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Journal of Behavioral Informatics
Digital Humanities & Development Research
Vol 11, No 5, March 2025 Series

Development of an Enhanced Point of Sales System for Retail Business in Developing Countries

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ABSTRACT

The use of Point-of-Sale (POS) system for buying, selling, cash withdrawal, and cash deposit has become a norm in the society. Thus, this study developed a point-of-sale recommender system, that ensures that transactions are reliable, accurate, faster and secure. The programming language used for implementation is Hypertext Preprocessor (PHP) with MYSQL as database. This developed POS recommender system has the capability to keep records of previous sales and update the daily sales of the company. A customer can return products due to one or two tangible reasons with this POS system. This system makes use of the barcode scanner system where by the barcode scanner scans and verify products bought by a customer. The mode of payment on this system is through the use of debit card. The new thing added to this POS system that makes it different from other existing POS system is its ability to suggest or recommend related items bought by a customer. It was tested using interactions between a sales person and a customer.

Keywords: Point-of-Sale, Recommender System, Barcode, Debit card

Journal Reference Format:
Sebastina Nkechi Okofu, Clive Asuai, Oniovosa Okumoku-evroro & Maureen Ifeanyi Akazue (2025): Development of an Enhanced Point of Sales System for Retail Business in Developing Countries. Journal of Behavioural Informatics, Digital Humanities and Development Rese Vol. 11 No. 5. Pp 1-24. https://www.isteams.net/behavioralinformaticsjournal dx.doi.org/10.22624/AIMS/BHI/V11N1P1

1. INTRODUCTION

With the digital revolution, the global economy is become more info-based and dependent. Sebastina, et al., (2024). One of the notable recent advancements in the field of information and digital technology pertains to the rapid progress in communication, which has effectively transformed the world into a global village. This development has facilitated various activities such as electronic mail (e-mail) correspondence, information retrieval through the World Wide Web (WWW), online purchasing of goods (e-commerce), electronic banking transactions (e-banking), and online educational platforms (e-learning). These technological advancements have had a significantly positive impact on society. Consequently, the computerization of sales processes should not be overlooked. The integration of technology in sales has been widely embraced in developed nations for more than two decades. This adoption can be attributed to the governments' aspirations to enhance the efficiency of their goods and services, streamline processes, and ensure accountability (Hermawan & Sutrayana, 2022).

However, transitioning from a conventional cash register to a computerized Point of Sale (POS) system can present challenges. It requires careful consideration of various factors and necessitates the avoidance of potential pitfalls The POS system is a modern transaction processing technology widely used across different business sectors such as retail, hospitality, and healthcare. POS System and Its infrastructure helps keep businesses connected to their clients on a digital marketplace, helping businesses to meet the daily needs of their customers (Margaret, et. al. 2024). It offers a range of benefits to businesses, including faster and more accurate transaction processing, improved inventory management, and enhanced customer experience. Despite these benefits, the design of POS systems remains a challenge due to factors such as user interface, compatibility with existing systems, and scalability Almsick (2023).

Several studies in the past five years have attempted to address these challenges and improve the design of POS systems. For example, a study by (Subhiyakto & Astuti, 2020), proposed a personalized POS system design based on user behaviour analysis. By analysing real-time transaction data and user interactions, the study proposed personalized sales strategies that improve customer satisfaction and sales. Similarly, a study by (Mafimisebi et al., 2019) suggested a design framework for POS systems based on an analysis of user requirements and system functionality. The framework emphasizes the need for user-centred design, which takes into account the needs and preferences of both employees and customers.

Furthermore, with the advent of emerging technologies such as artificial intelligence, blockchain, and the Internet of Things, designers of POS systems face new opportunities and challenges. Recent studies have explored the potential of these technologies to improve the design of POS systems, for instance, by enabling better data analysis and system integration (Abdullahi et al., 2019) and enhancing security and privacy (Guenzi & Habel, 2020). Therefore, to maximize the benefits of POS systems, it is essential to address the challenges associated with them. This can be achieved by developing user-friendly interfaces, implementing effective inventory management systems, and providing adequate staff training (Alilam et al., 2020). By doing so, businesses can operate more efficiently, reduce errors, and improve the overall customer experience.

1.1 Advantages associated with POS Systems

Businesses of various forms are springing forth Sebastina et al., (2024), which require seamless means of making transactions. The following are the advantages associated with POS Systems.

a. **Streamlined Inventory Management:** EPOS systems can provide real-time stock control and alerts, reducing stock wastage and improving stock management across locations. (Hussain et al., 2020).
b. **Improved Customer Experience:** Electronic Point of Sale (EPOS) systems enable retailers to offer efficient and seamless checkout processes, resulting in heightened customer contentment. (Hussain et al., 2019) conducted a study on the use of EPOS (Electronic Point of Sale) technology by independent retailers. The study focused on contextual factors, benefits, and challenges associated with this adoption.
c. **Enhanced Analysis and Decision-Making:** Electronic Point of Sale (EPOS) systems offer retailers sophisticated reporting and analytics functionalities, enabling them

to scrutinize sales data and make well-informed choices regarding pricing, promotions, and inventory management. (Hussain et al., 2020) conducted a study on the benefits of EPOS (Electronic Point of Sale) technology in independent retailers in the UK.

d. **Enhanced Staff Management:** Electronic Point of Sale (EPOS) systems enable merchants to optimize staff scheduling, resulting in reduced labour expenses and increased staff efficiency. Additionally, EPOS systems facilitate streamlined staff training processes. (Hussain et al., 2019) conducted a study on the use of EPOS (Electronic Point of Sale) technology by independent retailers. The study focused on contextual factors, benefits, and challenges associated with this adoption.
e. **Improved Efficiency and Accuracy:** EPOS systems help in improving the speed and accuracy of billing and inventory management, reducing the processing time and minimizing errors in transactions. (Smith et al., 2017).

1.1 Problem Statement

Sales play a crucial role in the functioning of business organizations, serving as a fundamental tool for generating profit and managing losses. In order to facilitate effective decision-making and implementation, it is imperative to possess comprehensive information regarding sales. Failing to establish accountability in this area can lead to the eventual collapse of a business. Consequently, industries such as retail, hospitality, and food service require a system that provides management with feedback to support decision-making processes. This is where point of sale systems proves to be advantageous.

