ASHESI UNIVERSITY

BUILDING A POS TERMINAL AND AN ONLINE SHOP FOR

NATIVELAND GHANA

APPLIED PROJECT

B.Sc. Computer Science

Joseph Prince-Agbodjan

2021

ASHESI UNIVERSITY COLLEGE

BUILDING A POS TERMINAL AND AN ONLINE SHOP FOR

NATIVELAND GHANA

APPLIED PROJECT

Applied Project submitted to the Department of Computer Science, Ashesi

University College in partial fulfilment of the requirements for the award of
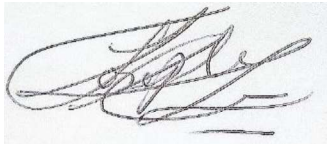
Bachelor of Science degree in Computer Science.

Joseph Prince - Agbodjan

2021

DECLARATION

I hereby declare that this Applied Project is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

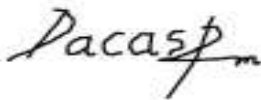Candidate's Signature:

Candidate's Name:

Joseph Edward Felix Prince-Agbodjan

Date:

Friday, 14 May 2021

I hereby declare that preparation and presentation of this [capstone type] were supervised in accordance with the guidelines on supervision of [capstone type] laid down by Ashesi University.

Supervisor's Signature:

Supervisor's Name:

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Date:

Friday, 14 May 2021

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Abstract

Information technology plays an increasingly important role in the management of complex retail operations. The modern world is integrating technology into different parts of business, educational system, healthcare and many more. Customer service and experience is key, and it is important that a business aims to provide high-end service to their customers. Nativeland is a small retail outlet that sells household and office products. However, they make use of the traditional manual method of inventory management and sales tracking, where all records and data are handwritten. My proposed solution to this problem is the Nativeland POS terminal. A custom-built point-of-sale system that will replace the traditional manual method of handling business operations, from inventory management to sales reporting.

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CHAPTER 1: Introduction

Information technology plays an increasingly important role in the management of complex retail operations [1]. Market knowledge, as well as control of data and information, is key to obtaining a competitive advantage in the retail sector [2]. Currently, there are a lot of small-scale retail businesses that are operating while keeping manual records of their good for sale. It is important to be able to have some system in place that is functional and reliable for the business to use and rely on when making sales or taking record of their inventory and make monthly finance statements.

1.1 Background Information

Nativeland is a small Ashfoam retail business outlet that has been operating in Adabraka for roughly about one year now. Currently, they only sell furniture and some few household accessories and hope to expand to sell some other household product to their customers. The business is owned and operated by Mrs Prince-Agbodjan and due to the fact that it is a start-up venture their methods of operation are all manually done by employees.

Products and services offered at Nativeland are all based on customer preference. Noting that this is currently a small retail outlet it is more difficult to have a lot of products in the display room on a regular basis. Thus, only products that are purchased or ordered more often are given priority to and get displayed to walk in customers. It is important to make as many sales as possible at this stage to give Nativeland leverage to expand the showroom and provide more products.

Nativeland as mentioned earlier is a sub-outlet for a bigger manufacturing company, Ashfoam. The aim of the retail store is to give some customers access to some of the products that Ashfoam produces but are unable to visit the main showroom at Industrial Area, Accra. Nativeland provides delivery services, but due to how small their outlet is right now, they only have one vehicle available for deliveries. Therefore, they have restricted all deliveries to areas within Accra. As I mentioned earlier, Nativeland is still in the start-up phase, therefore all business operations are manually done by the administrator and the employees, so the only available methods of payment are physical cash and mobile money.

1.2 Project Aims and Objectives

The main aim of my capstone project is to be able to design a robust POS system that allows Nativeland to keep track of stock and make sales, and to provide weekly, monthly, and yearly reports on how sales are doing and when stock is reducing. Some other objectives for this project are as follows:

- Perform a full in-depth requirement analysis with the client

- Determine the effect of switching from manual to digital records

- Model a high-fidelity prototype of the system for Nativeland to test for a period of 1 week prior to the full system deployment.

1.3 Expected Outcome of Project

It is expected that after the entire process is done, right from data/requirement collection up until the final design of the software application, the system can be used in the daily operations of the retail store (Nativeland).

1.4 Significance of Project

The purpose of this project is to make the tracking and keeping of information more accessible and reliable for Nativeland. At the end of this project, I aim to build a secure and reliable application that will be able to run smoothly on their computer system. To enable Nativeland to reach a wider market, there will be consideration of prospects for a web application.

In addition to being able to design a system that will be a POS terminal for Nativeland, I also intend to explore whether a technological upgrade in sales operations can give Nativeland a competitive advantage in its market. I understand that using technology can help automate some processes, which means sales can be faster and more reliable [6]. But to be able to make a distinguishing advantage on the market with respect to customer satisfaction, the business will need to automate some process so that they have time to focus on others.

1.5 Research Methodology

Data for this project will mainly be obtained from primary and secondary sources. Primary sources will consist of physical interviews with the client Mrs. Prince-Agbodjan. Secondary

sources will be from academic journal and articles that will outline some research into related works as well as some appropriate methods to go about the design of the solution.

1.6 Literature Review / Related Work

An online-purchasing and support system for retail chain stores

[3] is looking into how to integrate online purchasing with an inventory management system for a chain of retail stores. This integration will aid in the decision making with regards to online distribution and sales. The application that was built uses a distributed database system that solely stores information that is relevant to customer satisfaction, products transaction, and manufacturing at different geographic locations. The system, moreover, is strategically designed to facilitate the management process between the Headquarters and the POS outlet. It does this by providing top-level management the information necessary to make the right business decisions with respects to the right product to distribute at the right location at the right time, and also for designated POS outlets to deliver products ordered by home users. I believe this work can contribute to my project because of the learning algorithm patterns designed into the systems. Not only does it help the company keep inventory and make sales but also learn what products make the most sales to help them manage distribution.

POS terminal and POS system using a mobile terminal

The general functions of POS terminal, i.e., barcode scanners, NFC (Near Field Communication), signing, (RFiD) Infra-Red Readers and many more, can be performed all from one central point based on the functionality given to that mobile terminal in order to provide optimum sales [4]. This paper explores this hypothesis, which is that how can all the

functionalities of a standard POS terminal be combined into one mobile terminal that can operate at optimal output. Management of sales information, ordering and payment can all be done irrespective of location, thereby maximizing user convenience. The basis of this research is that mobilizing all payment and product management system can make business more lucrative, because it allows more operations to be carried out from different geographic location and to bring convenience to the customer.

Point of Sale system and method for retail stores

[5] focuses more on the interaction between a customer and a point of sale (POS) system. The case study was conducted to see how customers respond to a self-service POS meaning that the system is operated by the customer and not a shop clerk. The system is designed to be simple and easy to use and understand. The paper explores some research question on the feasibility of the idea and how some customers responded to the proposition of implementing the system in supermarkets across the United States. Currently this is not exactly related to my research scope, but on wider scope where a better POS system is being implemented on a national scale, this technology is a great idea to implement.

Big data-driven service level analysis for a retail store

The discussion in [7] may be a bit advanced with regard to the topic or problem my capstone wishes to solve. However, I believe that there are some concepts here that can be reflected in the process of my capstone development. The paper talks about using simulation technology, a big data service-level driven analysis of retail stores. The idea here is to select a random number of customers on a certain business day, then tabulate their purchases and clerk schedules using a simple excel sheet. Finally, you simulate a model to analyse the customer

service level based on the selected data and the inputted clerk schedules. The basic idea here is to watch the trend of customers coming to the shop and the service being provided. This can also be applied within my project but from a different angle. Using models to simulate what products are mostly patronized by customer, with respect to taste, price, season, and some other factors.

A mobile retail POS: Design and implementation

[8] explores the development of simple yet robust mobile POS (Point of Sale) System. I found this paper interesting to include in my research because the authors explain that the main goal of the development of this Point-of-Sale system was to design an easy-to-use and understand User Interface and allow for improvements to be made based on the needs and requirement of the business owner. They were of the opinion initially that this can only be accomplished by creating a web-based POS, which follows the norms of all other POS systems [1]. However, they proceed to mention that the only limitation they will experience is internet connectivity. Experiencing a power outage or hardware failure has no direct negative effect on the system due to the fact that it is virtual. They finally conclude that building a web POS is more beneficial because it is much easier to improve the User Experience and businesses that have to interact with clients on-the-go will be able to easily access the web platform. This research aims to satisfy data availability, data security and data reliability. Building the system virtually to not store information locally but to a secure cloud server will make it accessible and safe as compared to locally.

Inventory control and POS system and method

[9] also describes another point-of-sale system and method. The system and method allow the consumer to make a purchase within a retail store and at the same time remove the purchased item from the retail area without causing any of the alarms to trigger. All these functionalities working in Realtime, the system identifies the customer and the product being purchased, then validates the purchase. When the item is confirmed, and the product is validated the system then makes the deduction / transaction to the consumer's account. However, this is optional, but if the system is used by the consumers, there is a convenience charge to the consumer. This system was to allow customers make small simple purchases and avoid the waiting for the availability of a salesperson or a human cashier. Like some other works I cite in this research, this system blends both a cahier operated terminal and a consumer operated terminal to allow for business to be more lucrative and less clustered line at the payment booths. This paper is relevant to my research because it also highlights the need for technology to ease the stress on business when there are a lot of customers patronizing their stores.

