(RESEARCH ARTICLE)

# Smart store in multiple platforms

GRACE MARJORIE B. BERBER [1, *], ELIZA B. AYO [1], STEPHANIE B. BERBER [2], MICHELLE F. ALBERTO [1] and MARLON RYAN I. RICASATA [3]

[1] Computer Education, School of Science and Technology, Centro Escolar University Manila, Philippines.
[2] University Registrar, Centro Escolar University Manila, Philippines.
[3] Institutional Development Department, Centro Escolar University Manila, Philippines.

## Abstract

Smart Store was an ecommerce platform application that runs and could be accessed through web browsers on different devices, including PCs, mobile devices, and standalone kiosks, regardless of the underlying operating system. It served as an ordering system for consumers to search for and purchase products, offering common ecommerce features and unique functions using a recommendation algorithm. In order to identify research gaps from previous studies and determine the functional and non-functional requirements for the smart store system – including understanding user needs, platform requirements, and functional requirements like product search, e-wallet, and virtual cart – the researcher reviewed previous research and related literature.

The researcher based the functionality of the proposed system on the EKB Model theory and Agile Development Cycle. The system was developed using web-based and object-oriented programming on its front end and backed by properly integrated database design techniques. Additionally, procedures were included to ensure the success of the study. The developed system was evaluated using test scripts and validated by at least five (5) IT experts. The evaluation results showed that the user creation and login, product management, inventory management, sales management, report management, virtual assistant, system integration, and e-commerce functions all received very good ratings from users, with certain aspects of each function being particularly appreciated.

The proponent recommended acquiring the needed technologies, subscribing to cloud services. However, for continuous improvement, after the system was in place and adapted by its users, an assessment should be conducted to further improve the application.

**Keywords:** Smart Store; Multiple Platforms; PC; Mobile; Kiosk; Ecommerce Features; Recommendation Algorithm; Virtual Assistant; EKB Model; Agile Development Cycle; Test Scripts; Functional Requirements; Non-functional Requirements; System Integration; Expert Validation

## 1. Introduction

Smart Store was an ecommerce platform application that could be run and accessed through web browsers on different devices, including PCs, mobile devices, and standalone kiosks, regardless of the underlying operating system where it served as an ordering system for consumers to search and purchase products.

In addition to being an ecommerce platform, Smart Store also helped stores increase their brand awareness and provided detailed statistics for consumer behavior studies and strategic planning. The objective was aligned with the research discussed in (Jin, et al., 2020), which focused on big data analysis of user behavior for e-commerce platform

* Corresponding author: GRACE MARJORIE B. BERBER.

optimization. This study was relevant to Smart Store's aim of utilizing user behavior data to enhance performance and user experience. It highlighted the significance of analyzing user behavior to optimize e-commerce platforms.

Furthermore, the accessibility of the Smart Store application on mobile devices is related to the reference by (Kuo, et al., 2021). This research explored the impact of mobile apps on consumer purchase intention, which aligned with the Smart Store's accessibility on mobile devices. The study delved into the stimulus-organism-response model and provided valuable insights into how the Smart Store app may have influenced consumer behavior.

The system development involved web-based and object-oriented programming on the front-end, along with database design techniques for integration on the back end. The system featured two interfaces catering to distinct user groups: 1) The Consumer Interface, enabling consumers to register as members, search for specific products, and make purchases; and 2) The Store Owner Interface, allowing store owners to view and accept consumer orders, add products for purchase, monitor inventory, and access consumer purchase statistics.

## *Objectives of the Study*

The objective is to develop a smart store that will run in multiple platforms such as PC, Mobile devices and through a standalone kiosk.

Specifically, it sought to achieve the following:
- To develop a multi-platform store that features common ecommerce functions such as virtual online carts that displays specifications of the added items, History of product purchases, product search functions, account login function, e-wallet system, the components and information on basic items such as price and other basic information intended for the user to make it easier to find what needed and good items are.
- To implement a product recommendation algorithm recommends appropriate products based on the user's health condition, previous transactions, and popular products among other users for faster and more convenient product selection.
- To develop smart virtual assistance to handle consumer queries and concerns.
- To conduct White Box Testing to assess the system's functionality, code quality, and user satisfaction.
- To evaluate the smart store system using a test script and validate the system with the help of at least five (5) IT experts.

## 2. Theoretical framework

The study of attitudes and behavior within human actions stemmed from Martin Fishbein and Icek Ajzen in the late 1960s, called the "Theory of Reasoned Action" or ToRA. It was used to analyze the importance of pre-existing attitudes of consumers in the decision-making process. The theory implied that the consumer's behavior would be based on their desired outcome. ToRA was then expanded through the Engel, Kollat, Blackwell (EKB) Model and was laid out in five consumer buying processes as seen in Figure 1 below.
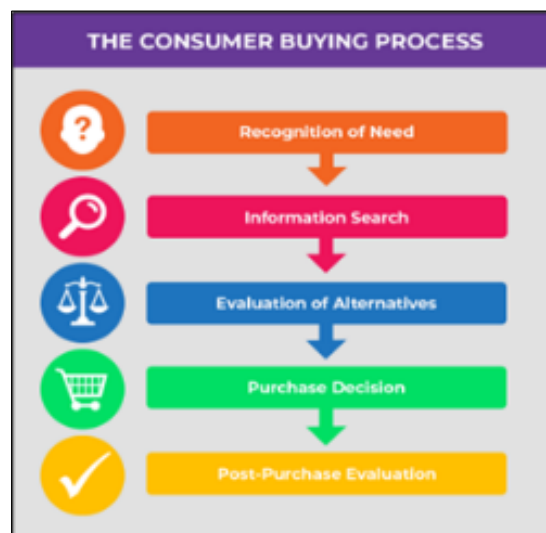


**Figure 1** Engel, Kollet, Blackwell (EKB) Model

The ToRA and EKB model illustrated the system's process structure on how consumers would purchase. Once a consumer decided what he/she would buy (Step 1. Recognition of Needs), the system would then be used as a search facility to look for that specific product (Step 2. Information Search). The system automatically showed suggestions of the same product from the store (Step 3. Evaluation of Alternatives). Once the consumer selected a product from the store (Step 4. Purchase Decision), he/she would be redirected to a page where he/she would be asked for the payment method and delivery method, and to review his/her final purchase (Step 5. Post-Purchase Evaluation).

The researcher converted the structure on how consumers shopped into the system through the help of the ToRA and EKB Model. However, it was still not possible to say that many consumers would have used the system, especially the first-time shopper. To encourage consumers to use the system, the researcher identified what products does user needs. This was facilitated using a Product Recommendation algorithm (O'Brien, 2020) that could predictively offer users what they want. A product recommendation algorithm encouraged user to become a buyer. These product recommendation algorithms were one of the most useful features an online store could have.
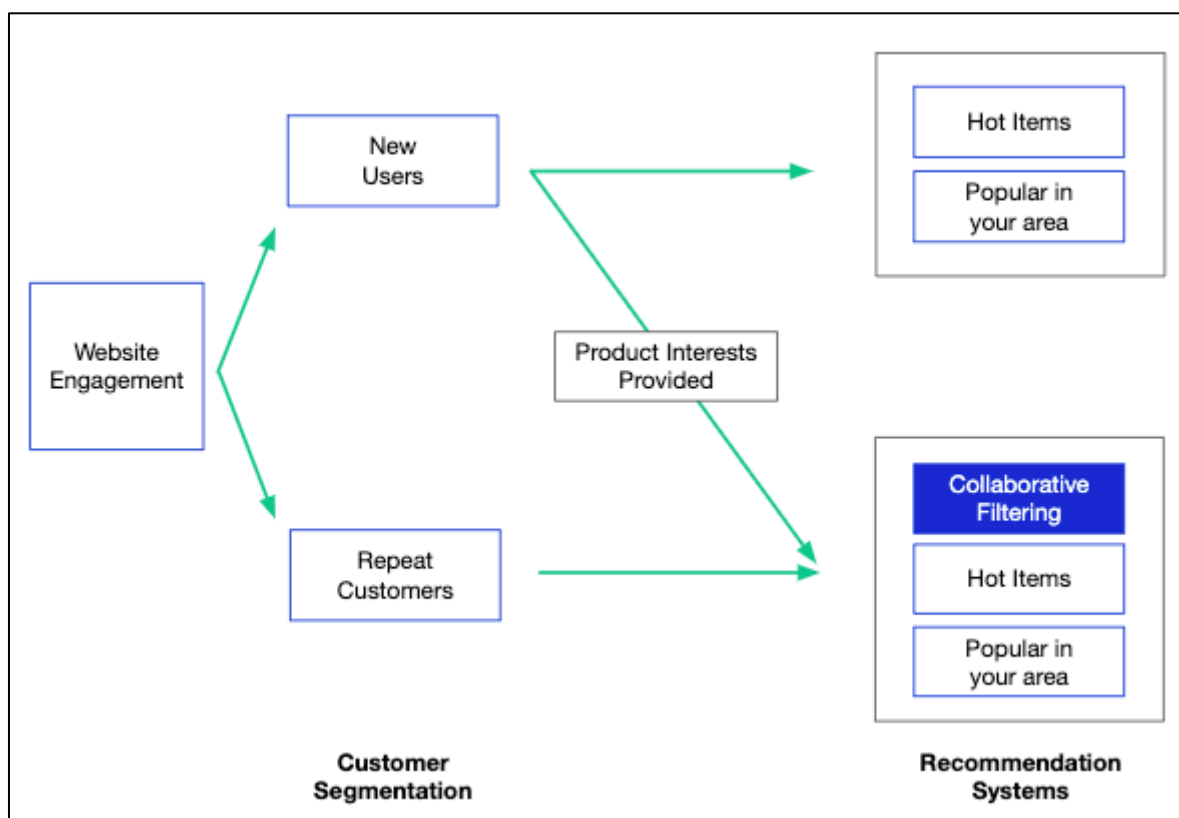