The manual approach to managing transaction processes and generating reports in contemporary retail establishments might be characterized as laborious and challenging. The process is time-consuming and may not consistently yield reports that are very accurate and reliable. Moreover, the maintenance costs associated with the system are too high.
The utilization of manual procedures results in a significant number of individuals forming queues around the cashier's counter, awaiting service. Additionally, the utilization of manual methods results in a delay in the process of management decision-making, as the reports necessary for informed decision-making are received late and lack accuracy.

2. RELATED WORKS

The Internet and the constant evolution in informatics – have become both the mainstay of and backbone of businesses today Margaret et al., (2024). Over the years, there has been an increasing interest in research efforts to develop Akazue et al., (2015) an enhanced point-of-sale (POS) system- Several researchers have been on the forefront Akazue et al., (2016) of proffering solutions to seamless payments. Computer technology has emerged as a valuable tool for addressing Sebastina, et al , (2024) and proffering such solutions. The point-of-sale (POS) system plays a critical role in modern retail management by enabling efficient transaction processing, inventory management, and customer relationship management.

Significant advancements have been made in computing over the last decade Maureen et al., (2023), In recent years, various studies have focused on the design and implementation of POS systems to meet the changing needs of a digital-savvy and diverse customer base. In a study by (Fonseca et al., 2020), the authors designed and implemented a payment gateway service for non-contact payment transactions, using a web-based POS system. The authors noted that security and usability are the key factors to consider in designing a POS system that supports contactless payments.

(Kim et al., 2020) proposed a design and implementation model for a POS system that caters to the needs of small- and medium-sized enterprises (SMEs). The authors identified that integration with third-party payment gateways, inventory management systems, and valuable analytics for data-driven decision-making are the core features of an efficient POS system. (Li et al., 2019) designed a mobile POS system that enhances customer engagement and personalization in retail environments. The authors noted that user experience, interactive design, and mobile-friendliness are critical factors to take into account when designing a POS system for customer-facing environments.

(Zhang et al., 2020) proposed a convolutional neural network-based POS system that enables real-time processing of product images, enabling fast and accurate scanning of products. The authors noted that the integration of machine learning and computer vision technologies can significantly enhance the usability and efficiency of POS systems. (Zhang et al., 2020) developed a cloud-based POS system that uses blockchain technology to improve transaction security, transparency, and accountability. The authors noted that the use of blockchain technology in POS systems can mitigate the risk of data breaches and fraudulent activities.

Intelligent machines, and more broadly, intelligent systems, are becoming more prevalent in people's daily lives. Akazue et al., (2023) The flexibility and automation that a new point of sale system provides over manual processes is a key motivator for upgrading systems. A POS system is a means to collect and aggregate sales data automatically, which can then be used to produce a variety of sales reports including: daily reports with historical data, six-week history reports, top selling categories, top margin categories, top margin customers, top margin items, customer rank by sales, top selling items, and sales by time of day (Li et al., 2019).

Both employees and customers are benefactors of implementation as manual processes typically requires heavy time inputs during checkouts and an electronic system expedites these transactions. Electronic point of sale systems creates a major competitive advantage for shopping centres of any size. Customer inquiries can be handled much more quickly because “sales staff can locate stock on hand at any store location right from the POS terminal, and check the status of backorders, enabling [employees] to efficiently fulfil customer needs and move them through checkout quickly”. Without inventory counts provided by an electronic POS system, employees cannot easily provide information to customers about product availability. Physical inventory counting is expedited by using sales data to keep track of current inventory levels; employees and managers no longer need to spend the day wandering the sales floor counting every item (Kim et al., 2020).

3.0 Methods and Analysis

The development of software demands that the produced software meets the desired expectation, and customers' satisfaction, before marketing it for use and profit making Akazue et al., (2023). This section provides a detailed explanation of the design and implementation of the proposed Point of Sale system. The system aims to enhance efficiency and reduce waste in physical and human resources for retail businesses. The Method of study used in the system design is the waterfall method. Waterfall method or the so-called waterfall method is often called the classic life cycle (classic life cycle), in which it describes the systematic approach and also sequentially on software development. Design research is used for planning, drawing and sketching or set of elements - separate elements into a unit that is intact and functioning properly. The organisational structure of the research is shown in figure 1.

After analysing the requirements of the task, the next step is to scrutinize the problem and grasp its context. The primary objective in this phase is to analyse the existing system and fully understand the specifications and extent of the new system. Both activities are equally important, but the initial activity serves as a basis for establishing the functional specifications and ultimately completing the successful design of the proposed system. Comprehending the characteristics and novel framework, as well as the current system and innovative thinking, are crucial because a flawed comprehension can result in deviation from the answer. The primary objective of this chapter is to provide a comprehensive understanding of the analysis and requirements of the system, as well as to ascertain the operational characteristics of the system.

3.1 Types and sources of data

Data connotes everything we can manipulate Akazue et al., (2024) Clive et al., (2024). It can exist in structured and unstructured forms Akazue et al., (2024) Clive et al., (2024).The research is exploratory research, and approaches used include: Point of Sales, information systems, web, HTML, PHP, CSS, MySQL, XAMPP and QR Code. There are two (2) sources of data in this study:

- The primary data obtained through interviews with business owners and two employees in the store resignation related to the study and direct observation of the object to be studied.
- Secondary data, obtained indirectly from the object of research.

3.2 Input analysis and design

The input processes carried out mostly is from customer to the casher (cash register), is shown in figure 1 and figure 2.

3.2.1 Processing of the input pos data

The processing done here is working with the variety of product ordered for by the customer with the corresponding amount attached to it, this amount is summed up and a total amount is issued with a receipt to the customer

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Items	Description	Width	Data type
Food	Food menu available for the day	20	Character
Drinks	Drinks available for the day	20	Character
Snacks	Snacks available for that day	20	Character
Total	Total amount	12	Numeric
Receipt Num	Receipt ticket issued to customer	30	Character

Figure 1: Input Analysis and Desing I

Items	Width	Data type
Food	20	XXXXX
Drinks	20	XXXXX
Snacks	20	XXXXX
Total	12	99,9999.99
Receipt	30	XXXXXX

Figure 2: Input Analysis and Design II

3.3 Problems of the existing system

The main problem of the existing system is inventory doesn't match your tallies. Sales are going unrecorded. Staffs are spending far too much time chasing mistakes instead of attending to customers. These and other things suggest that it's time that your business did away with its cash registers and stepped up to a point-of-sale (POS) system.

