technology that simplifies shopping by displaying scanned products and amounts on an LCD display. Customers can buy within budget, avoid queues, and pay bills through QR codes or online/offline methods. The Smart Cart includes a load cell system to prevent theft and dropping of items beyond the customer's limit [19].

An automated smart trolley system [20,21] for supermarkets and malls that uses RFID technology and the Node MCU microcontroller to scan products and automate the billing and transaction process.

Even though there are a lot of proposed approach has been introduced. However, RFID technology implementation can be expensive, including the cost of RFID tags, readers, software, and infrastructure upgrades. Integrating RFID technology with existing point-of-sale (POS) systems, inventory management software, and other systems can be complex and may require custom software development. Next, Item identifier of the system with RFID reader requires larger amount of the RFID tag in order to input the item detail into the system. From this, the shop owner is required to increase the total cost in buying the RFID tag in order to use the system in their shop as compared to the barcode reader which can just simply read the barcode on the product to record into the system.

Besides, many available smart trolleys allow only online payment or payment through master cards which is not afforded by all customers [22]. Smart trolleys are not installed in many stores because of its cost. The cost is high because of the design that includes servo motor which also requires high maintenance [23].

The above reviewed approaches also need to include login, or membership card only they can use the smart trolley. The difficulty in using existing smart trolley is reduced, additional options are included, many components are replaced from the existing one to decrease the cost of the smart trolley [17].

Therefore, implementing smart cart calculators or similar technology that could greatly improve the shopping experience by providing real-time pricing information and reducing waiting times at checkout is needed with low-cost implementation.

3. Proposed Solution

The proposed design consists of 2 main parts. One is for the shopping cart Calculator install at Trolley and another one is the shopping cart calculator App.

The Shopping cart calculator architecture design is shown in Figure 1.

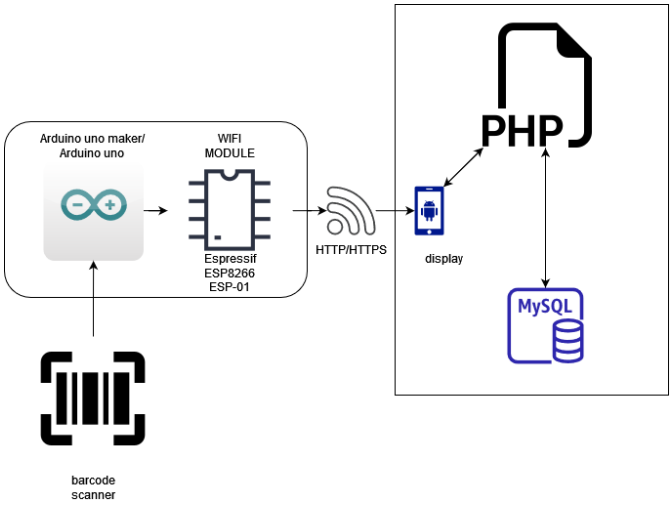

Fig. 1. The Shopping cart calculator architecture design

3.1 Shopping Cart Calculator Setup

The architecture of the system whereby a scanner is used to read the data to Arduino is shown in Figure 2. Subsequently, the Arduino will process the data and submit it to the devices (computer or phone) through the Wi-Fi module (Espressif ESP8266 ESP-01). The received data will use PHP to retrieve data from MySQL database.