1.7 Project Scope

This project will primarily focus on the design and implementation of a robust POS terminal in Mrs. Prince-Agbodjan's retail shop, Nativeland. The second phase will focus on the beta testing I will be performing in the shop over a period of time to get feedback for future improvements.

CHAPTER 2: Requirement Analysis Plan

2.1 Overview

This chapter describes the scope of this capstone project, the functionalities of the application being built and the users of the application. The project aims to develop a stand-alone application that allows the user to keep record and track items that are on sale and in stock. The user will also be able to perform sales analysis on products and observe the preferences of customers. The requirement analysis will be done with a simple interview, and a private orientation session with Nativeland Administrator, Mrs Prince – Agbodjan and the employees. Also, some field research to survey their current situation with regards to available hardware will be considered. Data of inventory and products being sold will be collected, inputted, and stored in the database, and can be retrieved when the user searches for a particular item.

2.2 Requirement Gathering

In gathering the requirements of the application, an interview was used. This is because the business currently is on a small-scale and is a retail outlet with the owner and two employees. Therefore, using a questionnaire did not seem appropriate. Some external information was also collected regarding the business's Internet Service Provider (MTN), customers and other shopping POS terminals. The aim of this interview and requirement gathering was to aid in the answering of the following questions:

- How easy is it to take new stock manually?

- Are there ever any errors in the input when manually taking stock?

- How do you view your past sales to tell customer preferences?

- How often do you balance your sales?

- What mode of payment is preferred by customers?

- Do you create reports of sales to submit to your suppliers?

- Do people prefer to have their items delivered or personally picked?

- Are people satisfied with current condition of manually issuing sales?

- Will you prefer an easier method that is, to keep track of your data digitally to help boost and sales and reduce data inconsistencies?

2.3 Requirement Analysis

This section highlights the functionalities of the application after analysing the requirements from the data gathered in the previous stage. The aim of requirement analysis is a process designed to help determine the needs and the expectation of the product being developed [11].

2.3.1 Core Features for User App:

- Authenticate a user

- Search for a product

- Inventory management

- Process a product for purchase

- Generate reports

2.3.2 Non-Functional Requirements

- Security

This is an application that will serve as a Point-of-Sale Terminal (POS), to a small-scale retail shop. The shop is responsible for selling products from a supplier to earn profit. Therefore, it is important that all information is made secure. Any user without authorized credentials will not be able to open the application or view any data. Also, it is important to keep a log of sales on the system by authorized users of the application to ensure that none of these users will cause or make any suspicious act like theft. There are some applications available that can help with mitigating security risks, an example is Regin. Regin is a fairly new language runtime that help prevent some security vulnerabilities, such as SQL injections, cross – site scripting to inadvertent password disclosure and missing access control checks [10]. This will be especially useful during the implementation of the web application in the future.

- Reliability

The shop clerk and owner should be able to trust the authenticity of the data always entered into the application. They should also be able to trust the data that the queries retrieve for them.

- Performance

The application should work as efficiently as possible without taking too much time or wasting too much space. Simple queries will be used to communicate directly with the database, so that time to return results is minimized.

- Availability

The app must be available to be always utilized by the user (shop clerk) with rarely any system downtimes. It should be able to handle business rush sales and allow the clerk to process purchases for a vast number of customers at a time without crashing or delaying.

CHAPTER 3: Architecture and Design

3.1 Introduction

This chapter describes the design and the architecture to be used in the implementation of the computer application for Nativeland retail furniture store.

The architecture used in this design and implementation of the application is the one – tier architecture. The one – tier architecture is a type of architecture that involves putting all or most of the required components for the software application or technology being designed on a single server or platform. Fundamentally, the one – tier architecture keeps all the elements of a software application, including the interface, middleware, and back-end data in one place. The logic, data and processing are all done on the server or host computer that the application is sitting on.

The server device contains all the necessary resources needed in the running and managing of the application. All requests for data or storing of data are all processed on the same device and the resources are utilized on the same device. As stated in earlier chapters this project will be built as a stand-alone application with Java. The server resource that will be included to help with the building, manipulation, and management of the database will be Java Database Connectivity (JDBC). JDBC is an application programming interface (API) for the Java programming language, which shows how the client can access a database.

For the application, the client will also be the same as the host computer where the application will be installed and run with the database. The JDBC is also a Java-based data access technology used for Java connectivity.
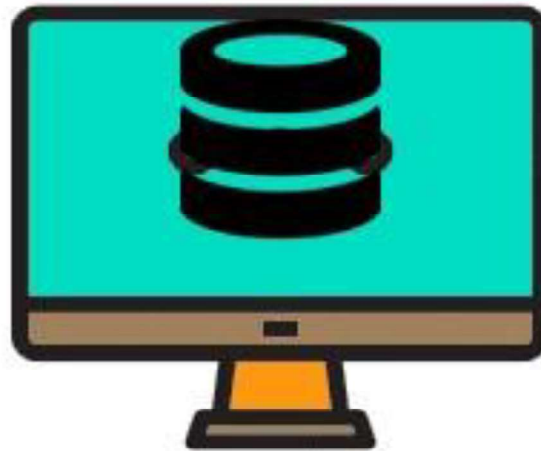
Figure 3.1: Single tier architecture

Figure 3.1 is a simple illustration of the one/single – tier architecture. As we can observe from Figure 3.1, there is very little connections between other units or components to form the entire platform. All the hardware and software components are all on one device.

3.2 Presentation Layer

The presentation layer is responsible for what appears to the user and what they interact with on the software application. It is the layer that presents the simplest way for easy interaction between the user and the software application. Given that the application is currently set to run on a computer, it will not be able to run on any other platform such as a mobile phone.

3.3 Application Processing Layers and Data Management

This layer solely deals with the data from the user that is to be processed and the functions the application will provide to the user. It also deals with the data the different users will be able to view based on their credentials into the system, the data they can interact with and the responses to the requests and queries they will make to the database.

Given that this is a one – tier architecture, the queries are made and processed on the same host computer. With the addition of the JDBC, it will allow for the processing and communication of the application with the database.

3.4 Database Layer

The last layer of the architecture which is the database layer. This layer, however, is the key and most important layer of the entire architecture simply because the business wants their system to keep track of all operations and products. The script for this layer will be written in Structured Query Language (SQL).

The details that will be stored in the database will also include details of the retail shop's supplier (Ashfoam), the products they are supplied with and the stock and new requests.

3.5 User Interface Requirements

For this application, the interface is built on a principle of efficiency, simplicity, and beauty. There is only one application being built. However, as a security and functionality measure, the interface requires user authentication before it can be used. There is the

authentication for the clerk, that only gives access to the POS part of the system where they make sales. There is also an administrator authentication that accesses additional functionality like stock keeping, report and profit generation and analysis.

3.6 User Classes and Characteristics

This app is to help users' easily make sales and track products that are stocked and sold. It is also to help make reports of sales and learn from customer preferences. Lastly, it is to generate sales reports to be able to see profits over a specified period.

3.6.1 Use Case Scenarios

3.6.1.1 A user who wants to make a sale to a customer

Figure 3.2: *Use case diagram*
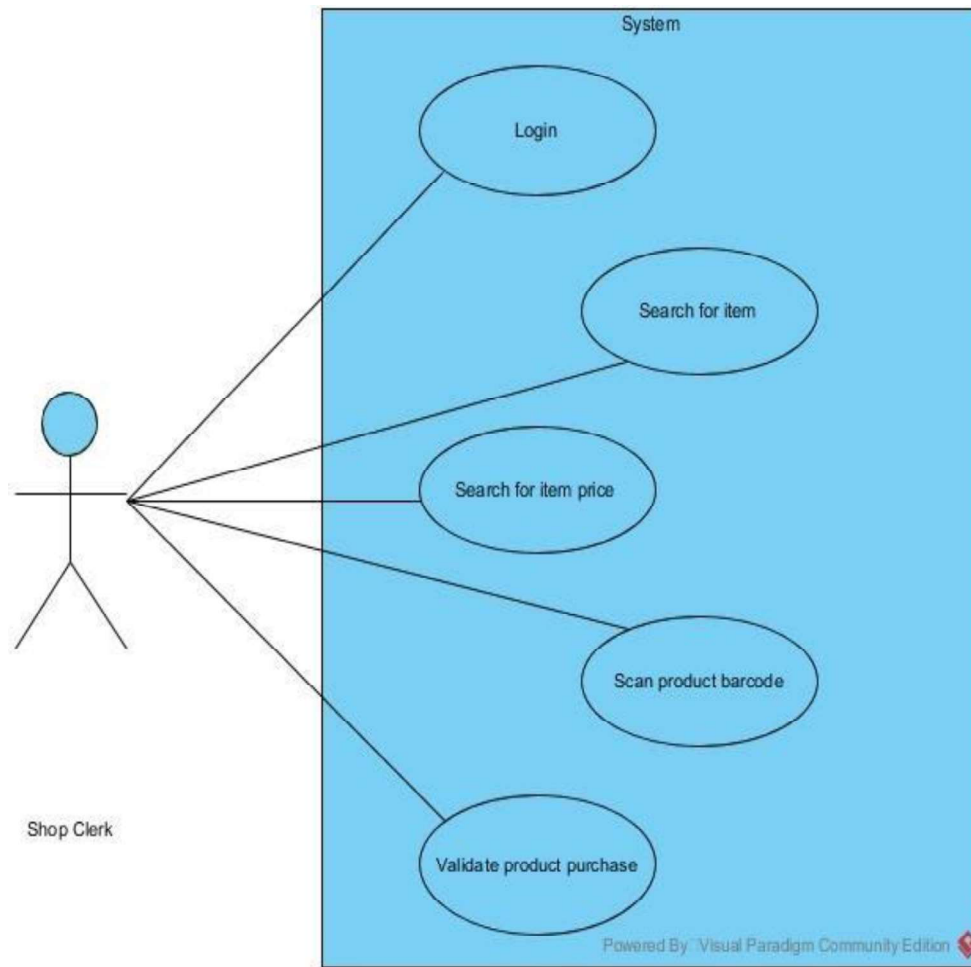
Figure 3.2 is a use case diagram of how the shop clerk / cashier will interact with the system. There is very little functionality they have access to satisfy the requirement of security and data accuracy. We can observe that the core functions that the shop clerk has access to are, logging into the system, searching for an item when a customer wished to buy a product, scan