3.4 Justification of the new system

The new system will store information with easy, allow easy retrieval of existing sales transactions, and can print information from any date and year as hard copy (i.e., on a paper) and also be able to suggest or recommend related items bought by a customer (Recommendation system).

3.5 The Proposed System and Specifications

3.5.1 Architecture of the proposed system

Point of Sale systems offer a wide selection of features to improve control of your business and save time spent on inventory, purchasing and accounting. A computerized point of sale system can drastically cut down on shrinkage, the inventory that disappears from your store or restaurant due to theft, wastage, and employee misuse.

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Since employees will know that inventory is being carefully tracked, internal shrinkage will dwindle. This chapter will explain the software aspect of the project, we will talk about the language use, data requirements, features of the language, flowchart.

3.5.2 Output specifications and design

The output specification can be viewed from the receipt issued after sales is shown in figure 3 .

Items	Description	Width	Data type
Food	Food menu available for the day	20	XXXXXX
Drinks	Drinks available for the day	20	XXXXXX
Snacks	Snacks available for that day	20	XXXXXX
Quantity	Quantity of each product bought	15	999
Total	Total amount	12	99,999.99
Receipt Num	Receipt ticket issued to customer	30	XXXXXXX

Figure 3: Output Specifications

3.5.3 Input Specification

The input specifications can be viewed from the system while orders are being placed. The input specification is shown in figure 4

Items	Description	Width	Data type
Food	Food menu available for the day	20	Character
Drinks	Drinks available for the day	20	Character
Snacks	Snacks available for that day	20	Character
Quantity	Quantity of each product bought	15	Numeric
Total	Total amount	12	Currency
Receipt Num	Receipt ticket issued to customer	30	Character

Figure 4: Input Specifications

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4. SYSTEM DESIGN AND ANALYSIS

4.1 File design

This face of the design illustrates the database used to store all data accepted and processed from the entry of the user. The file design is shown in figure 5.

Items	Description	Width	Data type
Food	Food menu available for the day	20	XXXXXX
Drinks	Drinks available for the day	20	XXXXXX
Snacks	Snacks available for that day	20	XXXXXX
Quantity	Quantity of each product bought	15	999
Total	Total amount	12	99,999.99
Receipt Num	Receipt ticket issued to customer	30	XXXXXXX

Figure 5: File Design

4.2 Analysis of existing system

4.2.1 Procedure chart

The diagram below traces how data moves through the system, from its sources to destinations. It displays data from a customer order to the point a transaction is completed. The procedure chart of the existing system is shown in figure 6.

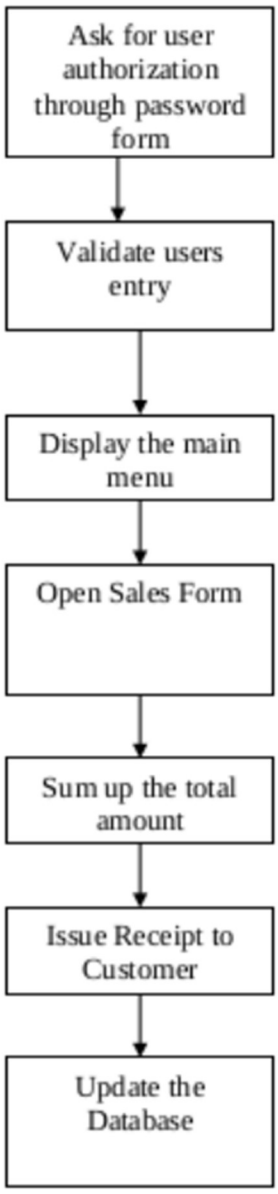

Figure 6: Procedure Chart of Existing System.

4.3 Flowchart research diagram of existing system

The flowchart research diagram of the existing system is shown in figure 7

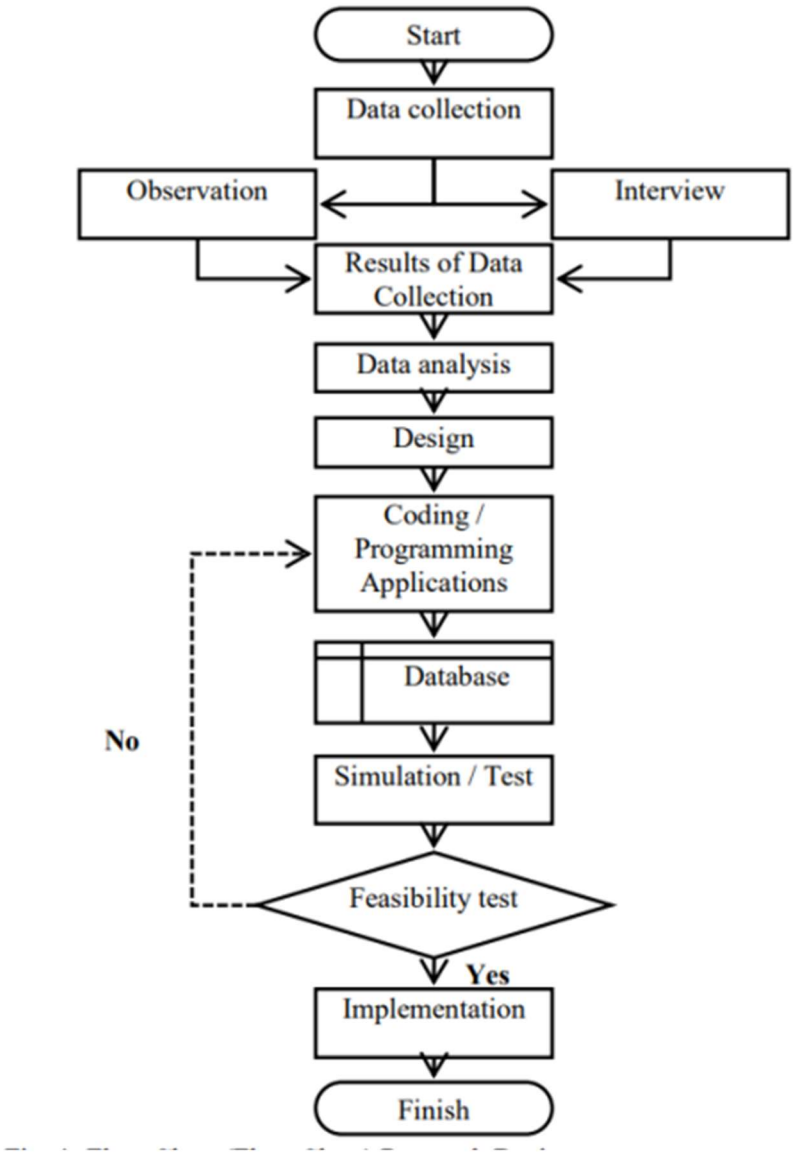

Figure 7: Flowchart Research Diagram of Existing System

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4.4 Analysis of proposed system