**Figure 2** Product Recommendation Algorithm

In the case of repeat users, the algorithm employed a collaborative filtering approach by leveraging their historical interactions and purchase history to generate personalized recommendations. It conducted an analysis of the items they had previously purchased or shown interest in, employing techniques such as pattern recognition and similarity matching to suggest relevant products that aligned with their individual preferences.

For first-time users, the algorithm utilized a hybrid recommendation approach. It incorporated general factors, including item popularity and user location, to provide initial recommendations. Due to the limited data available for these users, the algorithm relied on broader trends and user demographics to suggest products that would likely appeal to a wider audience.

To implement the collaborative filtering model, the algorithm required a structured data frame with three essential columns: user ID, item ID, and rating. The user ID column served as a unique identifier for each user, the item ID column represented specific products within the dataset, and the rating column denoted the user's preference or level of interaction with the corresponding item.

By leveraging this structured data frame, the algorithm conducted comprehensive analysis of user-item interactions. It employed advanced data mining and machine learning techniques to identify underlying patterns, understand user preferences, and generate accurate recommendations customized to meet the specific needs and preferences of each individual user.
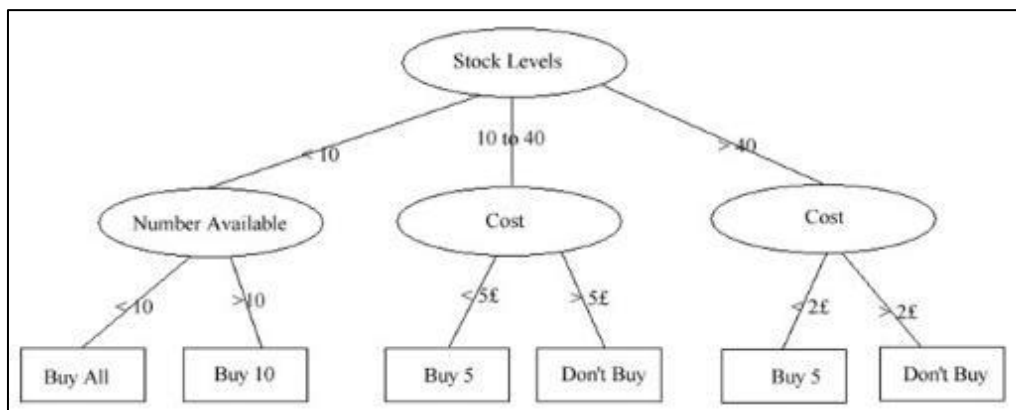


**Figure 3** C4.5 Decision Tree

The researcher used the C4.5 decision tree to identify possible matches for the items that the customer was looking for, as well as providing alternative choices if the primary product was not available or not suitable for their health condition. Recommendations can be made at any stage of the customer journey, whether the person was a first-time shopper or a loyal customer. These different types of recommendations encouraged a browser to become a buyer. In any case, product recommendation algorithms were a valuable and helpful tool for the researcher.
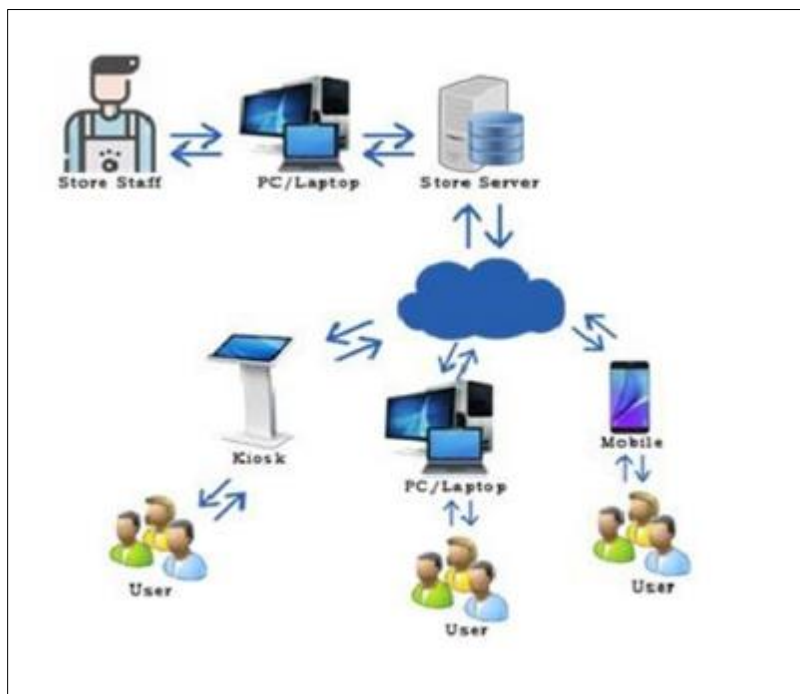


**Figure 4** Framework of the Proposed System

As presented in the figure above (Figure 4), the Smart Store application ran through multiple platforms, from PC and mobile devices to a standalone kiosk, where it displayed all basic information, such as item description, product features, price, brand, and store details provided by the system.

## 3. Research methodology

The research method served as the blueprint for the researcher to follow in order to complete the study and meet its objectives. Each phase of the method was strictly followed and fully observed to achieve the desired results. Throughout the method, the researcher reviewed previous research and related literature to identify research gaps, determine the problem, and seek a solution. The next phase involved analyzing use cases, developing, and evaluating the proposed system using a test script and validating it with at least five (5) IT experts. With this approach, the researcher was able to evaluate the study's functionality, usability, and reliability in the software development process.
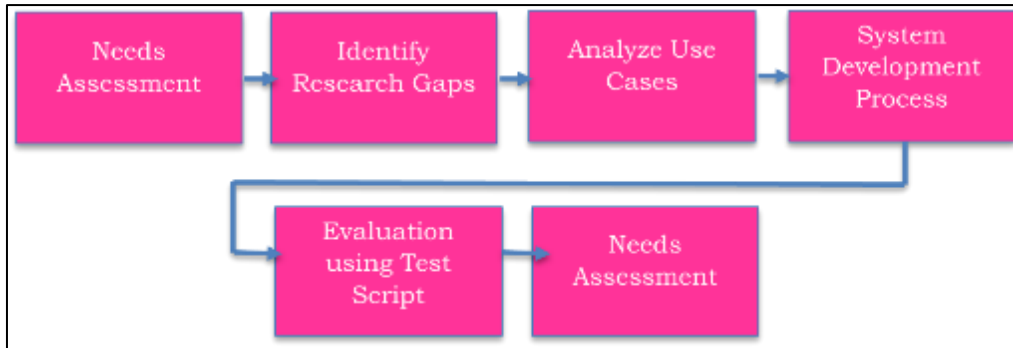


**Figure 5** Research Methodology

As part of the needs assessment, the researcher studied previous research and related literature to gather data to identify the functional and non-functional requirements for the smart store system, including understanding the needs of the users, the platform requirements, and the functional requirements such as product search, e-wallet, virtual cart, etc. By studying other research and related literature, the researcher was able to identify research gaps from other studies that could be improved and helped avoid making the same errors. As a result of analyzing the needs assessment and related literature, the researcher visualized the flow and functionality of the proposed system and its use cases. Subsequently, the researcher began software development using an agile model. The developed system was evaluated using the test script and validated by at least five (5) IT experts.