a product barcode to search for the product and validating a customer's purchase. A case scenario of how this entire interaction process works from start is as followed.

A mother wants to purchase some bed frames, mattress, and pillows for her children as they are moving into a new home. On her last visit to the shop, she was having some difficulty with the customer care because the clerk was not sure of some of the prices and had to consistently call the owner to confirm the prices. She does not like shopping online because of the uncertainty that comes with the product, such as quality and size, so she prefers to do her furniture shopping physically. During her physical visit to the store, she can ask the shop clerk for the prices and he is able to verify from the system the correct prices and to tell the customer. Immediately she can make a decision on the products she wishes to purchase. She heads over to the counter for her items to be scanned and billed. Within a few minutes she walks out of the store satisfied with the speed of service and the quality of the products she paid for.

3.6.1.2 A user who want to take stock and generate reports

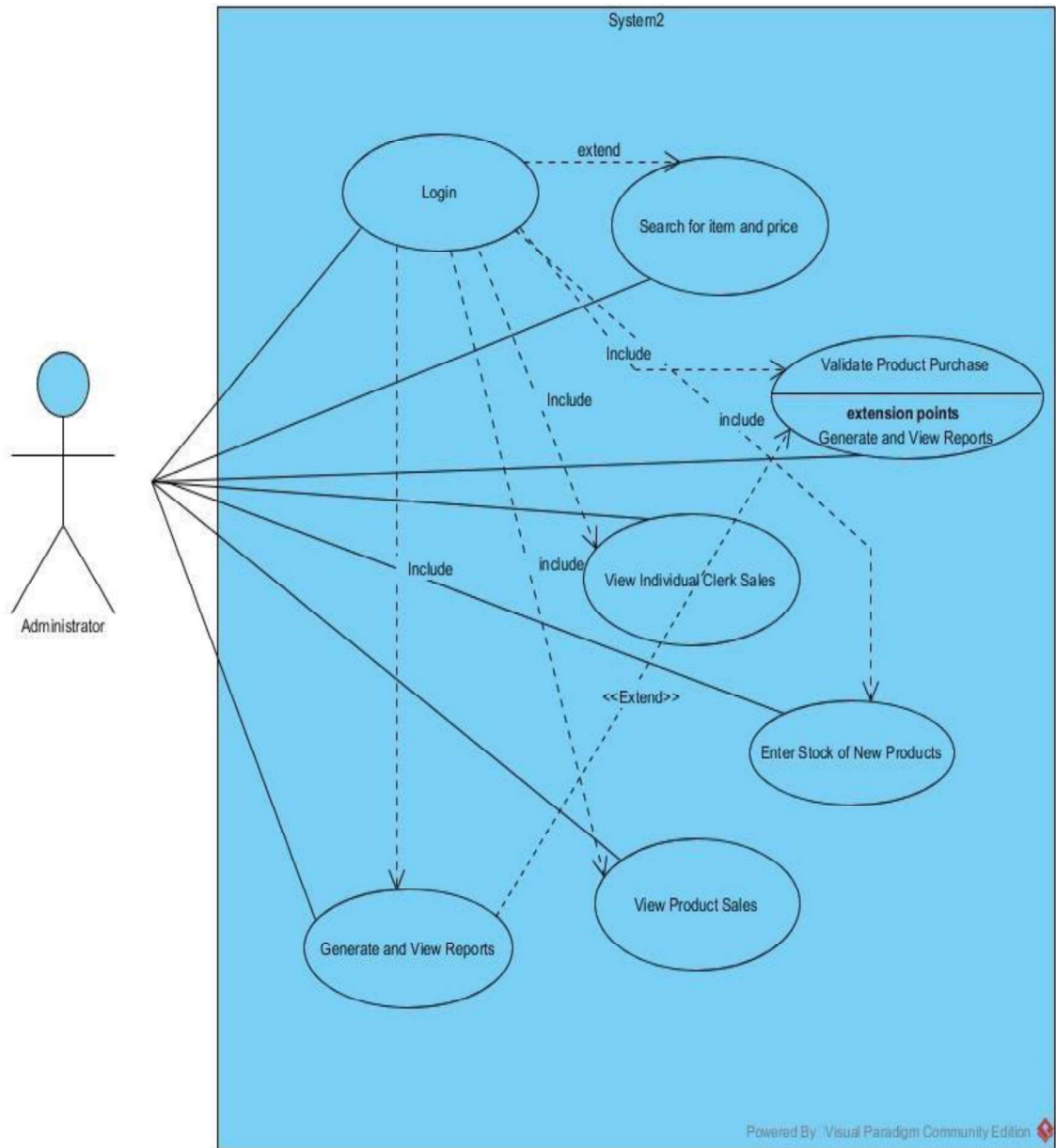***Figure 3.3:*** *Use case diagram*

Figure 3.3 is a use case diagram of how the administrator interacts with the system. This user is the administrator and has full access to all functionalities of the entire system. This user is the owner of the retail business and will have the control of the system. There are multiple functionalities that are included that a clerk user cannot use. The shop owner logs

into the system and is also able to view the POS interface of the system. There is also the interface to view sales made in the shop over a given period. Also, information about which clerk made a particular sale will be available to view. Then, there is the option to generate reports based on the period chosen by the administrator. These reports can help the administrator see how much they have made and perform their calculation for their profit and the amount they need to re-invest into the business. Lastly, the administrator alone can take stock. This is to help limit the chance of data inaccuracy that could result from giving every user access to inventory.

3.7 Database Design

This section provides a simple description and design on the final database system to be designed for Nativeland.

3.7.1 Database Description

USERS	Sales
• userID	• saleNo
• Name	• prodID
• Email	• Price
• Phone Number	• Date
	• Time
	• userID

Products
- prodID
- Name
- Category
- Price
- Quantity
- Status
- suppID

Suppliers
- suppID
- Name

KEYS
- Primary Key
- Foreign Key
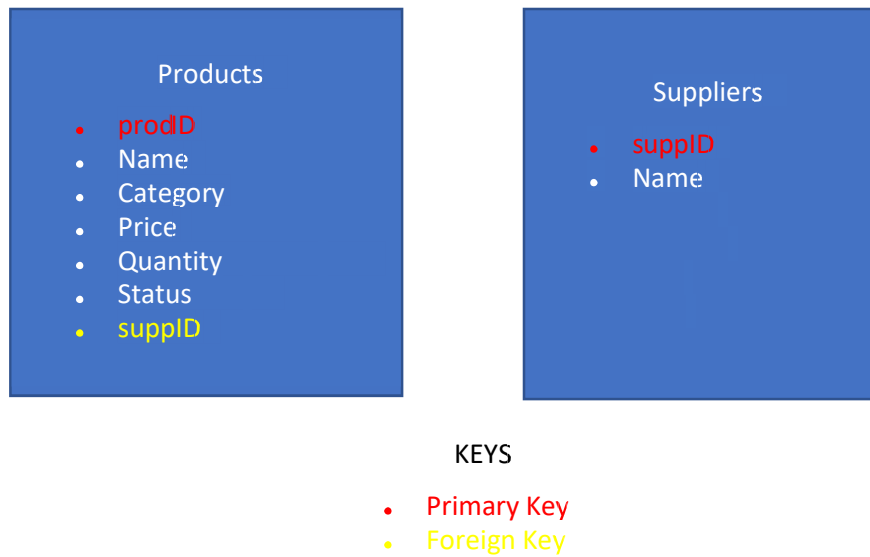
Figure 3.4: Database Design

From Figure 3.4, which show the database design with the necessary keys, we can observe that the structure is not too large. The two largest table are the product table, which is mainly for inventory management, and the sales table, which will help with the report generating. There is a relationship that exist between some tables such as:

- One supplier can supply many products

- Many products can be supplied by one supplier

- One sale can have many products

- One user can make may sales

- Many sales can be made by one user

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3.8 Database Dictionary

This section takes the database design step a bit further. Table 3.1 provide a more detailed breakdown of what each table columns data type will be, how the data will be stored and a brief description of what the individual data field represent. The column labelled "Allow Nulls"; means that will that data field allow for no data to be entered when information is being stored. Majority of the field will say 'No' because almost all these fields are important in making the system fully functional.