4.4.1 System flowchart

The system flowchart of the proposed system is shown in figure 8

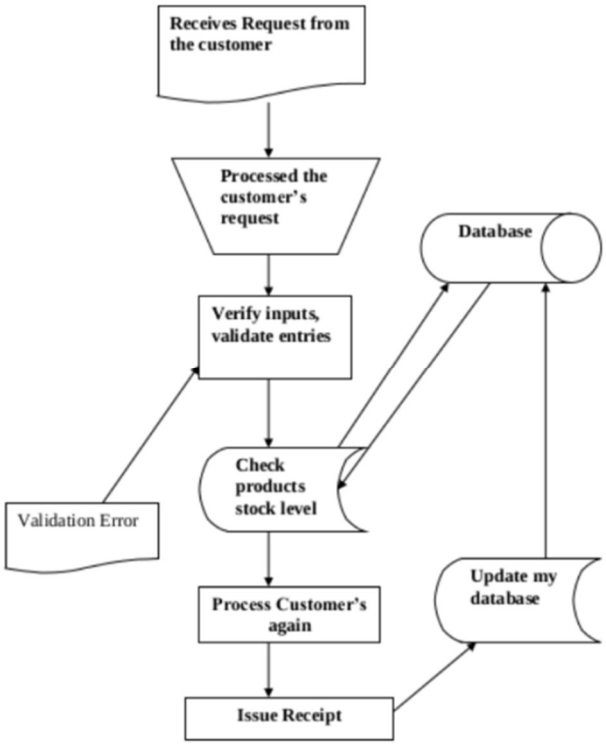

Figure 8: System Flowchart of Proposed Systems

4.4.2 Entity relationship diagram (erd)

The diagram of the entity relationship diagram of the proposed system is shown in figure 9.

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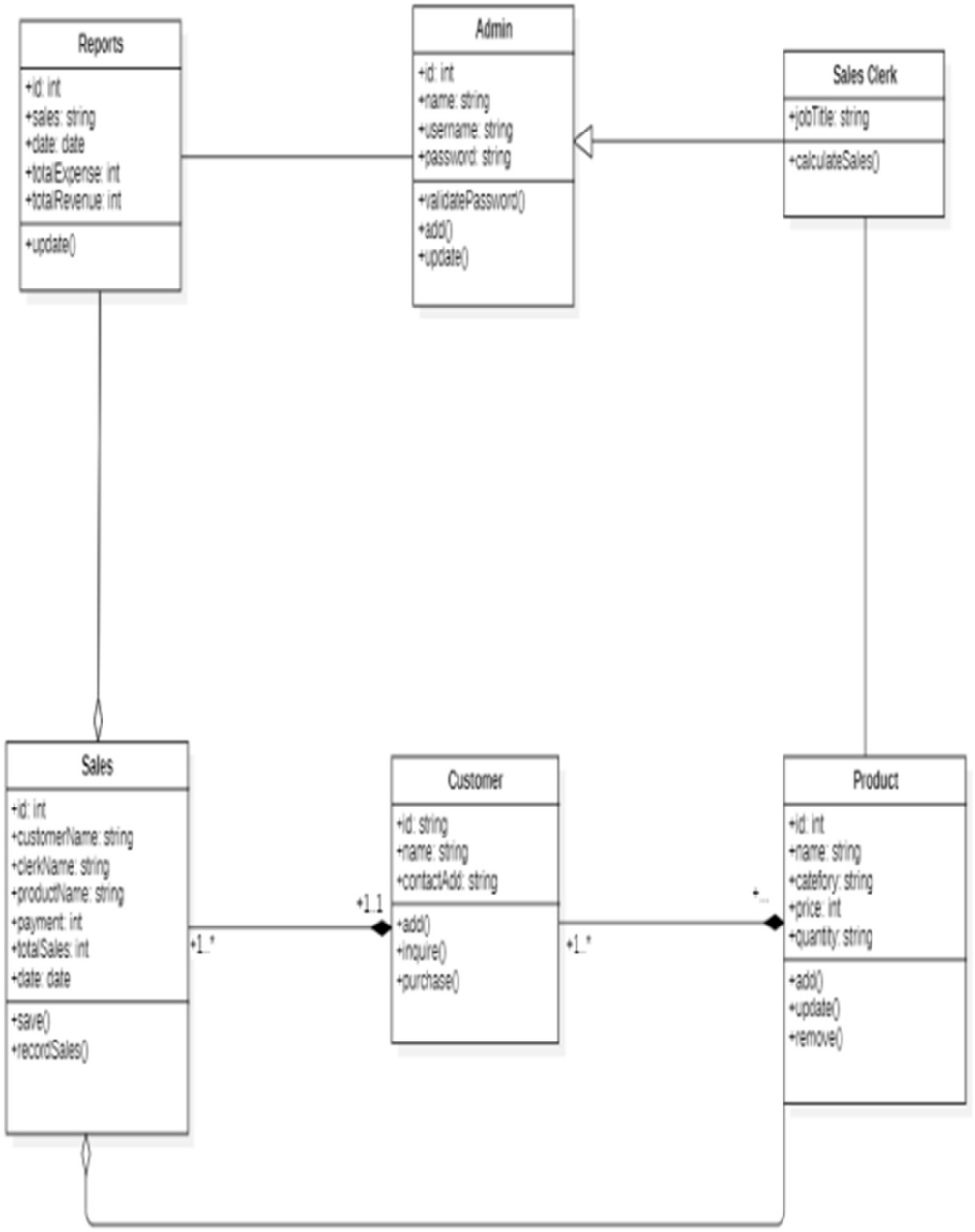