## 4. Results and discussion

### 4.1. System Development Methodology

This section provides information about the procedure and techniques used in developing the system. The research required an established design process, from the initial design to implementation and final stage. The researcher chose the Agile method (Figure 6) to meet this demand. To analyze each stage, the researchers had to go back to the start and analyze every result that the software will perform



**Figure 6** Agile Model

Following the Agile Model Development Cycle, the proposed system was developed

## 4.2. Define Requirements

This section served as an introductory stage in the system development process. The researcher began by collecting the necessary requirements for the smart store, which encompassed both hardware and software aspects to accurately depict the system's nature.

In addition, factors that contributed to achieving specific objectives were taken into consideration. The requirements for creating the online store were divided into three distinct groups: customer page, employee page, and administrator page, as depicted in the use case diagram.

### 4.2.1. Hardware and Software Requirements

**Table 1** Hardware and Software Requirements

| During Development | During Implementation |
|---|---|
| Hardware<br><br>1.8 ghz quad core; 4gb of RAM; Touch Screen | Hardware<br><br>End-user<br><br>1.8 ghz quad core; 1020x740 screen resolution Monitor; 8gb of RAM; 1 GB Storage; 100BaseT Ethernet; Kiosk: Info/Internet Kiosk; Mobile Device: Android; Standard Keyboard and Mouse; Touch Screen<br><br>Web Hosting<br><br>16Gb of ram; 50gb of SSD/Magnetic Drive; 3.0ghz Multi Core; 100baeT Ethernet |
| Software<br><br>Adobe Photoshop; Ajax; Any OS; Bootstrap; CSS; HTML; JavaScript; jQuery; PHP Language; SQLite Database; XAMPP local webserver | Software<br><br>Any OS; Latest Browser; SQLite Database<br><br>Server<br><br>Linux (CENT O.S); Php 8.1; SQlite PDO; Cpanel |

Determining the system requirements was crucial as it enabled them to accurately describe the nature of the system and identify the necessary factors to achieve specific objectives. It was essential to identify both the hardware and software requirements during the development and implementation phases of the system. To ensure optimal user experience, it is recommended to have hardware specifications that include a device with a minimum 1.8 GHz quad-core processor, a monitor with a screen resolution of 1020x740, 8GB of RAM, 1GB of storage, 100BaseT Ethernet connectivity, support for kiosk and mobile device usage, a standard keyboard and mouse, and touch screen capability.

For web hosting, it was advised to have 16GB of RAM, 50GB of SSD/magnetic drive storage, a 3.0GHz multi-core processor, and 100BaseT Ethernet connectivity to handle concurrent requests and ensure efficient performance.

Additionally, for the server environment, it was recommended to have used the Linux operating system, specifically CENT O.S, known for its stability and security. PHP 8.1 should have been used to ensure compatibility with the latest enhancements and features in the PHP programming language. SQLite PDO was recommended as a lightweight and efficient database engine for reliable data storage and retrieval. Lastly, utilizing the Cpanel control panel simplified server management, website administration, and account management tasks. By meeting these hardware and server requirements, users could have enjoyed smooth operation, clear display, multitasking capabilities, reliable network connections, and interactive interfaces, while web hosting services could have handled multiple requests and maintained high performance levels.

### 4.2.2. Use Case Diagram

The use case diagram provided a visual representation of the actions required within the system. This section aimed to highlight the distinctions among the actions performed by user, employee, and administrator roles. It effectively showcased the varying responsibilities and functionalities assigned to each role within the system.
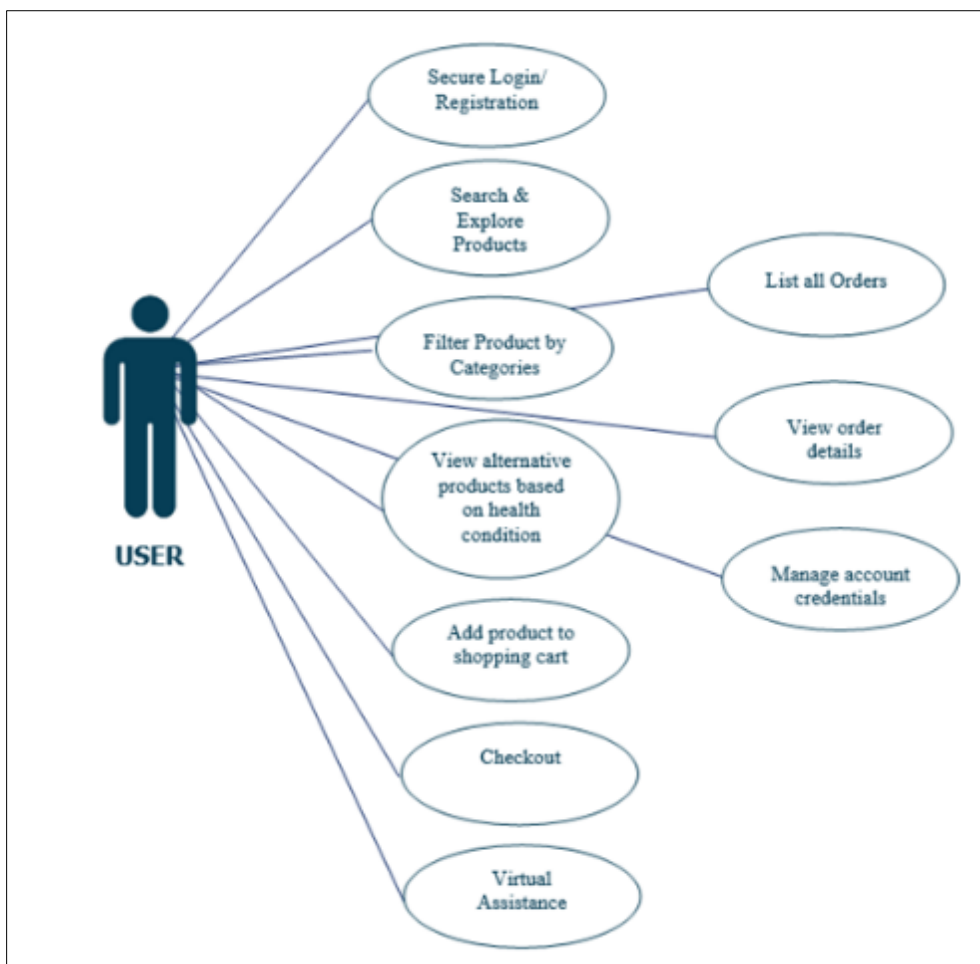
**Figure 7** Use Case for Customers