Table 3.1: Database Outline

TABLE NAME	FIELD NAME	DATA TYPE	ALLOW NULLS	FIELDS DESCRIPTION
USERS	userID	Numeric	NO	This is the unique ID given to every user of the system.
	Name	Text	NO	The user must also provide their name
	Username	Text	NO	This is the name the user can use to login to the system
	Password	Text	NO	This is the password the user can use to login to their account

	Email	Text	YES	Option to provide email address
	Phone Number	Numeric	NO	The user must enter their phone number, so that they can be contacted.
PRODUCTS	prodID	Numeric	NO	This is a unique ID given to every product.
	Name	Text	NO	This is the name of the product
	Category	Dropdown	NO	Product type can be - Bedroom furniture - Kitchen furniture - Bathroom - Living room - Dining room - Garden - Office
	Price	Float	NO	This is the selling price of the product

	Quantity	Numeric	NO	This is the quantity of the product that the business has in immediate stock
	Barcode	Text	NO	This is the alphanumeric data that is read from scanning the barcode tag on the product
	Status	Text	NO	This will show whether a product is available or not
	suppID	Numeric	NO	The unique ID for the supplier
	Date	Date	NO	The date the products were supplied
	Time	Time	NO	The time the products were supplied
SUPPLIERS	suppID	Numeric	NO	The unique ID for the supplier
	suppName	Text	NO	The name of the supplier of the product
CATEGORIES	catID	Numeric	NO	This is an ID for the unique categories

	Name	Text	NO	This is the name of the category to which a product belongs
SALES	saleNo	Numeric	NO	Unique ID for to represent the sales number.
	prodID	Numeric	NO	ID of the product that is sold
	prodName	Text	NO	Name of the product that is sold
	Category	Text	NO	Category of the product that is sold
	Price	Float	NO	The price of the sold product
	Date	Date	NO	The date the product was sold
	Time	Time	NO	The time the product was sold
	userID	Numeric	NO	The ID of the user that sold the product
	Cashier	Text	NO	Name of cashier that sold the product

CHAPTER 4: Implementation

4.1 Implementation Structure

The purpose of this chapter is outlining the necessary implementation needed to build this POS application for my client. The scope of the requirement spans from hardware to software and some basic technology skills and knowledge.

4.2 Application Overview

The system to be implemented will be a stand-alone system that enables my client and her employees at Nativeland to have access to sales, inventory management and reporting system. Sales attendants are then given accounts managed by the administrator to deliver POS services to walk in customers.

The system also has the functionality to allow sales attendants to search for store items from the database and inform customers of their prices and availability. The system comes with the following interfaces.

1. An administrative portal for overall management and record keeping

2. An administrative screen to add and remove users from the system

3. A basic user view for sales processing and inventory management

4. A payment screen to display the customers purchase total and their difference

5. A sales report generator to display periodic sales report on products

4.3 Hardware and Software Requirements

To enable the use of this application, in the case of the administrator who will be managing the entire system and viewing reports, and the cashier who will be searching for items that a customer would like to buy and process the product to be sold, they will need to have a computer system with internet access. The computer system will need to have an OS installed, preferably Windows with internet connectivity. The POS application is built primarily with JAVA for both frontend and backend, and MySQL for the database.

The frontend portal will be built primarily with JAVA and alongside the computer system running a windows operating system, it is necessary for some version of Java Runtime Environment (JRE) to be installed to help run the application better. The aesthetics of the system are built with JavaFX libraries which are all integrated directly into the system and do not require any internet connection to view the system frontend with the programmed aesthetics.

The server side is built with MySQL in phpMyAdmin. The computer hardware will need to run a Windows or MAC operating system. Since the database will not be hosted locally on the client's computer but rather on an online hosting platform, it is important that the store has internet access and a working internet browser installed on the computer.

Lastly, the application is not a processor intensive program. Therefore, it does not require a high-end laptop or computer to execute. However, given the circumstance that it is a sales business and the service provided needs to be quick and responsive, it would be a much better situation to have a base hardware and software requirement for using the POS application. For the hardware requirement, a computer with a Core i5, 7th Gen processor and

above will be appropriate. Then, for the software requirement, as mentioned earlier, there needs to be a Windows or Mac operating system installed, a java runtime environment, and some java development kits added to the program files.

4.5 Administrative / User Portal

The application interface varies for various purposed. Currently the most important functionalities of the system are the login profiles for the users, the inventory management, and the sales reporting interface.

When the application is first run, the user is shown the login screen, Figure 4.1, for them to enter their valid credentials.
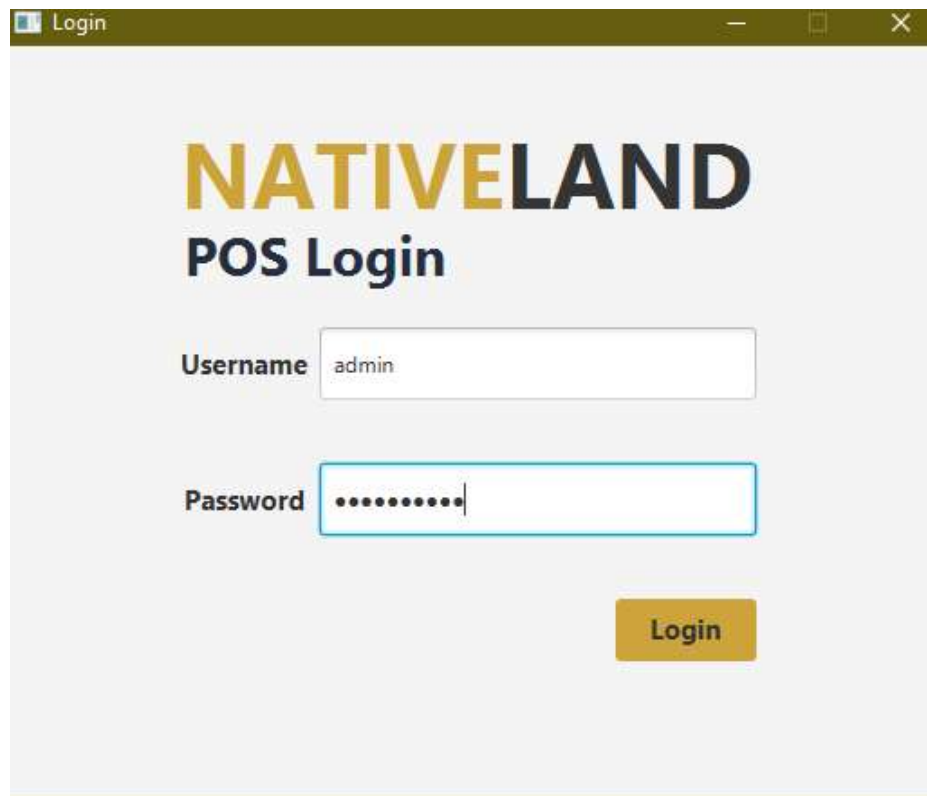

Fig 4.1: POS Login Screen

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There is some additional functionality for error checking and user security. There are popup windows included to alert the user when they have entered an invalid username or password. Also, to satisfy the security requirement, there is a functionality to timeout the application when a user credential is entered wrongly after 10 attempts.