Figure 9: Entity Relationship Diagram of proposed system

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4. 5 Use case diagram

The diagram of the use case diagram of the proposed system is shown in figure 10

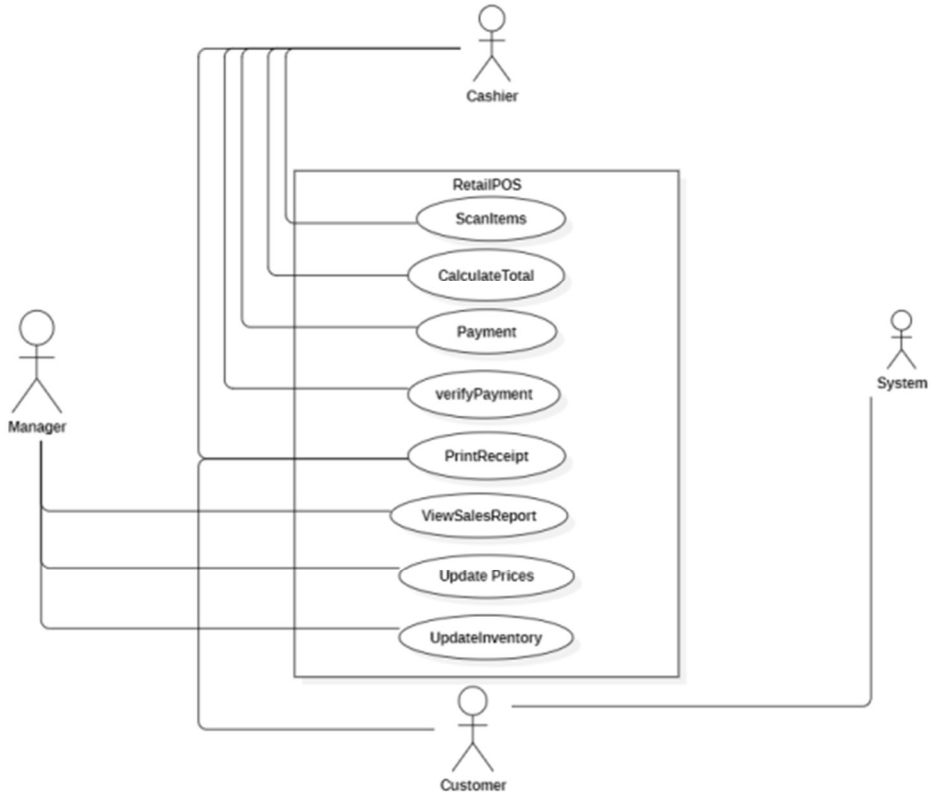

Figure 10: Use Case Diagram of the Proposed System

4.6 System requirements

The specifications for operating this point-of-sale system may not be familiar to individuals in the intended setting. Additionally, it encompasses both software and hardware factors.
The necessary hardware specifications encompass:

- A PC (personal computer) with 2GB minimum, 4GB recommended RAM and 250GB disk space
- Mouse
- CPU: Pentium 4 or higher
- Keyboard
- Printer; the choice is then left for the user to select the appropriate printer for a print operation or a heavier-duty receipt printer depending on the budget.
- A 1500v uninterrupted power supply (UPS)
- Cash drawer
- Barcode Scanner
- Label Printer

The software requirements include:
- Windows 11 OS or a more recent version
- Microsoft SQL Express Server 2022
- Microsoft Visual Studio 2023

4.7 Sample implementation

Data and storage are fundamental to any information system. Computers, unable to process data in forms like spoken words or handwritten documents, require data in a format suitable for conversion into their electronic, pulse-based system. This is accomplished through the use of input devices like keyboards, which translate data into a form comprehensible to machines. Additionally, computers generate output via monitors and printers, making the information accessible in human-readable formats.

5. SYSTEM INTERFACE

5.1 Input design

1. Admin Login Page

This page includes sections for entering the login information of the POS administrator, typically the store owner. It verifies the correctness of the admin's login credentials before granting access to the POS dashboard. The login interface is depicted in figure 11. Additionally, figure 12 illustrates the screen that appears if incorrect details are used to attempt access to the POS dashboard.

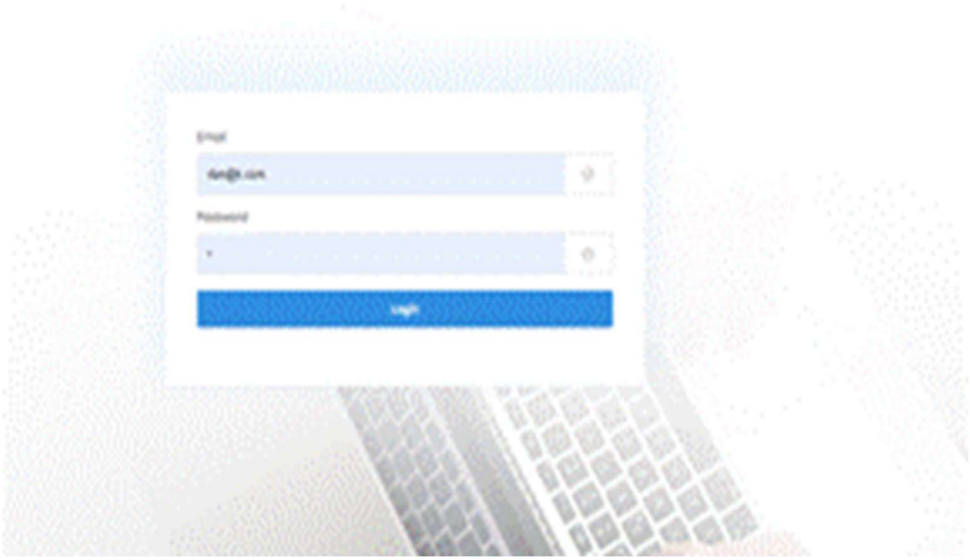

Figure 11 - Showing the Login Window.

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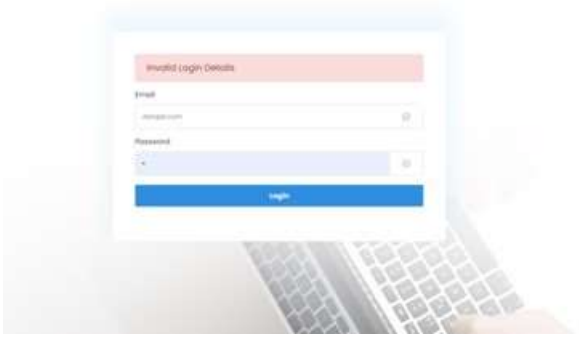

Figure 12 - After invalid access information is used to login

2. Add Products Page

This form enables administrators to add new products to the retail store, requiring information like product name, barcode, category, and price. The page for adding products is depicted in figure 13.