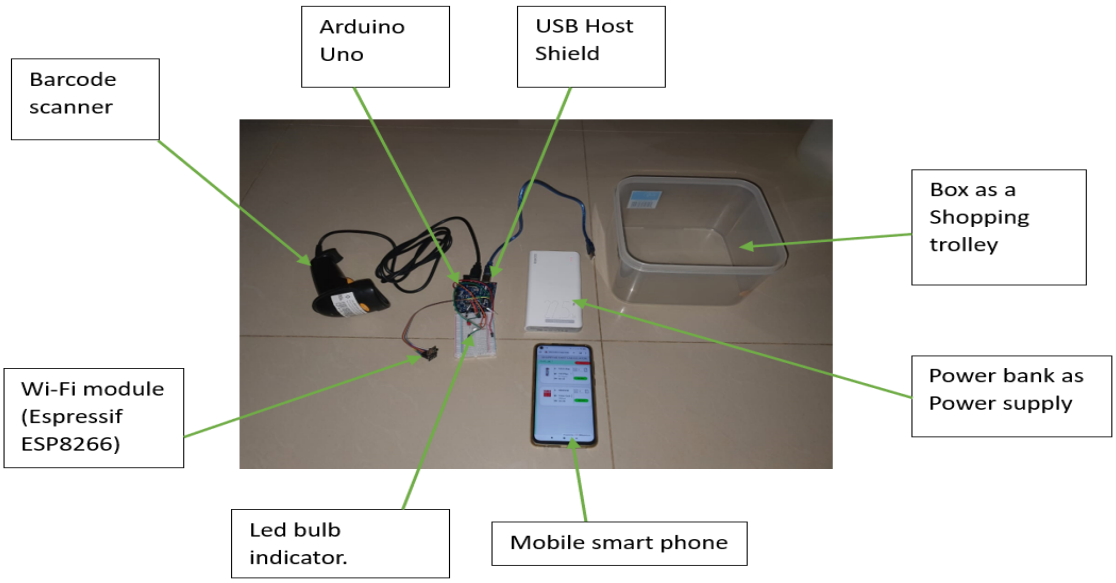

Fig. 2. Shopping Cart Calculator Setup

The explanation on how the connection of the Arduino UNO REV 3 board with the Wi-Fi module (Espressif ESP8266) is shown in Figure 3. The ESP8266-VCC is connected with Arduino UNO REV 3-3.3V, ESP8266-CH_PD is connected with Arduino UNO REV 3-3.3V, ESP8266-GND is connect with Arduino UNO REV 3-GND, ESP8266-TXD is connected with Arduino UNO Rev 3-Pin 3, and the ESP8266-RXD is connected with Arduino UNO REV 3-Pin 2.

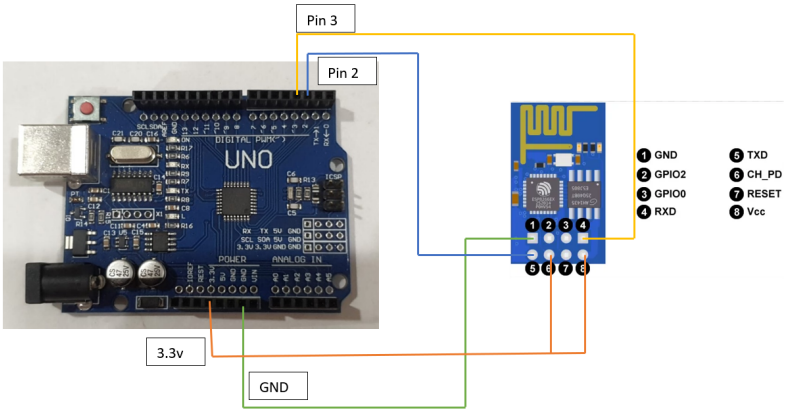

Fig. 3. Wire connection of Arduino UNO REV 3 board and Wi-Fi module (Espressif ESP8266)

The back end of the system is built with MySQL and PHP programming language, operating with database in phpMyAdmin. The front-end of the system is built with HTML, CSS, and Bootstrap based on the prototype created in the previous phase. The Arduino IDE is the IDE used to program the hardware component is shown in Figure 4.

Fig. 4. Arduino IDE

3.2 Shopping Cart Calculator App

There are 2 modules for the Shopping Cart Calculator App which is Customer module and also Administrator module.