Figure 4.2 shows the application dashboard from where all the other functionalities can be accessed.
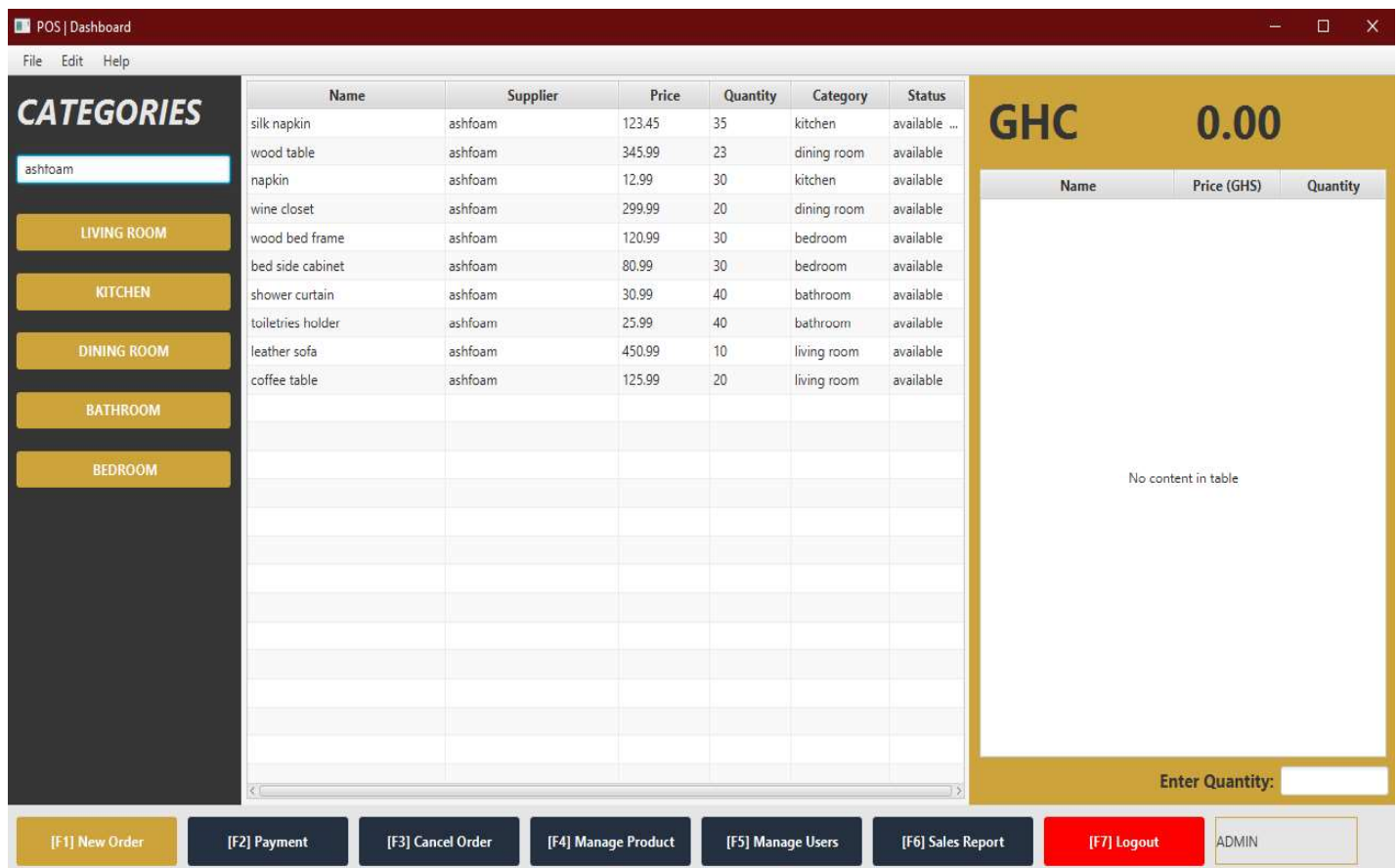

Fig 4.2: POS Dashboard

The POS Dashboard (Figure 4.2) is the central control to all other interfaces of the system. The other functionalities are assigned to buttons that are arranged at the base of the screen view in Figure 4.2. These include: New Order, Payment, Cancel Order, Manage

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Products, Manage Users, Sales Report, and Logout. On the far left of this screen, there is a list of categories by which a cashier can search for a product if they know what category it falls under. There is also a search bar above that allows the user to search for the product by scanning the barcode or entering some detail of the product. Lastly the table on the extreme left displays the items the customer is purchasing along with displaying the total price above the table.
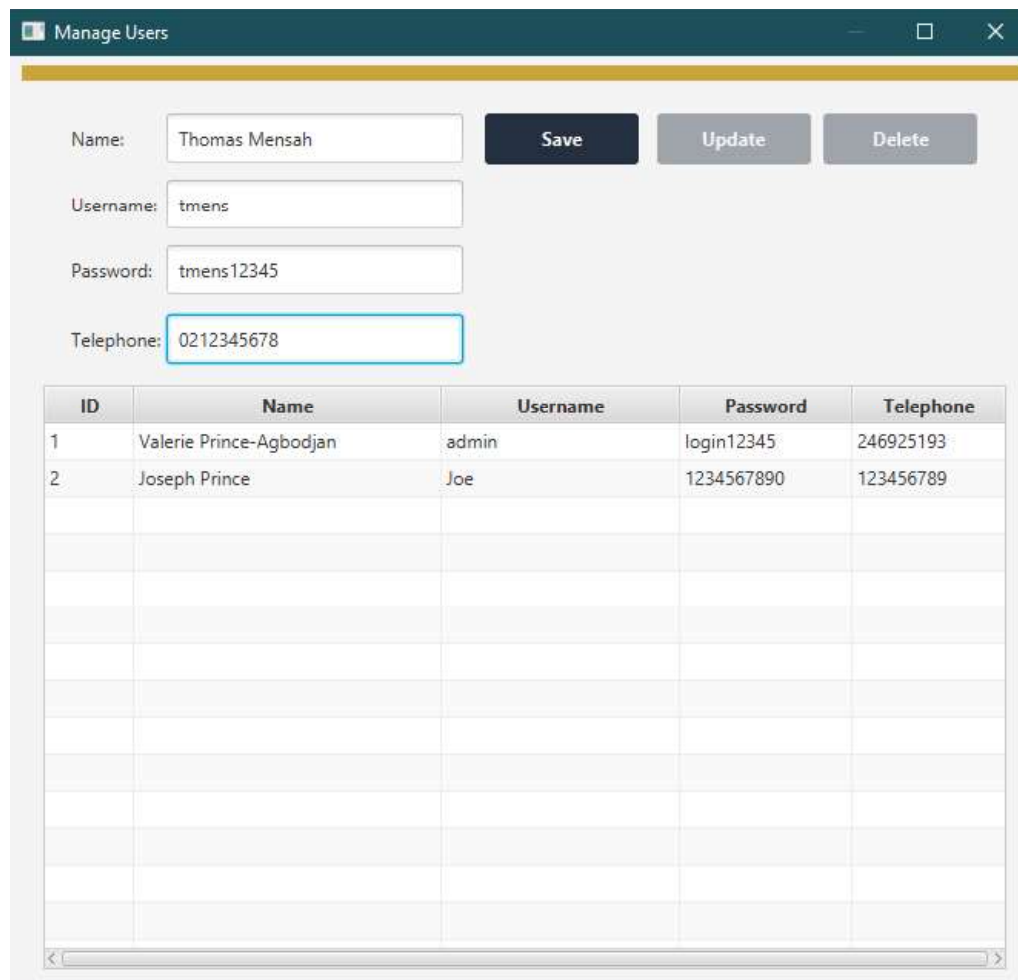

Fig 4.3: Manage Users

The manage users screen, Figure 4.3, is only access when the administrator logs in to their personalized dashboard. This screen gives the administrator control to manage who can use the system by creating accounts for them when they enter their details. Likewise, there is

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additional manipulation to 'update' a user's details in the event that they have forgotten their

password or to delete their details when they do not work at the shop anymore. The inclusion

of storing a user's telephone number serves as a secondary resource for the administrator to be