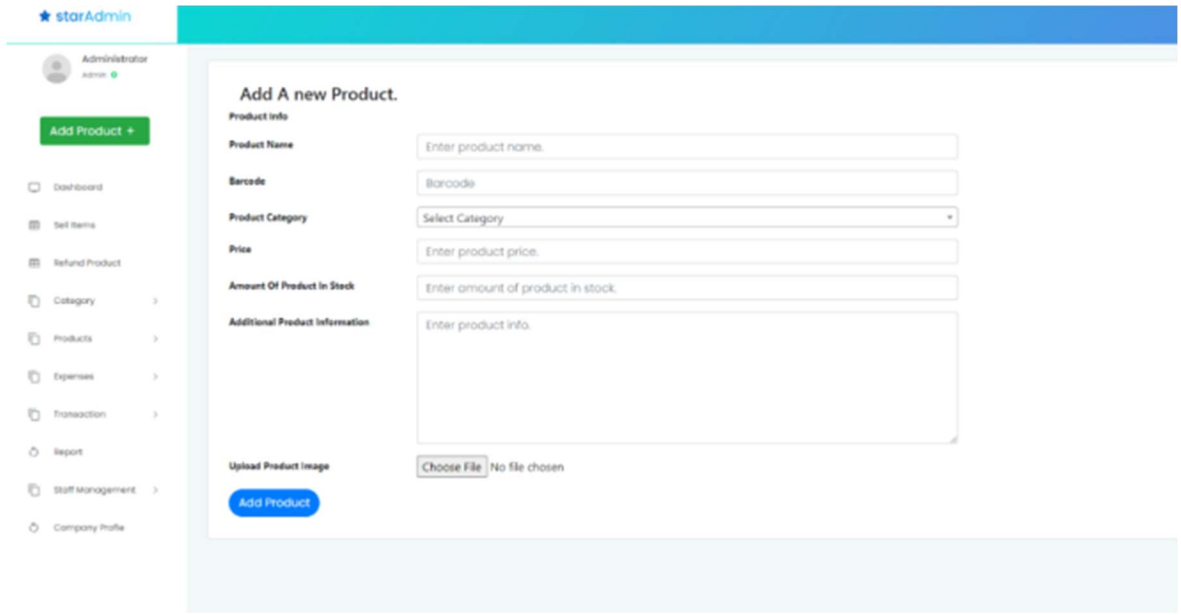

Figure 13 - Add new Products Page

3. Sell Items Page

This page allows sales staff to process customer purchases by scanning the items selected. Once scanned, details such as the product's price and name are displayed. The interface for selling items is illustrated in figure 14.

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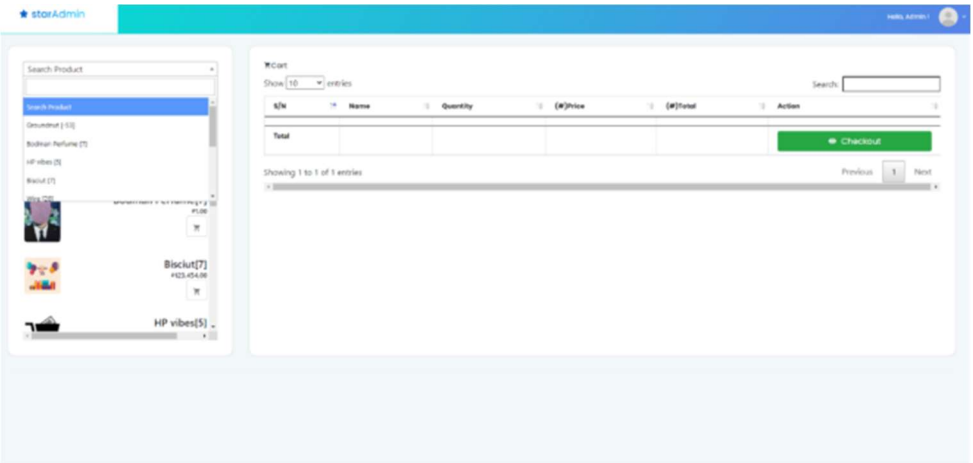

Figure 14 - Sell Items Page

4. Edit Company Profile Page

On this page, administrators have the opportunity to modify various company details. This feature is designed to be useful for any retail establishment. You can find essential information here, including the company's name, email address, physical address, and more. As depicted in Figure 15, you can see a visual representation of the edit company profile page.

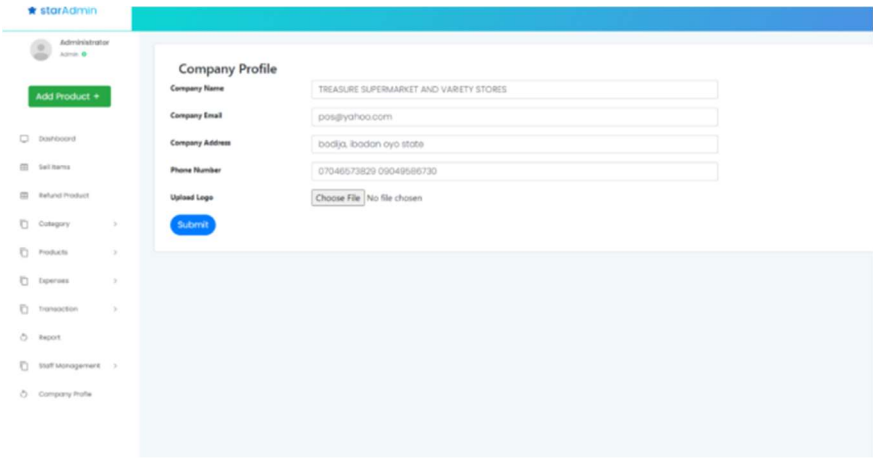

Figure 15 - Edit Company Profile

5. POS Dashboard

The dashboard of a Point of Sale (POS) system is a crucial component, functioning as the central hub for managing various aspects of sales and business operations. It contains data such as; add product, sell items, category, products, etc. A visual representation of the POS dashboard is shown in figure 16.