Figure 7 provided a visual representation of the actions available to users within the system. It showcased a comprehensive list of functionalities, including login and registration, product search and exploration, product filtering by categories, viewing alternative products based on health conditions or declarations, adding items to the shopping cart, completing the checkout process, utilizing virtual assistance for questions and queries, accessing and modifying orders, as well as managing account credentials. This illustration effectively captured the range of actions that users could perform to enhance their overall experience within the system.
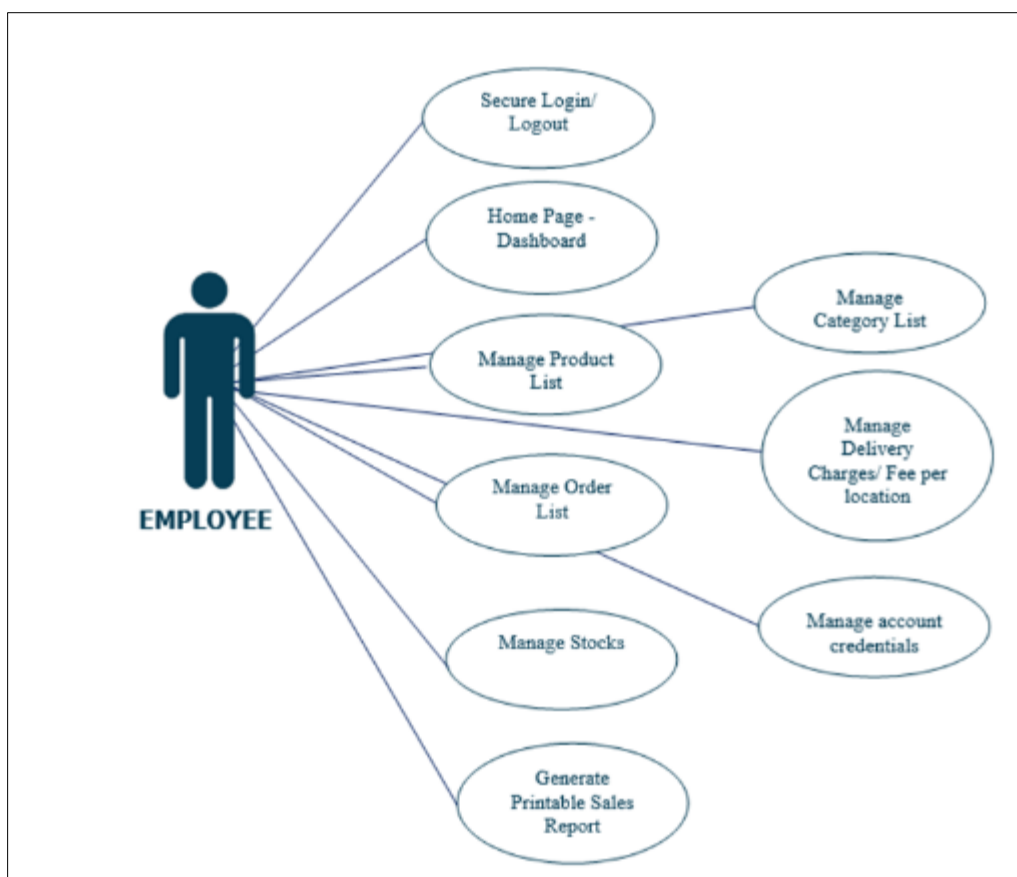
**Figure 8** Use Case for Employee

Figure 8 provided a visual representation of the actions available to employee within the system. It highlighted a range of functionalities, including logging in and out, accessing the dashboard, managing categories, products, and order lists, overseeing stock management, generating printable sales reports, handling delivery charges or fees based on location, as well as managing account credentials. This illustration effectively showcased the various actions that employees could undertake to efficiently manage and maintain the system, thereby enhancing their overall experience.
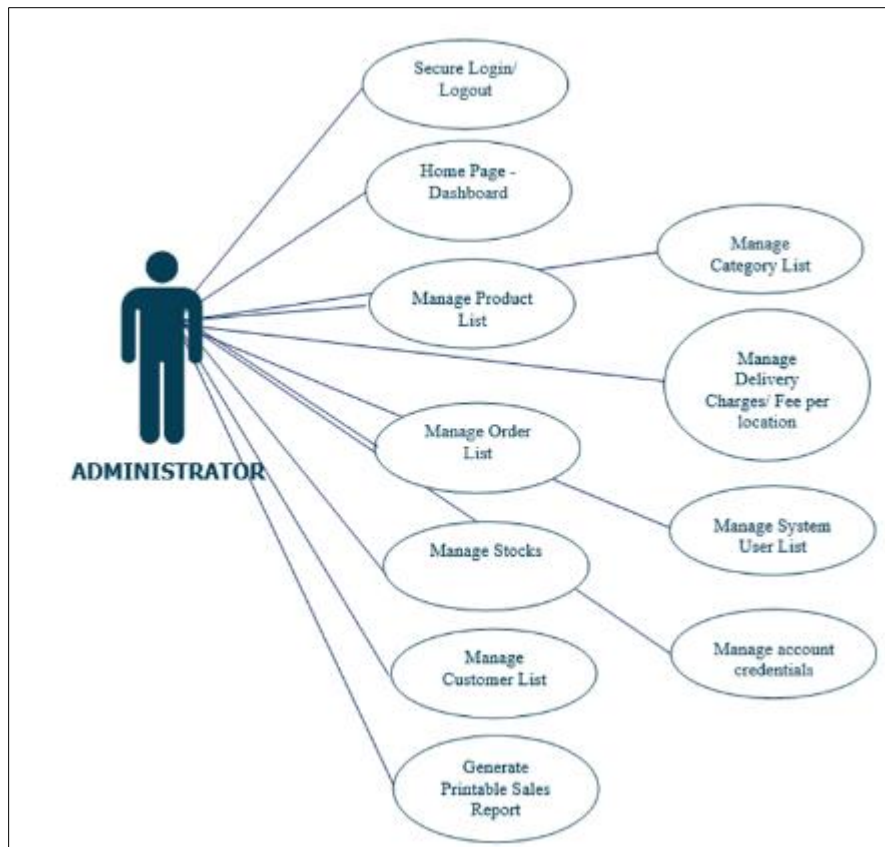
**Figure 9** Use Case for Super Administrator

Figure 9 provided a visual representation of the functions available to the administrator within the system. These functions encompassed all the capabilities accessible to employees, except for managing customer lists and the system's user lists. Administrators were equipped with a comprehensive set of functionalities that enabled them to perform various tasks and operations within the system, allowing for efficient utilization and navigation.

## 4.3. UI Design

In this stage, the functions were enhanced to align with the layout design. Through thorough analysis, it was determined that the most used components on existing websites included a landing page showcasing all products, registration for new accounts, a login page for existing accounts, an add-to-cart function for purchases, a sales invoice for each ordered item, logout functionality to end sessions, and the ability to order items by quantity.

For administrators, the key components included a sales invoice listing, the ability to update sales invoices, user account management, inventory updates, and product updates.

Armed with this knowledge, the researcher embarked on designing an interface that incorporated all these essential features. Various CSS styles and scripts were employed to create a visually appealing and user-friendly layout, enhancing the overall user experience.
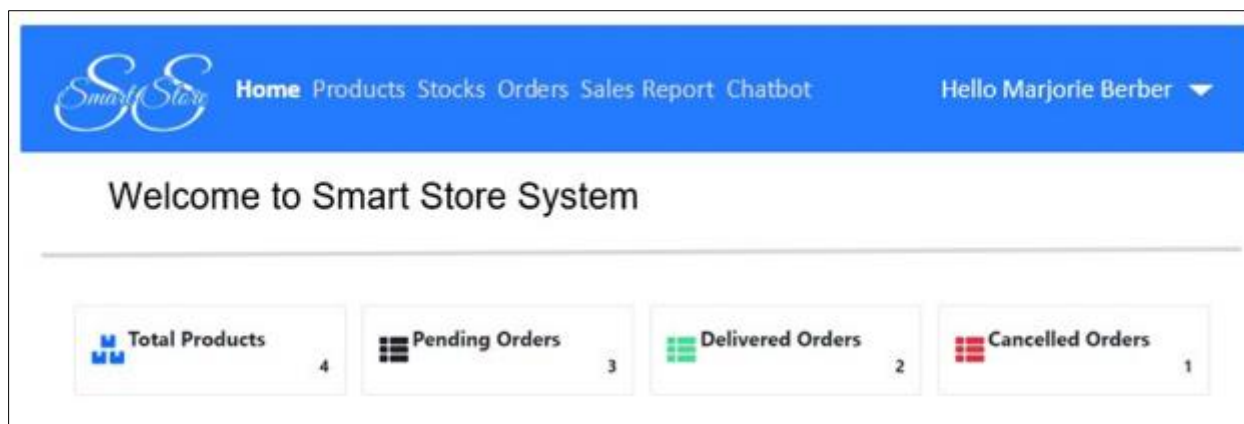
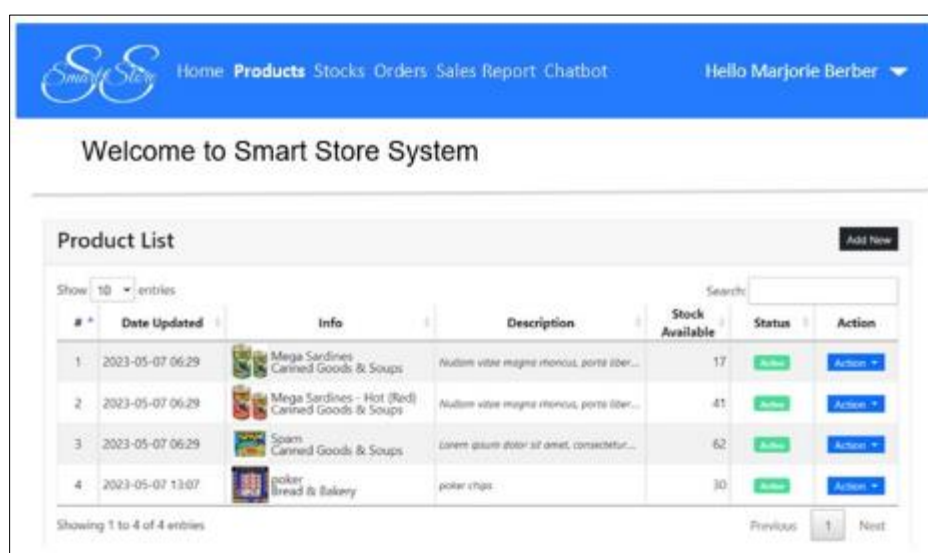**Figure 10** Dashboard of Smart Store System