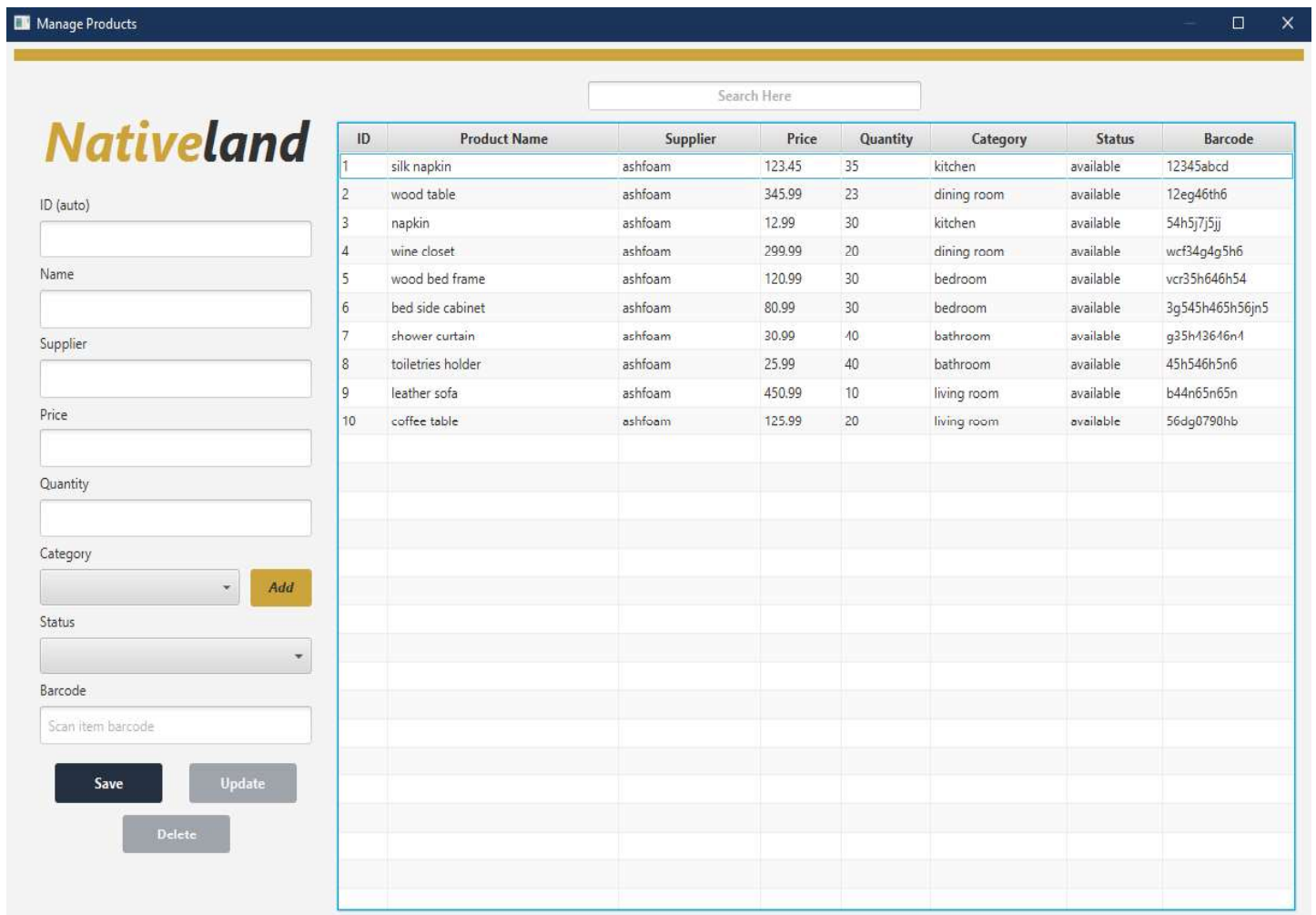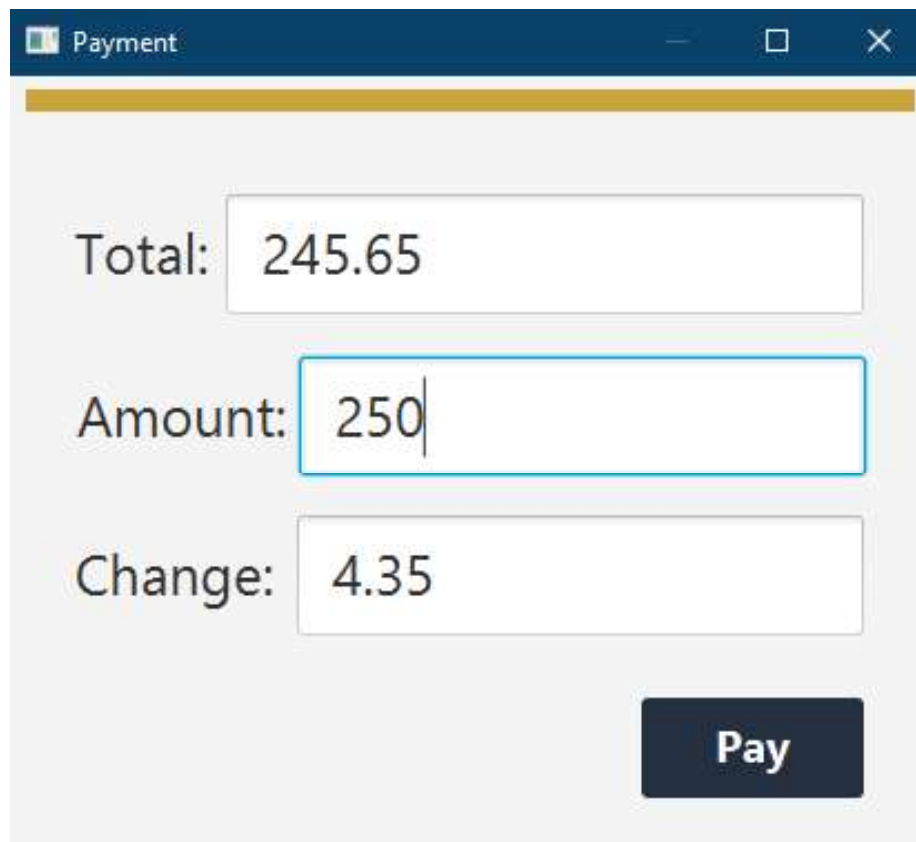able to contact a specific user if need be.

Fig 4.4: Manage Product

The Manage Product (Figure 4.4) is designed to serve the purpose of inventory

management and manipulation. The table displayed on the left will show all products in stock

when the program is initialized. The search bar above the table allows the user to search for an

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item by name, category, supplier, or barcode. The form on the right-hand side of the screen allows for a new product to be added (saved), updated or deleted. Each functionality is mapped to the buttons beneath the form. The buttons are set to enable based on the action being done. Again, this screen is only accessible to the administrator as to help satisfy the requirement for data accuracy.

Figure 4.5: Process Payment

Figure 4.5 is a snapshot of the payment screen that is displayed to the user when they are done entering all the products that the customer is ready to purchase. On this screen the total and the change text field are set to not be editable, this is because they do not require any input from the user. Only the amount text field is editable and requires the user to enter the amount that is being paid by the customer. When the amount has been entered, the user will then proceed

to click the 'Pay' button, which will then calculate the change and display it in the change text field. This value will then tell the user how much difference is to be given back to the customer. At this point the entire transaction is complete and the customer is free to walk out of the store will all their purchased products.
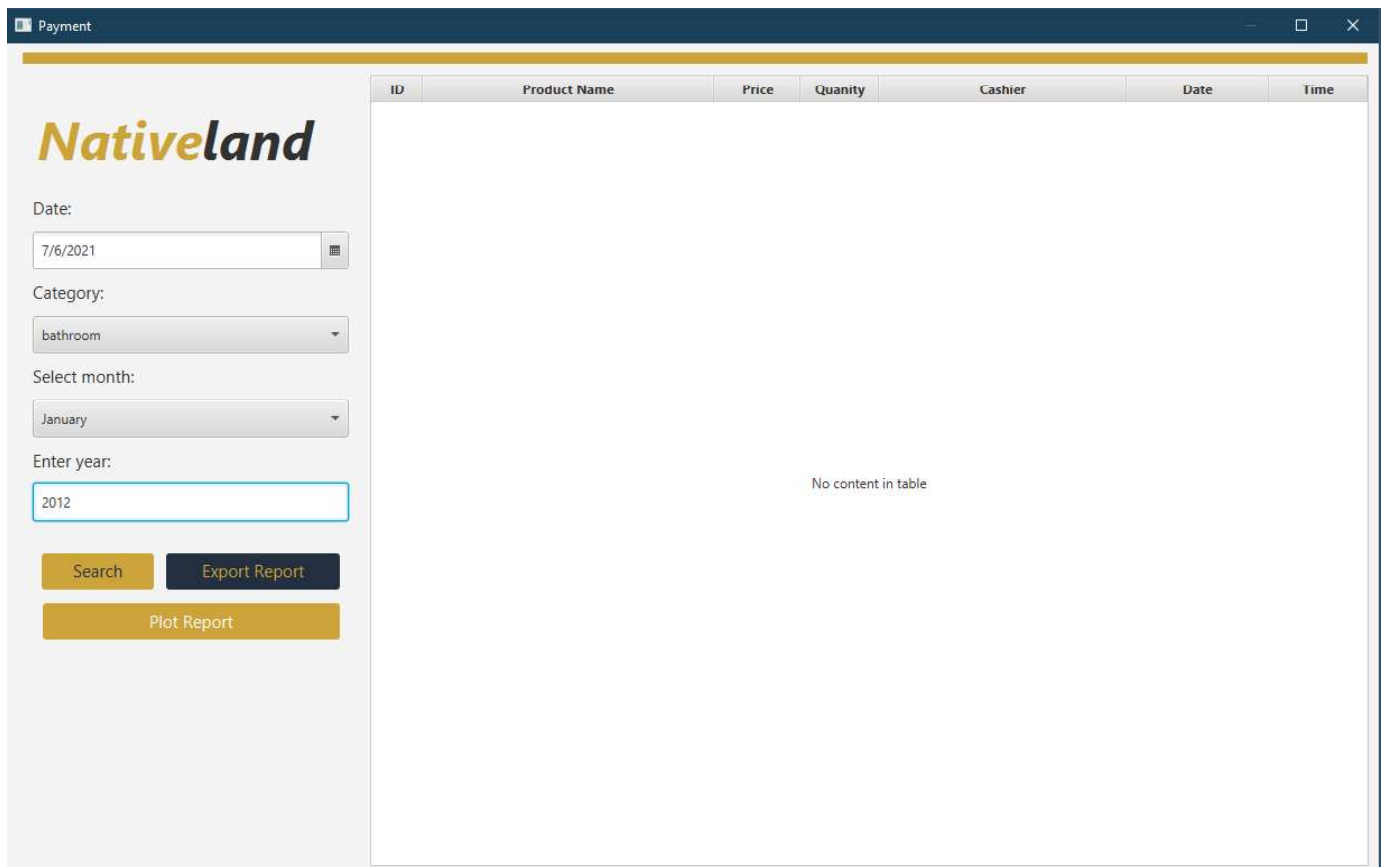
Figure 4.8: Sales Report

The sales report screen (Figure 4.8) provides a summary of sales. The form on the extreme left of this screen provides some options that the administrator can use to filter the search of what particular sales she would like to view. The administrator can search for sales on a particular day by choosing a date in the 'Date' section then click the search button. The administrator can also view sales by selecting a category from the dropdown or selecting a

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month from the dropdown. There is also the option to enter a particular year to view all sales that were made that year. After the search button is clicked, the table on the right will now display all the records that satisfy the parameters of the filter.