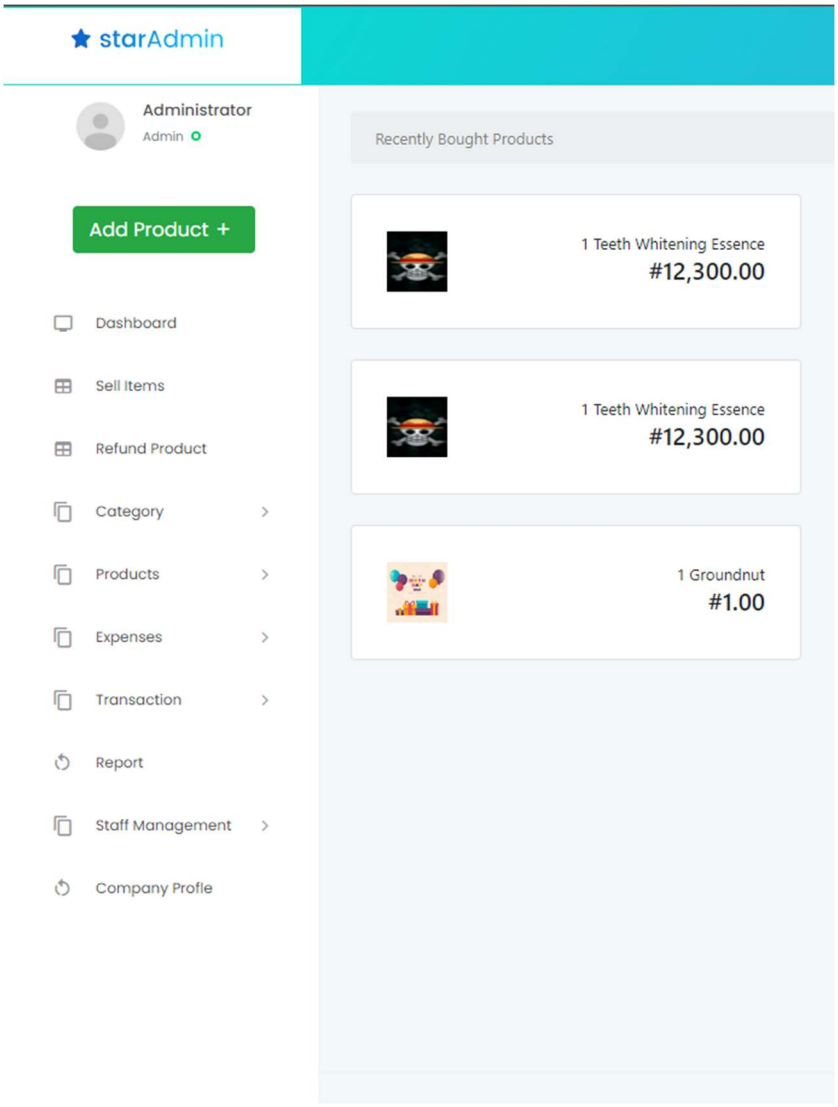

Figure 16 - The POS dashboard

6. View Products Page

This particular page displays the assortment of products accessible within the retail store. It not only presents the quantity of each product but also grants administrative authorities the capability to perform actions such as deletion, addition, or modification of the products. The view products page is shown in figure 17.

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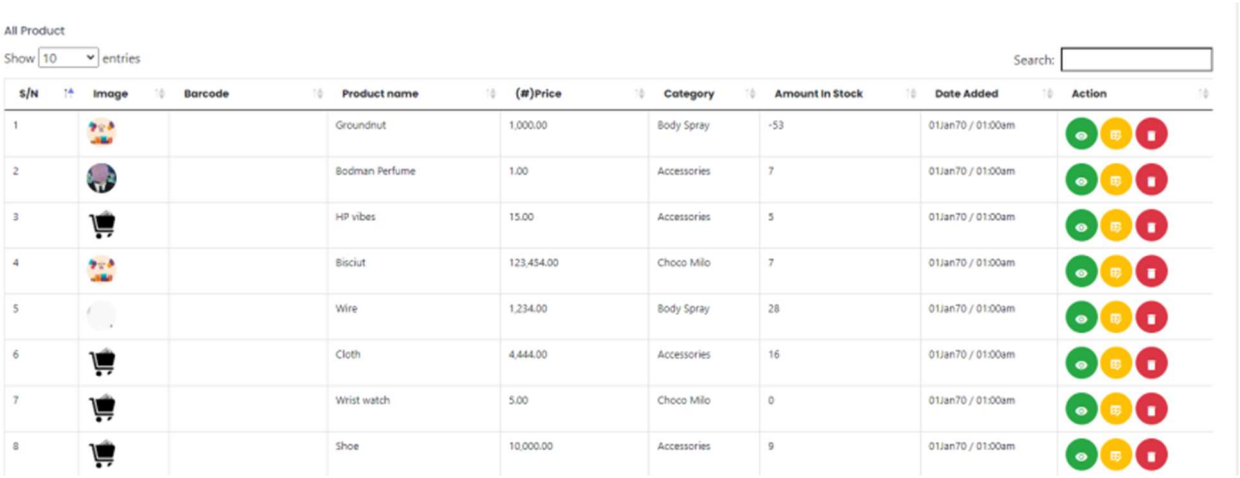

Figure 17: View Products Page

7. Transaction Page

This page provides a detailed overview of the transactions conducted by the retail store. Within this page, you'll find fields dedicated to various financial aspects, including giving money, receiving money, money given, and money received. You can get a visual representation of the transaction page, specifically focusing on the "money received" field, in Figure 18.