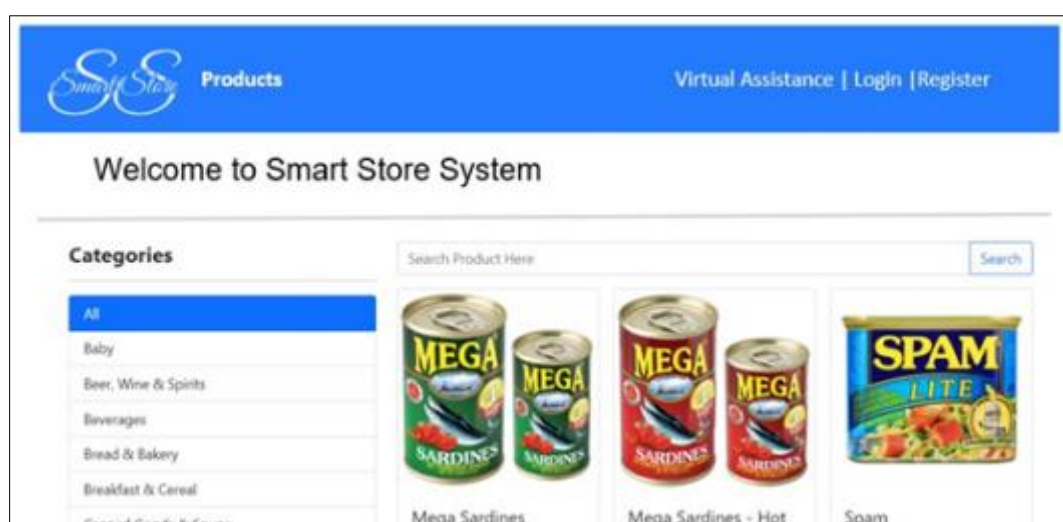**Figure 11** Sample Product Management



**Figure 12** Sample Order Management

## 4.4. Development

This stage involved the modules, algorithm, coding, and integration of the proposed system.

### 4.4.1. System Modules

This section presents the different modules of the proposed system.

Administrator – Common Features includes

- Secure Login/Logout - Provides access to the system's admin interface.
- Home Page - Presents the current transaction dashboard.
- Manage Order List - Lists current and past orders.
- Manage Customer List - Reflects all active and inactive user accounts.
- Generate Printable Sales Report - Generates a report based on a specified duration.
- Manage System Users List - Admin and employee account management.
- Manage Account Credentials - Allows for updating current account settings.
- Logout - Logs out of the system.

New Feature

- Chabot Maintenance - Manages the chatbot components such as responses and unanswered queries. It can modify the content and has a dashboard that can feature the most asked questions in the system. In the list of unanswered responses, there are questions listed with their corresponding numbers. If a question is deemed unacceptable, it will be deleted. Otherwise, a specific response will be set for the posted inquiry.
- Manage Product List - Displays the current inventory listing of uploaded products. It also indicates the health risk component that serves as the basis for the recommendation algorithm.

Employee

- Secure Login/Logout - Provides access to the assigned account on the system.
- Home Page - Displays the current product listing for the user.
- Manage Product List - Shows the current inventory listing of uploaded products.
- Manage Order List - Lists current and past orders.
- Generate Printable Sales Report - Generates a report based on a specified duration.
- Manage Account Credentials - Allows for updating current account settings.
- Logout - Logs out of the system.

User/Customer

- Secure Login and Registration - Grants access to the ordering module.
- Explore Products - Displays the current list of product details.
- Search Products - Enables searching for product availability.
- Filter Products by Categories - Segregates the data based on user search criteria.
- Add Product to Shopping Cart - Allows insertion of desired products.
- Checkout - Confirms the customer's order.
- List all Orders - Presents a current listing of all customer orders.
- View Order Details - Provides detailed information about selected orders.
- Manage Account Credentials - Allows for updating customer credentials.
- Logout - Logs out of the system.

New feature

- Chatbot: All user concerns shall be answered by all the possible inquiries stored on the admin page.
- Health Registration: Users must indicate the sickness they experienced, and the system will create a record for it.

### 4.4.2. Product Recommendation Algorithm

After researching on the internet to find the most suitable approach for selecting items to purchase, it is important to review the algorithmic flow. To do this, an illustration can be used to explain the steps involved. Once the appropriate

approach has been identified, the user can implement it by choosing specific health criteria to filter out products that do not meet their requirements.

To reflect this selection in a database, a SQL statement can be created to retrieve the necessary data. The SQL statement includes a joint between the product and category tables and an order by clause to sort the data alphabetically by product name. Here is an example of such a SQL statement

$sql = "SELECT p.*, c.name as category FROM product_list p inner join category_list c on p.category_id = c.category_id order by p.name asc";

$qry = $conn->query($sql);

Once the SQL statement is executed, the data is displayed on the user's page for review. The user is not blocked from proceeding with their purchase but instead could make an informed decision based on their selected health criteria.

By following the algorithmic flow, users can make informed decisions when selecting items to purchase online based on their specific health needs.

## 4.5. Testing

During the software development process, it is crucial to ensure seamless interaction between objects and the proper integration of software components. This guarantees that all requirements were accurately implemented, bugs were identified, tested, and ultimately resolved.
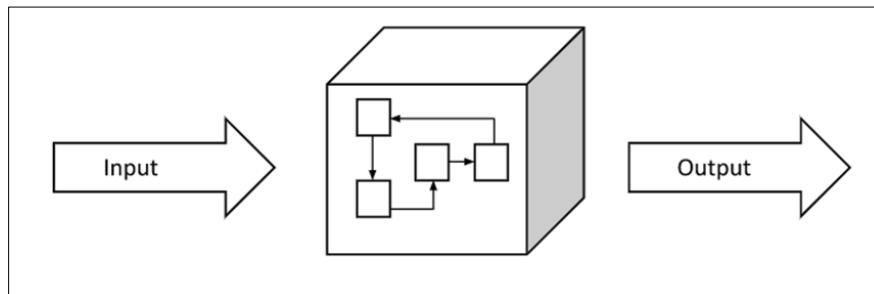


**Figure 13** White Box Testing

To achieve this, a systematic testing (figure 13) approach is followed. It begins with Step 1, where the inputs on the registration of accounts are thoroughly tested to ensure their validity and proper functioning. Moving on to Step 2, the system checked if the username, password, and account level are correct, providing a secure and reliable authentication process.

Continuing with Step 3, the system verified that the item ordered is available and not exceeding the current inventory, avoiding any potential issues with stock management. Step 4 involved testing the query that reflects alternative products, ensuring that the system can accurately provide suitable options based on user preferences.

Step 5 focused on testing the created products and categories to ensure their accuracy and proper organization within the system. Step 6 involved meticulously checking the words used in the dialogues, ensuring accuracy and eliminating any misspelled words that may impact on the overall user experience.

Lastly, in Step 7, the system performed and checked to identify duplicate accounts, ensuring data integrity and preventing any issues related to duplicate account creation.

### 4.5.1. Testing Smart Store System on different OS and browser using different devices

To ensure compatibility and functionality, the web page was tested on various operating systems and browsers across different devices.