3.2.1 Customer module

The app is designed to prevent the mixing of data among different sets of shopping carts. Each set of shopping carts is identified by its own unique ID. Therefore, the different shopping cart calculator devices have their own specific URL links, allowing customers to access the system. The shopping cart calculator device with ID number 1 can be accessed through the link "arduinoID=1," and ID number 2 can be accessed through the link "arduinoID=2," respectively. For example, the URL link for ID number 1 is “http://<IP/hostname>/shoppingcart/module/customer/cart.php?arduinoID=<ID>”. The visualisation of various shopping cart calculator devices access to the shopping cart is shown in Figure 5.

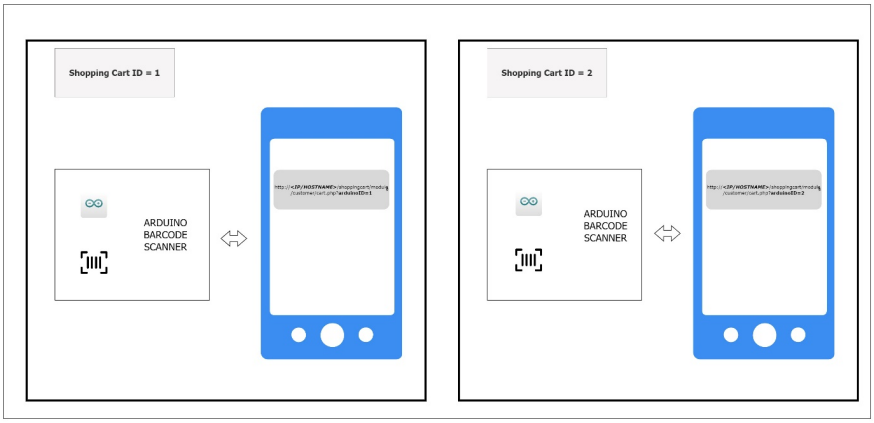

Fig. 5. The visualisation of various shopping cart calculator devises assesses to the Shopping cart

The interface for customers to monitor their cart list after accessing the web application is shown in Figure 6. On this page, customers can view the products that have been added to their cart list by scanning the item barcode. Customers have the option to adjust item quantities by clicking the "+" button to increase the quantity or the "-" button to decrease it for a specific item. Simultaneously, the quantity will increment if the same item is scanned multiple times. Furthermore, if customers realize that the total amount displayed at the bottom of the screen exceeds their budget, they can click the 'delete' button or reduce the quantity in the quantity box. Lastly, customers have the option to reset the entire cart list to remove all items.

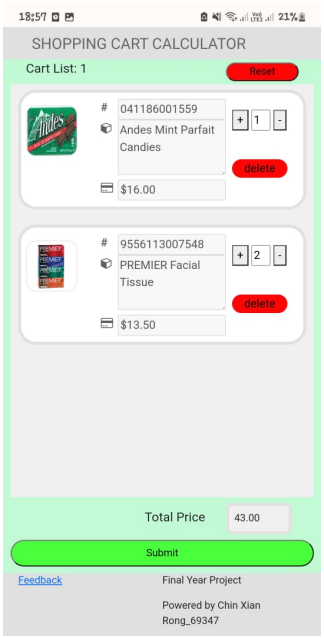

Fig. 6. Customer's cart list

3.2.2 Admin module

The admin login page is shown in Figure 7. On this page, both the admin and the staff can access the admin module of the system by entering the username and password created by the shop admin. This module is accessible exclusively to the admin and staff.

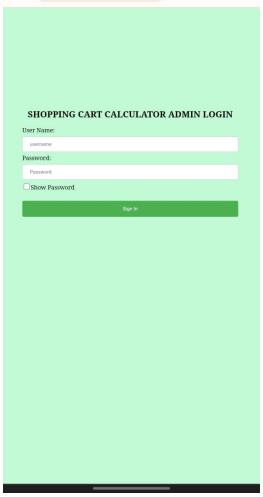

Fig. 7. Admin' dashboard page

Admin dashboard page is shown in Figure 8. On this page, the dashboard functions to display summaries of the relevant data in an easy-to-digest format. General data is presented on this page. Additionally, the page also showcases the recently added products to the store, allowing the admin and staff to take necessary actions regarding the newly procured stock by viewing this page.