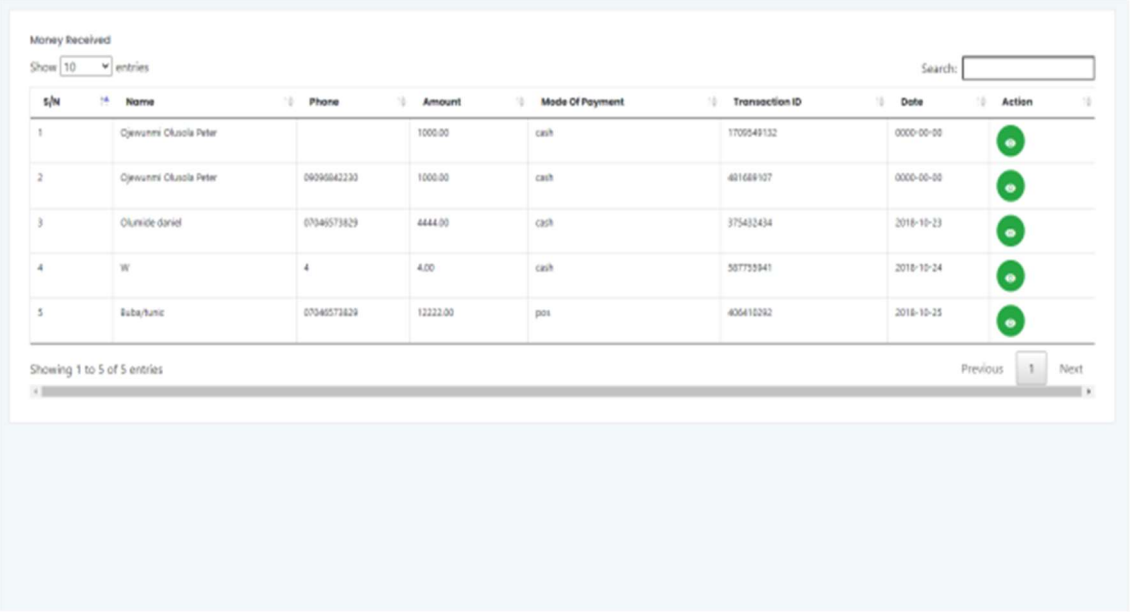

Figure 18: Money Received Field.

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5. 2 Output design

The design of the output is intricately linked to the inputs provided. The generated report offers valuable insights for the management team. The system's design resulted in the creation of the following reports.

1. Customer Receipt

This section pertains to the payment for items selected and purchased by the customer. It not only provides a comprehensive breakdown of the customer's order but also details the payment amount corresponding to the products chosen by the customer. You can visualize the customer receipt in Figure 19 for a clearer understanding.

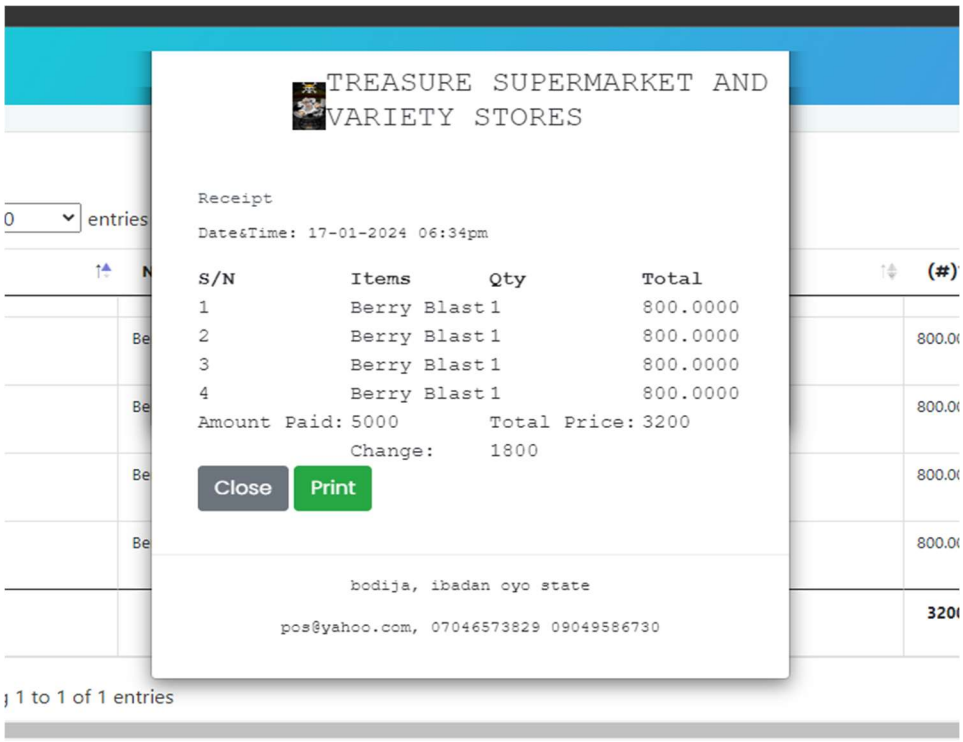

Figure 19: Customers Receipt

6. SYSTEM TESTING

This particular section is all about delving into the inspection and resolution of programs and the broader processes that aim to meet the system's requirements. System testing is executed on a fully integrated system to meet specific requirements. During this phase, there is a strong focus on scrutinizing the behaviour of the software design. It's also referred to as the investigative testing stage within the automated system development life cycle. Unit testing is the chosen approach within this system testing strategy.

6.1 Unit testing

Unit testing involves evaluating the entire system as a cohesive unit. This process assesses the interplay of numerous functions while containing the test within a single unit. In the context of unit testing, it encompasses three essential components: Test Data, Expected Data, and Actual Results.

7. CONCLUSION

In conclusion, this study has covered the entire process of designing and deploying an advanced Point of Sale (POS) system designed to improve efficiency and resource usage in retail organizations. The agile software development life cycle (SDLC), utilizing Scrum methodology, has evolved as a strong foundation for the methodical growth of the system through iterative and collaborative processes. The utilization of daily Scrum meetings, burn-down charts, and sprint planning facilitates the capacity to adjust and track progress in real-time, effectively capturing the ever-changing nature of the development process.

The backbone of the system was established through precise database architecture, implemented using SQL Server Management Studio, to ensure smooth interaction with the SQL infrastructure. The system's functionalities, which include inventory tracking and customer relationship management, were carefully integrated to automate essential business operations. Microsoft's C# and Visual Studio 2015 were employed to implement an object-oriented methodology, which improved the capacity to reuse code and simplified the process of designing user interfaces using Windows Presentation Foundation.

The dissertation's trajectory demonstrates a dedication to a user-focused methodology, as evidenced by the incorporation of Yoruba language assistance and Customer Relationship Management (CRM) functionalities. The proposed solution not only streamlines work but also enhances user and consumer experiences. The Scrum life cycle exemplifies a continuous process characterized by product demonstrations, testing, retrospectives, and better sprint planning.
This dissertation has explored the complexities of software development, demonstrating the integration of technology, methodology, and creativity in creating a groundbreaking POS system that has the potential to transform retail operations. The combination of requirements analysis, design thinking, and agile development approaches results in a concrete solution that offers improved efficiency for retail firms who use the suggested POS system.

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