**Table 2** Result of Testing Smart Store System on Different OS and Browser Using Different Devices

| OS | Edge | Chrome | Firefox | Safari | Opera |
|---|---|---|---|---|---|
| Win 10 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Ubuntu | N/A | ✓ | ✓ | N/A | ✓ |
| Mac OS | N/A | ✓ | ✓ | ✓ | N/A |
| Android | N/A | ✓ | ✓ | N/A | ✓ |
| IOS | N/A | ✓ | N/A | ✓ | N/A |

The proposed system has been tested on different operating systems and browsers using different devices. Here is the legend for the test results

"N/A" indicates that the browser is either not installed or not compatible with the operating system. This does not seem to run, but this development system environment is not compatible.

The program has been deployed on a web hosting platform, allowing access to the program from various browsers and operating systems. All functions of the program are functioning properly, and the chosen layout is adaptive, ensuring that the interface remains intact. The proposed smart store system is compliant with all operating systems and browsers. This is achieved by uploading all the required components and linking them to external directories, as well as incorporating any necessary plug-ins for smooth operation.

## 4.6. User Acceptance Testing

This stage occurs during the final phase of testing before the software application is deployed.
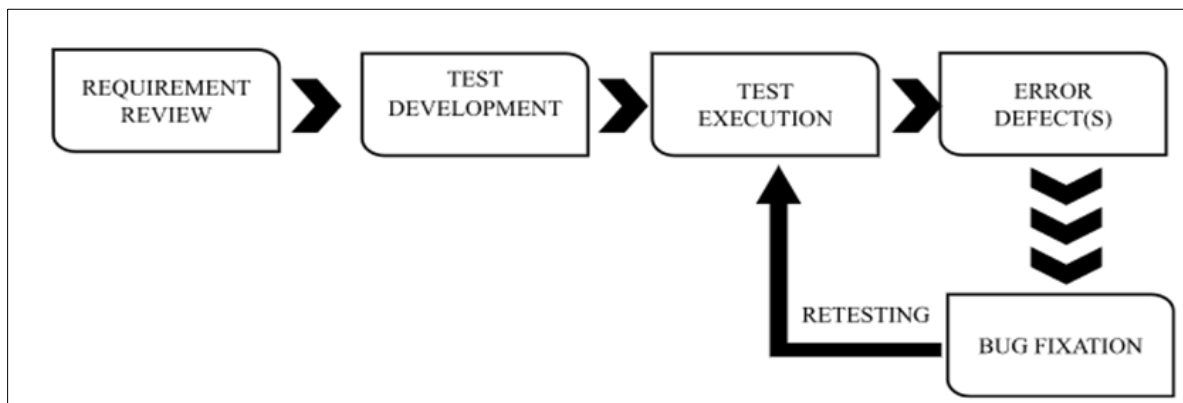


**Figure 14** Alpha Testing

Testing involves developers and researchers conducting tests to validate that the software meets its final product and technical specifications. During the Alpha testing phase, the researchers perform various trials to ensure that the software produces the expected output as per the system requirements. The Alpha test is utilized by developers and researchers to promptly address any software issues identified during testing and to swiftly update the test environment to enable further testing.

## 4.7. Evaluation

This was the stage where IT experts evaluated and validated the outcomes of the system. Reviewing the changes and improvements to the proposed system was necessary. The system underwent successive cycles of verification and testing until all conditions and errors were resolved.

For the study entitled 'Smart Store Multi-Platform,' at least five (5) IT experts were selected as respondents.

Furthermore, if permission was granted, the researcher sent a private chat message explaining the study's goals, objectives, and inspiration. The researcher also ensured that the participants were aware that their participation was entirely voluntary.

*4.7.1. Evaluation and Validation of the System by the IT Experts in*

**Table 3** Test Case 1 Login and User Management

| Domain | | Mean | S.D. | V.I. |
|---|---|---|---|---|
| Enter valid credentials and click on login button | Ease of Use | 4.50 | 0.55 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |
| | Security | 4.00 | 0.89 | Good |
| | Overall Satisfaction | 4.50 | 0.55 | Very Good |
| | Overall 2 | 4.42 | 0.44 | Good |
| Create a new user account using valid input data and with appropriate access permissions | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.50 | 0.55 | Very Good |
| | Security | 4.00 | 0.89 | Very Good |
| | Overall Satisfaction | 4.17 | 0.41 | Good |
| | Overall 3 | 4.38 | 0.44 | Good |
| Verify that the user profile was successfully created and stored in the system | Ease of Use | 4.50 | 0.55 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |
| | Security | 4.17 | 0.75 | Good |
| | Overall Satisfaction | 4.50 | 0.55 | Very Good |
| | Overall 4 | 4.46 | 0.46 | Good |
| Attempt to create a new user profile using valid input data | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |
| | Security | 4.33 | 0.52 | Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 5 | 4.63 | 0.41 | Very Good |
| Verify that the system correctly identifies and rejects invalid input data | Ease of Use | 4.50 | 0.55 | Very Good |
| | Speed | 4.33 | 0.52 | Good |
| | Security | 4.67 | 0.52 | Very Good |
| | Overall Satisfaction | 4.50 | 0.55 | Very Good |
| | Overall 6 | 4.50 | 0.39 | Very Good |
| Edit and delete the newly created user account | Ease of Use | 4.67 | 0.52 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |
| | Security | 4.17 | 0.98 | Good |
| | Overall Satisfaction | 4.33 | 0.52 | Good |
| | Overall 7 | 4.46 | 0.53 | Good |

Test Case 1 as shown in table 3, pertaining to login and user management, consists of six (6) domains. These domains include: entering valid credentials and clicking on the login button, creating a new user account using valid input data

and appropriate access permissions, verifying that the user profile was successfully created and stored in the system, attempting to create a new user profile using valid input data and verifying that the system correctly identifies and rejects invalid input data, and editing and deleting the newly created user account. According to the tabular values, the validators rated the domain of attempting to create a new user profile using valid input data and verifying that the system correctly identifies and rejects invalid input data as "Very Good," with mean scores of 4.63 and 4.50, respectively. The other domains were rated as "Good," with scores ranging from 4.38 to 4.46. When considering the items for each domain, security consistently had the lowest mean score, except under the domain of verifying that the system correctly identifies and rejects invalid input data, where speed obtained the lowest mean score of 4.33. On the other hand, either speed or ease of use obtained the highest mean score for each domain. The small standard deviation suggests that the scores of the validators are homogeneous.

*4.7.2. Evaluation and Validation of the System by the IT Experts in*

**Table 4** Test Case 2 Product Management

| Domain | | Mean | S.D. | V.I. |
|---|---|---|---|---|
| Add a new product with appropriate details (e.g., Name, Description, Category, Price, Image, Health concern and status) | Ease of Use | 4.67 | 0.52 | Very Good |
| | Speed | 4.50 | 0.55 | Very Good |
| | Security | 4.50 | 0.55 | Very Good |
| | Overall Satisfaction | 4.50 | 0.55 | Very Good |
| | Overall 4 | 4.54 | 0.43 | Very Good |
| Verify that the system correctly records the user's health concern/status | Ease of Use | 4.67 | 0.52 | Very Good |
| | Speed | 4.83 | 0.41 | Very Good |
| | Security | 4.33 | 0.82 | Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 5 | 4.63 | 0.52 | Very Good |
| Edit the details of the newly added product | Ease of Use | 4.50 | 0.55 | Very Good |
| | Speed | 4.50 | 0.55 | Very Good |
| | Security | 4.50 | 0.55 | Very Good |
| | Overall Satisfaction | 4.50 | 0.55 | Very Good |
| | Overall 6 | 4.50 | 0.47 | Very Good |
| Delete the newly added product | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.50 | 0.55 | Very Good |
| | Security | 4.50 | 0.84 | Very Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 7 | 4.63 | 0.52 | Very Good |
| Make several product purchases and verify that the system records these transactions | Ease of Use | 4.50 | 0.55 | Very Good |
| | Speed | 4.67 | 0.82 | Very Good |
| | Security | 4.67 | 0.52 | Very Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 8 | 4.63 | 0.52 | Very Good |
| Verify that the product recommendation algorithm is accurately recommending appropriate products/ | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |

| alternative products based on the user's health concern/status and previous transaction | Security | 4.50 | 0.55 | Very Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 9 | 4.71 | 0.37 | Very Good |
| Verify that the product recommendation algorithm is also accurately recommending products based on most purchased items from other user's | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.83 | 0.41 | Very Good |
| | Security | 4.50 | 0.55 | Very Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 10 | 4.75 | 0.39 | Very Good |

Test Case 2 as shown in table 4, pertaining to product management, consists of seven (7) domains. These domains include: adding products including appropriate details, user health status record, manage products and implementation of product recommendation algorithm. According to the tabular values, the validators rated all domains as "Very Good," with mean scores range 4.50 to 4.75, respectively. When considering the items for each domain, security consistently had the lowest mean score, except under the domain of managing products. The small standard deviation suggests that the scores of the validators are homogeneous.