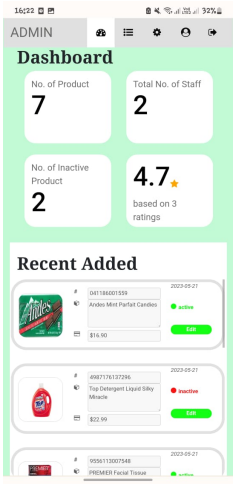

Fig. 8. Dashboard

The admin's product list page as shown in Figure 9, serving as an overview for both the admin and staff to access all the added products within the system. This page provides essential product information such as product code, product name, product price, product addition date, and product status. There are two statuses displayed: "active" and "inactive." An "active" status indicates that the product is currently available in the store, while "inactive" designates products that are either no longer available in the market or temporarily unavailable for a certain period. For products marked as "inactive," admin and staff are required to take action. Admins have the option to click the "add" button to introduce new products. Moreover, the page offers the convenience of clicking the "edit" button to modify product information, including product price, status, name, and details. Additionally, the admin can utilize the search bar to find specific products by entering relevant keywords.

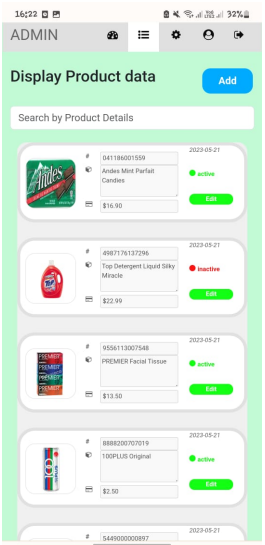

Fig. 9. Admin' product list page

The "Add New Product Details" page. Admins and staff are permitted to add product details by uploading a new product image, product barcode, product name, product status, product price, and product details is shown in Figure 10.

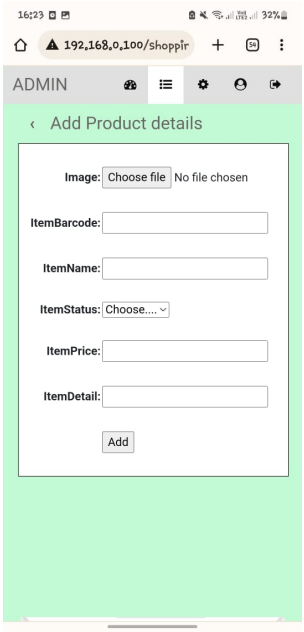

Fig. 10. Add new product details page

The "Manage Product Details" page is shown in Figure 11. Admins and staff have the capability to edit product details by uploading a new product image, modifying the product barcode, product name, product status, product price, and product details. After completing the updates to the product details, the admin can click the "Update" button to save the changes in the system. Additionally, both admin and staff are allowed to delete a product by clicking the "Delete Product" button.

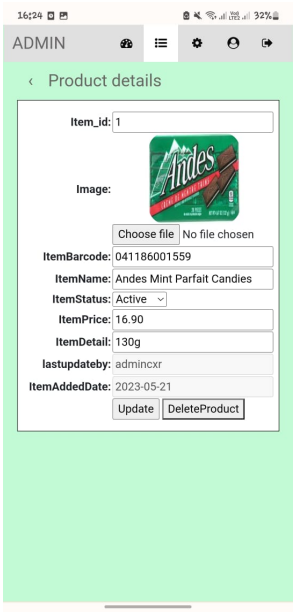

Fig. 11. Manage product details page

4. Results

After the design of the device is complete, the next step is to check, test and measure the device. This stage aims to check the overall function and performance of the device and also user satisfaction.