CHAPTER 5: Testing and Results

5.1 Overview

This chapter discusses the various tests that were carried out to check if the functional requirements of the system provided by the client were met and is fully exhausted. It also addresses how errors with the program were resolved. For this project, two tests were carried out, which are: component testing and user testing

5.2 Component Testing

The different components of the system were subjected to various test sequences to ensure efficiency and reliability as well as security for each component. These tests include a database test run to test its capability to accept large data volumes entered by the user.

To carry out this test, 10 different regular users were registered onto the system and given access to concurrently upload items / products into the system, with each person inserting roughly about 20 records. During the process of upload, I observed the server outputting an SQL error "Too many connections" and as a result some input statements failed to execute due to the configuration limitation.
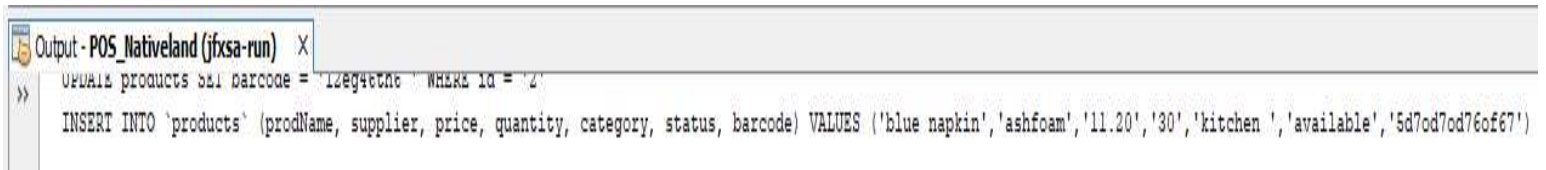
```
# The MySQL server
[mysqld]
port= 3306
socket = "C:/xampp/mysql/mysql.sock"
basedir = "C:/xampp/mysql"
tmpdir = "C:/xampp/tmp"
datadir = "C:/xampp/mysql/data"
pid_file = "mysql.pid"
# enable-named-pipe
max_connection = 100
key_buffer = 16M
max_allowed_packet = 1M
sort_buffer_size = 512K
net_buffer_length = 8K
read_buffer_size = 256K
read_rnd_buffer_size = 512K
myisam_sort_buffer_size = 8M
log_error = "mysql_error.log"
```

Figure 5.1: Configuration File "my.ini"

To solve this issue, the MySQL database configuration file with a default name as "my.cnf" or "my.ini" needed to be updated to include the line "**max_connecitons = x"** where x represents the allowed number of maximum concurrent connections to the database. By updating this value "**x**" to 100 as shown in Figure 5.1, the SQL connection error has been solved.

5.3 System Testing

This stage of testing puts together the various components of the system for testing together the entire system. For this a stage, a more wholistic test was used to validate the entire system. With the help of the administrator view, which gives full access to every system functionality, the system testing was a success.


```
Output - POS_Nativeland (jfxsa-run)  X
UPDATE products SET barcode = '12eg4ethe' WHERE id = '2'
INSERT INTO `products` (prodName, supplier, price, quantity, category, status, barcode) VALUES ('blue napkin','ashfoam','11.20','30','kitchen ','available','5d7od7od76of67')
```

Figure 5.2: System Testing

The administrator logs into the system with the login portal screen, Figure 4.1. This give Mrs. Agbodjan access to the "Manage Users" screen, Figure 4.3, and she is able to add or remove users from the screen. When a successful query is executed, a print statement is outputted in the console, Figure 5.2, indicating the product insertion is successful. The next step is for the new product to now be displayed on the product page, Figure 4.4, and the dashboard, Figure 4.2, to be available for purchase.

5.4 User Testing

The final and most important stage of the system development cycle, user testing. The system is deployed and given to the users to observe how they interact with the system. Given that this project is being developed specifically for an organisation, they will be the main beta testers of the system. The developer decides to implement the user testing in two different phases. Phase 1 involves deploying the system without any form of tutorials. This is to observe

how the users interact with the system and test how intuitive the design and functionalities are. Phase 2 involves deploying the system with a full tutorial on how the entire system works, from logging into the system, to inventory management and many more. At the end of each phase an evaluation form will be filled to give the developer a sense of how the user experience was in both phases. The testing phase will be carried out with the following plan:

Phase 1:

- The system will be deployed on the developer's computer to simulate a server.

- A notice will be sent to Nativeland to provide some employees for testing.

- All users will not be briefed on how to use the system.

- Users will then have accounts created for them and be given the system to use for a period of 1 week.

- The administrator will be required to enter some products into the system to populate the application.

- The products will then be visible to the cashiers to view the details of the products and allow sales to be processed.

- After the testing period is terminated, the users will then fill an evaluation form and explain how their experience with the system during unsupervised interaction.

Phase 2:

- The system will be deployed on the developer's computer to simulate a server

- A notice will be sent to Nativeland to provide some employees for testing

- All users will be briefed on the project scope and how to use the system for the testing stage

- Users will them have accounts created and be given the system to use for a period of 1 week.

- The administrator will be required to enter some products into the system to populate the application.

- The products will then be visible to the cashiers to view the details of the products and allow sales to be processed

- After the testing period is terminated, the users will then fill an evaluation form and explain how their experience with the system during supervised interaction was.

5.4 System Testing Results

The system was successfully tested with the users. Four individuals were used to test the system for this phase. These four individuals were then split into two groups to satisfy the different phases the developer made for testing. Phase 1 had Mrs. Prince – Agbodjan and a shop cashier, and phase 2 had two other shop cashiers. As mentioned earlier phase 1 users were given the system to use unsupervised and phase 2 users were supervised.

Prior to the testing phase I gave the administrator the chance to create accounts for the cashier users. This was to also observe how easy Mrs. Prince-Agbodjan found it navigating the system to the 'Manage Users' screen. Luckily, this was a success without supervision and all the accounts for the three cashiers were created. This gave way for the next step in testing.

To begin testing the developer arranged for phase 1 to commence on a business day, by setting up his computer in the shop to give the users the chance to use the system unsupervised. The following 2 days the same process was repeated but with supervision, which means the

developer was present throughout working hours to provide assistance while cashiers used the system. After these were completed the evaluation forms were filled for the respective groups.

An interesting observation that was made from both groups by analysing their responses from the questionnaire, was that they found it quite intuitive navigating the application. However, there were some functionalities of the system that did not quite work as expected. By referring to Table 5.1, you can view the results of the testing from the two groups. Also, please refer to the Appendix to view the individual responses of the test users to the post test questionnaire.

Table 5.1: User Testing Results

FUNCTION	EXPECTED RESULT	ACTUAL RESULT
User Login	If credentials are correct, the assigned dashboard is displayed to the user	If credentials are correct, the assigned dashboard is displayed to the user
Add new user (Administrator)	Functionality allows administrator to add a new user to the system	Functionality allows administrator to add a new user to the system
Update or delete user (Administrator)	Functionality allows the administrator to update a user's details or delete a user	Functionality allows the administrator to update a user's details or delete a user

Add product to database	Functionality populates the application product table	Service populates the application product table
Search for a product	Search terms serves as a query variable to obtain specific products from the database	Search term must be typed in full in order to return the desired results from the database.
Add product selection to sales table	The main table in the centre of the dashboard contains products that can be added to the sales table when a customer buys it	The main table in the centre of the dashboard contains products that can be added to the sales table when a customer buys it
Process payment	Service processes a customer's purchase and calculates change at the point of sale.	Service processes a customer's purchase and calculates change, but only works on mouse click.
Query sales report (Administrator)	Service provides a filter to query specific sales data from the database to display to the administrator. The data can then be exported to a document and printed or	Service provides a filter to query specific sales data from the database to display to the administrator. The data can then be exported to a document and printed or

	plotted on graphs for better visualisation.	plotted on graphs for better visualisation.
User logout	The user's session is terminated and redirected to the login screen.	The user's session is terminated and redirected to the login screen.

It is important to note that Table 5.1 contains the feedback from the testing phase of the protype and not the final system. The aim of this was to observe how intuitive the design is when the user is interacting with the system. Also, get feedback that can make the final system more reliable, intuitive and bug free. From Table 5.1, which shows a comparison of the expected outcome of the test and the actual outcome, there are two functionalities / components that both groups had a problem with during interaction.

The first functionality that gave an issue was the "Search for a product". The expected result for this function is that the user can search for a product using any detail such as name, supplier, category barcode. Although these parameters all work, the actual results from testing were different. The users explained that to be able to get a successful search, they had to enter the full details or what exactly they were looking for. This mean that to search for a product by 'name', they had to enter the full name of the product as it is saved in the database and this made it a bit challenge.

The next and last functionality that gave an issue was the "Process payment". The expected result of this function is the process the sales total for the customer as the cashier is entering the products and their respective quantities. However, for both groups they realised

that this function only happens after all the products have been entered and the payment button is clicked. This does not exactly follow the norm of standard POS systems, because other systems have the total being calculated in real time as their products are being scanned and entered into the system. Although they did not see it as a problem during testing, the user's expressed that is it a bit more intuitive to have total being calculated and displayed to the customer in real time so that they have a fair idea of how much they will have to spend.