*4.7.3. Evaluation and Validation of the System by the IT Experts in*

**Table 5** Test Case 3 Inventory Management

| Domain | | Mean | S.D. | V.I. |
|---|---|---|---|---|
| Click on the "Stocks" tab | Ease of Use | 5.00 | 0.00 | Very Good |
| | Speed | 4.83 | 0.41 | Very Good |
| | Security | 4.17 | 0.41 | Good |
| | Overall Satisfaction | 4.50 | 0.55 | Very Good |
| | Overall 2 | 4.63 | 0.26 | Very Good |
| Add a new item with appropriate details of the products | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.83 | 0.41 | Very Good |
| | Security | 4.50 | 0.55 | Very Good |
| | Overall Satisfaction | 4.50 | 0.55 | Very Good |
| | Overall 3 | 4.67 | 0.38 | Very Good |
| Update the quantity of the newly added item | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 5.00 | 0.00 | Very Good |
| | Security | 4.33 | 0.82 | Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 4 | 4.75 | 0.39 | Very Good |
| Delete the newly added item | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |
| | Security | 4.50 | 0.84 | Very Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 5 | 4.67 | 0.44 | Very Good |

Test Case 3 as shown in table 5, pertaining to inventory management, consists of four (4) domains. These domains include stocks, adding new items including appropriate details, updating quantity of products and deleting newly added item. According to the tabular values, the validators rated all domains as "Very Good," with mean scores range 4.63 to 4.75, respectively. When considering the items for each domain, security consistently had the lowest mean score. The small standard deviation suggests that the scores of the validators are homogeneous.

### 4.7.4. Evaluation and Validation of the System by the IT Experts in

**Table 6** Test Case 4 Sales Management

| Domain | | Mean | S.D. | V.I. |
|---|---|---|---|---|
| Click on the "Orders" tab | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.50 | 0.55 | Very Good |
| | Security | 4.67 | 0.52 | Very Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 2 | 4.67 | 0.34 | Very Good |
| View the Order List with transaction code and status: pending, confirmed, deliver, and cancel | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.50 | 0.55 | Very Good |
| | Security | 4.67 | 0.52 | Very Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 3 | 4.71 | 0.37 | Very Good |
| Delete the orders | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |
| | Security | 4.50 | 0.84 | Very Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 4 | 4.67 | 0.44 | Very Good |
| Display the User's bills | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.50 | 0.55 | Very Good |
| | Security | 4.67 | 0.52 | Very Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 5 | 4.67 | 0.34 | Very Good |

Test Case 4 as shown in table 6, pertaining to sales management, consists of four (4) domains. These domains include orders, view order list, deleting orders and displaying user's bills. According to the tabular values, the validators rated all domains as "Very Good," with mean scores of 4.67 and 4.71, respectively. When considering the items for each domain, speed consistently had the lowest mean score, except under the domain of deleting orders, where security obtained the lowest mean score of 4.50. The small standard deviation suggests that the scores of the validators are homogeneous.

*4.7.5. Evaluation and Validation of the System by the IT Experts in*

**Table 7** Test Case 5 Report Management

| Domain | | Mean | S.D. | V.I. |
|---|---|---|---|---|
| Generate a report using valid input data and verify that the report is accurate and complete | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |
| | Security | 4.33 | 0.82 | Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 2 | 4.63 | 0.41 | Very Good |
| Attempt to generate a report using invalid input data and verify that the system correctly identifies and rejects invalid input data | Ease of Use | 5.00 | 0.00 | Very Good |
| | Speed | 4.83 | 0.41 | Very Good |
| | Security | 4.67 | 0.52 | Very Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 3 | 4.83 | 0.30 | Very Good |
| Verify that the report can be displayed correctly on different devices and web browsers | Ease of Use | 5.00 | 0.00 | Very Good |
| | Speed | 4.50 | 0.55 | Very Good |
| | Security | 4.33 | 0.82 | Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 4 | 4.63 | 0.41 | Very Good |

Test Case 5 as shown in table 7, pertaining to report management, consists of three (3) domains. These domains include generating reports using valid input data, rejecting invalid input data and displaying reports correctly. According to the tabular values, the validators rated all domains as "Very Good," with mean scores of 4.63 and 4.83, respectively. When considering the items for each domain, security consistently had the lowest mean score. The small standard deviation suggests that the scores of the validators are homogeneous.

*4.7.6. Evaluation and Validation of the System by the IT Experts*

**Table 8** Test Case 6 Virtual Assistance

| Domain | | Mean | S.D. | V.I. |
|---|---|---|---|---|
| Test the virtual assistant's ability to respond to common consumer queries and concerns | Ease of Use | 5.00 | 0.00 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |
| | Security | 4.67 | 0.52 | Very Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 2 | 4.79 | 0.29 | Very Good |
| Verify that the virtual assistant is able to provide accurate and helpful information to the user | Ease of Use | 4.67 | 0.52 | Very Good |
| | Speed | 5.00 | 0.00 | Very Good |
| | Security | 4.33 | 0.82 | Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 3 | 4.67 | 0.34 | Very Good |
| | Ease of Use | 5.00 | 0.00 | Very Good |
| | Speed | 4.50 | 0.55 | Very Good |

| Verify that the virtual assistant is able to escalate complex queries to a human customer service representative when necessary | Security | 4.33 | 0.52 | Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 4 | 4.67 | 0.26 | Very Good |
| Verify that the virtual assistant is able to operate across multiple platforms and devices | Ease of Use | 4.67 | 0.52 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |
| | Security | 4.33 | 0.52 | Good |
| | Overall Satisfaction | 4.33 | 0.52 | Good |
| | Overall 5 | 4.50 | 0.39 | Very Good |

Test Case 6 as shown in table 8, pertaining to virtual assistance, consists of four (4) domains. These domains include virtual assistance ability to respond, providing accurate and helpful information, escalate complex queries and operate multiple platforms and devices. According to the tabular values, the validators rated all domains as "Very Good," with mean scores range 4.50 to 4.79, respectively. When considering the items for each domain, security consistently had the lowest mean score. The small standard deviation suggests that the scores of the validators are homogeneous.

*4.7.7. Evaluation and Validation of the System by the IT Experts in*

**Table 9** Test Case 7 System Integration

| Domain | | Mean | S.D. | V.I. |
|---|---|---|---|---|
| Verify that the system can communicate with external systems and services using standard communication protocols | Ease of Use | 4.67 | 0.52 | Very Good |
| | Speed | 4.83 | 0.41 | Very Good |
| | Security | 4.33 | 0.82 | Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 1 | 4.67 | 0.26 | Very Good |
| Test the system's ability to import and export data to and from external systems and services | Ease of Use | 5.00 | 0.00 | Very Good |
| | Speed | 4.67 | 0.82 | Very Good |
| | Security | 4.50 | 0.84 | Very Good |
| | Overall Satisfaction | 4.50 | 0.55 | Very Good |
| | Overall 2 | 4.67 | 0.44 | Very Good |
| Verify that the system can integrate with different authentication and authorization mechanisms | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.83 | 0.41 | Very Good |
| | Security | 4.33 | 0.82 | Good |
| | Overall Satisfaction | 4.50 | 0.55 | Very Good |
| | Overall 3 | 4.63 | 0.41 | Very Good |

Test Case 7 as shown in table 9, pertaining to system integration, consists of three (3) domains. These domains include communication of system, importing and exporting of data, and integrating different authentication and authorization. According to the tabular values, the validators rated all domains as "Very Good," with mean scores of 4.63 and 4.67, respectively. When considering the items for each domain, security consistently had the lowest mean score. The small standard deviation suggests that the scores of the validators are homogeneous.