4.1 Unit Testing

The main purpose of unit testing is to segregate the application into a smaller part of the function. Each of the functions is tested separately to ensure each of it is performed as its designs. Test case for customer module and Admin module has been carried out with 30 respondents. All test cases were passed.

4.2 Performance Testing

Shopping cart calculator is carried out by 40 respondents to complete the task given. This system test aims to test the performance of the Shopping cart calculator with the Shopping cart app. With this testing, the performance of the device is achieved 97% of successful rate by the expected design.

4.3 Usability Testing

The main purpose is to have a better understanding of how real users interact with the application created and improve the design based on the given set of test tasks. The usability test result is shown in Table 1 where most of the respondents are satisfied with the proposed solution.

Table 1
Usability Testing Evaluation Result

Functionality and feature	Strongly disagree	Disagree	Sometimes	Agree	Strongly agree
Satisfied with the functionalities in Admin Portal	0	0	0	8	17
Admin and Staff User Account Management	0	0	0	10	15
Product Management	0	0	1	7	17
Help the customer to monitor the total number of items and the total amount of the items being added into the shopping cart.	0	0	0	2	23
Notify the total amount of the items being added into the cart to keep track.	0	0	0	3	22
The proposed system allows users to add or remove the items into the shopping cart.	0	0	0	4	21
The proposed system is easy to use.	0	0	1	7	17
The response time and performance of the hardware component of the system is fast.	0	0	0	10	15

5. Discussion

The Smart Shopping Cart Calculator Using Barcode Scanner provides a simpler and widely adopted identification method compared RFID, reducing implementation complexities. Additionally, Arduino's open-source platform allows for easy customization and integration, enabling a seamless and adaptable shopping experience. Furthermore, the barcode scanner with Arduino enhances user convenience, as it leverages ubiquitous barcodes already present on products. This eliminates the need for specialized RFID tags, making the system more scalable and applicable to a broader range of products. The open-source nature of Arduino also encourages innovation, fostering a community-driven approach to improvements and updates. Overall, the introduced smart shopping cart calculator offers a streamlined, accessible, and flexible alternative to existing technologies, addressing both practical and economic considerations in the realm of automated shopping systems.

RFID readers typically command a higher price range, ranging from RM500 to RM800, while barcode scanners offer a more budget-friendly alternative. Basic handheld barcode scanners compatible with Arduino can be procured at a cost ranging from RM50 to RM150. The Arduino Integrated Development Environment (IDE) is freely accessible as open-source software. Libraries facilitating barcode scanning with Arduino are readily available at minimal or no cost.

In contrast, RFID tags, vital for RFID-based systems, vary in price from a few cents to several ringgits per tag, contingent on their type and functionality. RFID systems may also necessitate additional middleware and software, introducing supplementary expenses. Notably, as all products already feature barcodes, there is no requirement for extra tags, mitigating additional costs associated with barcoding.

The simplicity of barcode technology translates to reduced implementation costs, as it demands less infrastructure and technical expertise. Maintenance costs are further diminished as barcode scanners have fewer components susceptible to failure compared to RFID systems. This cost-effectiveness positions the barcode scanner with Arduino as an appealing solution for businesses aiming to implement automated shopping systems without incurring the elevated expenses linked with RFID technology. This affordability not only enhances feasibility but also augments market acceptance, rendering it a compelling choice for diverse applications.

6. Conclusions

In summary, the addition of a smart shopping cart calculator can help customers by simplifying cost estimation and encouraging responsible spending. This innovation has received strong support, with usability test results showing a 99% favourability rating among both customers and management staff. Moreover, its low-cost implementation aligns with the supermarket management's requirements in Kuching, Sarawak. All of this underscores the increasing demand for enhanced shopping experiences and improved financial awareness.

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