*4.7.8. Evaluation and Validation of the System by the IT Experts in*

**Table 10** Test Case 8: E-Commerce Functions

| Domain | | Mean | S.D. | V.I. |
|---|---|---|---|---|
| Verify that the virtual online cart displays accurate specifications of added items | Ease of Use | 4.67 | 0.52 | Very Good |
| | Speed | 4.83 | 0.41 | Very Good |
| | Security | 4.67 | 0.52 | Very Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 1 | 4.75 | 0.39 | Very Good |
| Verify that the history of product purchases is accurately recorded and can be viewed by the user | Ease of Use | 4.67 | 0.52 | Very Good |
| | Speed | 4.83 | 0.41 | Very Good |
| | Security | 4.83 | 0.41 | Very Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 2 | 4.75 | 0.39 | Very Good |
| Verify that the product search function returns accurate search results | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.67 | 0.52 | Very Good |
| | Security | 4.50 | 0.84 | Very Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 3 | 4.71 | 0.37 | Very Good |
| Verify that the account login function works correctly and allows access to account features | Ease of Use | 4.83 | 0.41 | Very Good |
| | Speed | 4.83 | 0.41 | Very Good |
| | Security | 4.50 | 0.84 | Very Good |
| | Overall Satisfaction | 4.67 | 0.52 | Very Good |
| | Overall 4 | 4.71 | 0.49 | Very Good |
| Verify that the e-wallet system is working correctly and allows for seamless payment processing | Ease of Use | 5.00 | 0.00 | Very Good |
| | Speed | 4.50 | 0.55 | Very Good |
| | Security | 4.67 | 0.52 | Very Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 5 | 4.75 | 0.27 | Very Good |
| Verify that the system displays accurate and up-to-date information on product price and other basic information | Ease of Use | 5.00 | 0.00 | Very Good |
| | Speed | 5.00 | 0.00 | Very Good |
| | Security | 4.50 | 0.55 | Very Good |
| | Overall Satisfaction | 4.83 | 0.41 | Very Good |
| | Overall 6 | 4.83 | 0.13 | Very Good |

Test Case 8 as shown in table 10, pertaining to e-commerce functions, consists of six (6) domains. These domains include virtual online cart, history of product, product search, account login function, e-wallet system and display product price. According to the tabular values, the validators rated all domains as "Very Good," with mean scores range of 4.71 to 4.83, respectively. When considering the items for each domain, security consistently had the lowest mean score. The small standard deviation suggests that the scores of the validators are homogeneous.

## 5. Conclusion

The objectives related to developing a smart store that runs on multiple platforms, featuring common e-commerce functions, implementing a product recommendation algorithm, and creating a smart virtual assistant have been successfully achieved. The system has undergone thorough testing on different operating systems and browsers, ensuring compatibility and proper functioning across various devices. It has been deployed on a web hosting platform, providing accessibility on different platforms such as PCs, mobile devices, and standalone kiosks.

The e-commerce functions of the store, including virtual online carts, product history, search capabilities, account management, e-wallet integration, and clear display of product prices, have met the objective of facilitating convenient and efficient shopping. The system also incorporates a product recommendation algorithm that considers user health conditions, previous transactions, and popular products to enhance product selection.

The smart virtual assistant effectively handles consumer queries and concerns by responding promptly, providing accurate information, escalating complex queries, and operating seamlessly on multiple platforms and devices.

The system has been evaluated and validated by IT experts, who consistently rated its performance across different test cases as "Very Good." However, the domain of security received lower scores and indicated an area for improvement.

Overall, the findings demonstrate the system's effectiveness, reliability, and successful achievement of the stated objectives. Further enhancements can be made to strengthen security measures and ensure the system's continued excellence in providing a seamless and convenient shopping experience.

## Compliance with ethical standards

*Disclosure of conflict of interest*

No conflict of interests to be disclosed.

*Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

## References

[1] Asada, Y., Harris, J. L., Mancini, S., Schwartz, M. B., and Chriqui, J. F. (2020). Food and beverage marketing in schools: school superintendents' perspectives and practices after the healthy, Hunger-Free Kids Act. Public Health Nutrition, 23(11), 2024–2031. https://doi.org/10.1017/S1368980019004804

[2] Babcock, J. (2016). Mastering Predictive Analytics with Python. Packt Publishing.

[3] Blazquez Cano, M., Perry, P., Ashman, R., and Waite, K. (2017). The influence of image interactivity upon user engagement when using mobile touch screens. Computers in Human Behavior, 77, 406–412. https://doi.org/10.1016/j.chb.2017.03.042

[4] Cai, B., Yang, X., Huang, Y., Li, H., and Sang, Q. (2018). A Triangular Personalized Recommendation Algorithm for Improving Diversity. Discrete Dynamics in Nature and Society, 1–11. https://doi.org/10.1155/2018/3162068

[5] Choi, S. H., Kang, S., and Jeon, Y. J. (2006). Personalized recommendation system based on product specification values. Expert Systems with Applications, 31(3), 607–616. https://doi.org/10.1016/j.eswa.2005.09.074

[6] Cook, D., and Das, S. K. (2005). Smart Environments: Technology, Protocols, and Applications. Wiley-Interscience.

[7] Foodnavigator.com. (2018, September 28). 'Ingredients lists are powerful purchasing motivators': Study finds consumer care more about ingredients than brand. Retrieved from https://www.foodnavigator.com/Article/2018/09/28/Consumers-care-more-about-ingredients-than-brand-Survey

[8] Jeffrey J P Tsai, and Zhenwei Yu. (2011). Intrusion Detection: A Machine Learning Approach. Imperial College Press.

[9] JIMÉNEZ GARCÍA, L. (2017). Presente y futuro de la conducción automatizada. Carreteras, 4(216), 36–44.

[10] Jin, X., Song, Y., Liu, L., and Chen, J. (2020). Big Data Analysis of User Behavior for E-commerce Platform Optimization. IEEE Access, 8, 6215-6227. doi:10.1109/ACCESS.2019.2961802.

[11] Jin, X., Song, Y., Liu, L., and Chen, J. (2020). Big Data Analysis of User Behavior for E-commerce Platform Optimization. IEEE Access, 8, 6215-6227. doi:10.1109/ACCESS.2019.2961802.

[12] Kuo, Y.-C., Hu, Y.-T., and Tsai, C.-Y. (2021). The Impact of Mobile Apps on Consumer Purchase Intention: A Perspective of the Stimulus–Organism–Response Model. International Journal of Environmental Research and Public Health, 18(4), 1757. doi:10.3390/ijerph18041757.

[13] Kusumawati, R. E., Muslim, E., and Nugroho, D. (2020). Usability testing on touchscreen based electronic kiosk machine in convenience store. RECENT PROGRESS ON: MECHANICAL, INFRASTRUCTURE AND INDUSTRIAL ENGINEERING: Proceedings of International Symposium on Advances in Mechanical Engineering (ISAME): Quality in Research 2019, 1–9. https://doi.org/10.1063/5.0000982

[14] O'Brien, M. (2020, October 16). 8 Product Recommendation Algorithm (and How You Can Use Them). Sailthru. Retrieved from https://www.sailthru.com/marketing-blog/recommendation-algorithms-guide/

[15] Pereira, J. A., Matuszyk, P., Krieter, S., Spiliopoulou, M., and Saake, G. (2018). Personalized recommender systems for product-line configuration processes. Computer Languages, Systems and Structures, 54, 451–471. https://doi.org/10.1016/j.cl.2018.01.003

[16] Pollack, J. (2018). MARKETER A-LIST 2018: Warner Bros.' crazy smart marketing plan.

[17] Portugal, I., Alencar, P., and Cowan, D. (2018). The use of machine learning algorithms in recommender systems: A systematic review. Expert Systems with Applications, 97, 205–227. https://doi.org/10.1016/j.eswa.2017.12.020 Vo. T. H, P., and Czygan, M. (2015). Getting Started with Python Data Analysis. Packt Publishing.

[18] Wiley, J. F. (2016). R Deep Learning Essentials. Packt Publishing. Yingying Gong. (2015). Application of User-level Personalized Recommendation Algorithm in Sports Websites. Metallurgical and Mining Industry, 5, 375–382

[19] Yuan, S.-T., and Cheng, C. (2004). Ontology-based personalized couple clustering for heterogeneous product recommendation in mobile marketing. Expert Systems with Applications, 26(4), 461. https://doi.org/10.1016/j.eswa.2003.10.006

[20] Zhang, L., and Liu, X. J. (2020). A novel recommendation algorithm based on product life cycle theory. Journal of Computational Methods in Sciences and Engineering, 1–20. https://doi.org/10.3233/jcm-204562.