The insight gained from testing was very helpful in the development of the final product. For the first issue with the search product function, the developer will rectify that issue by adjusting the MySQL query statements so that the user does not have to enter the entire name to search for a product. For the second issue with the payment processing, the developer will have to restructure the function to execute whenever a new sale is being processed, so that the calculation begins from the moment the first product is added to the sales table. Although the project does have some limitation, which will be discussed in a later chapter, it is important to build the system as close to a market ready product as possible. Therefore, when the system is deployed, it can be fully utilised for business operations.

CHAPTER 6: Conclusion and Recommendations

6.1 Summary

The last and final chapter provides a summary of the complete project, the functional requirements of the application and how they were met, limitations / challenges encountered along the way and the future works that can be done to improve upon the system.

The project was set out to develop a stand-alone application for Nativeland that serves as a POS system to aid with sales processing for customer purchasing and inventory management as well as sales reporting to aid future business decisions. All requirement for core functionality were fully achieved, however, there is room for further improvement.

6.2 Limitation / Challenges

One major limitation of the system with respect to inventory management, is encountered during single bulk uploads of newly stocked products when the administrator is uploading new product details. This makes the process of inventory adding slow, cumbersome, and slightly inefficient.

Another limitation is the need for internet connectivity to be able to access the uploaded data in the database from the application. This means that in the absence of the internet access, users of the application will be unable to operate the system fully and will cause service disruption during sales.

Another limitation is the inclusion on a mobile or VISA mode of payment when purchasing a product. Currently the system is designed / set-up to process sales with only physical cash and this is not totally efficient given that most modes of payment are switching to electronic methods.

6.3 Future Works

Although all the stated requirements were met, there can be some more additions to the applications that can help to improve the system overtime. Some suggestions may include:

- Bulk upload: Adding this extra functionality will make it much easier for the administrator of the shop to add new product inventory. It will in effect increase the upload time due to the insertion of multiple records at a time. However, the time to enter records will reduce, given that all entries can be done in bulk or at once.

- Online Customer Portal: Given that most people like to shop online in modern times, it will be helpful to include an online store for customers to view and order products from the comfort of their homes. This will also help with the limitation of including an electronic mode of payment, whereby customer can use their card or mobile money accounts to pay for their purchases.

- Delivery Option: Introducing the option to request for delivery when the online portal is included will give users a wider range of options to choose from. The online customer portal will serve as a single platform for the multiple outlets of Ashfoam, including Nativeland. Therefore, when a customer chooses to have their product delivered, the web-receipt generated will include which outlet will be delivering their product. This

is to help the customer make a reference in case there is an issue with the product after delivery.

- Including Electronic Payment for Walk-in Customers: It is normal for the online portal to include an electronic payment system, but it will also be beneficial for the walk-in customers who interact directly with the cashier to have the option to pay with electronic services. This will allow the customers to shop even when they are not carrying physical cash.

- Developing the system to be generic: Looking beyond Nativeland, there some other small business sectors / owners that can equally benefit from having a POS terminal in their stores. Building the system to be more generic, will give these businesses the chance to setup the application and select their preferred features when they are installing it.

- Auto-stock updating: To give the system some extra functionalities that will make it smarter, an inclusion of an auto-stock update function can be helpful. When a product is entered into the database for the first time or after restocking, it has a fixed quantity that is available, therefore it is important to update this value after every sale. The aim of this is to allow the system alert the user when a product's stock quantity is going below a certain threshold quantity.

6.4 Conclusion / Recommendation

The entire process of development right from analysis to implementation and testing was a very interesting experience. Programming a full stack application in Java has been a very tedious experience for me. The hardest part of this project was attempting to build this project

with some features that stood out from other available POS terminal. Given that this was custom built to the specific requirements of the client, makes it easier to include all their preferred features that can make their work easier.

In conclusion, this application has taken the first step in providing an easier and more secure means for inventory management, Point of Sales Services and Sales reporting for Nativeland. It has a simple, interactive, and user-friendly interface that makes it easy to understand the application software. The inclusion of the functionalities mentioned in the previous section will take the application closer to being a more generic system to be sold on the sales market. The integration of POS and Online Store with efficient inventory management.

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Appendix A: Images of User Interface Design with Scene Builder

Error

Invalid Username or Password

OK
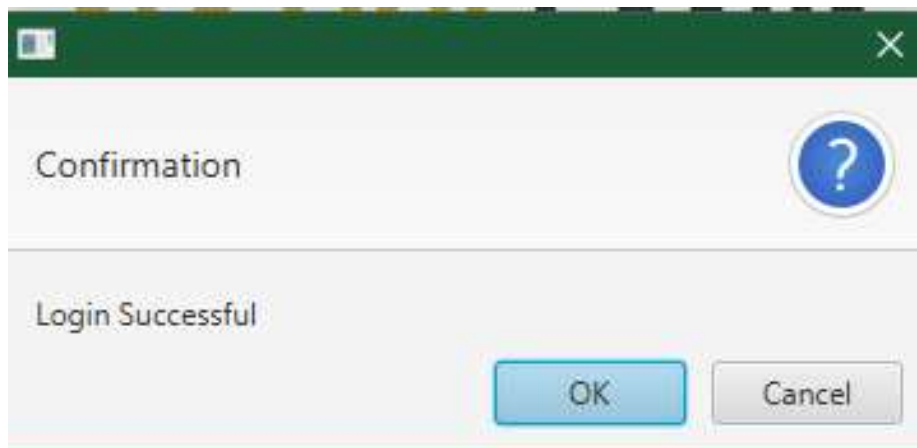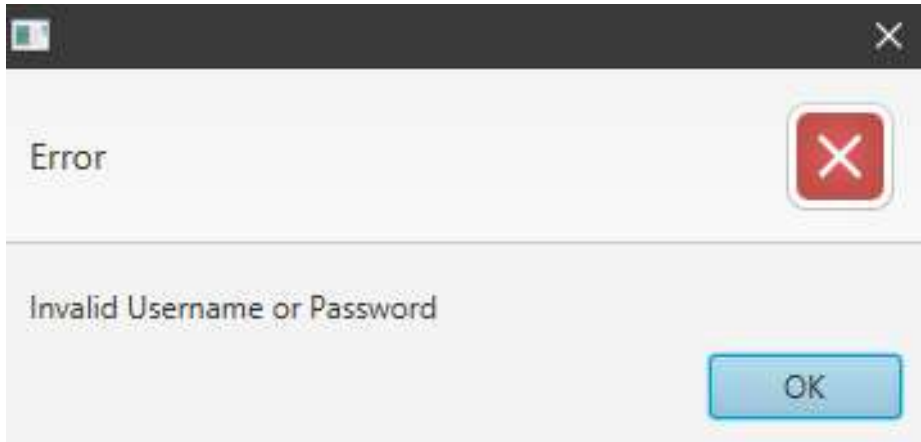
File   Edit   Help

CATEGORIES

Search Item

LIVING ROOM

KITCHEN

DINING ROOM

BATHROOM

BEDROOM

Name	Supplier	Price	Quantity	Category	Status

No content in table

GHC   **0.00**

Name	Price (GHS)	Quantity

No content in table

Enter Quantity:

| [F1] New Order | [F2] Payment | [F3] Cancel Order | [F4] Manage Product | [F5] Manage Users | [F6] Sales Report | [F7] Logout | * |

ID	Name	Username	Password	Telephone

Name:

Username:

Password:

Telephone:

Save

Update

Delete

No content in table

Nativeland

ID (auto)

Name

Supplier

Price

Quantity

Category

[▼] Add

Status

[▼]

Barcode

Scan item barcode

| Save | Update |
| Delete |

ID	Product Name	Supplier	Price	Quantity	Category	Status

Search Here

No content in table

Total:

Amount: Enter amount here

Change: GHC 0.00

Pay

Nativeland

Date:

Category:

Select month:

Enter year:

Search   Export Report

Plot Report

ID	Product Name	Price	Quanity	Cashier	Date	Time

No content in table

Appendix B: Administrator Response to Questionnaire

What is your role in the organization?

⦿ Adminstrator

◯ Cashier

Which test group were you a part of?

◯ Supervised

⦿ Unsupervised

If you were part of the supervised group, on a scale of 1 to 5, how easy did you find the system to use?

	1	2	3	4	5	
Easy	◯	◯	◯	◯	◯	Difficult

If you were part of the unsupervised group, on a scale of 1 to 5, how easy did you find the system to use?

	1	2	3	4	5	
Easy	◯	⦿	◯	◯	◯	Difficult

Please provide and Feedback you may have about the system. *

This is a impressive work you have done with the design and requirements we provided you. i was part of the unsupervised group but I only found my side of the system easier to use, because you and I have been in constant contact throughout the entire process. From previous sessions we had, I was able to remember some of the functions you showed me. However there were some few things i noticed.
1. The dashboard search bar was not working how I would have hoped for. I was trying to search for 'silk napkin' and I started typing the word like 'sil' and no products were showing. I then tried typing the full name and that is when I found what I was looking for
2. The same problem as i mentioned in point 1 also affects the manage product screen search bar.
3. The sales table works fine however, the total for the products of not calculated until i click the payment button.
4. The sales report screen was a bit confusing to navigate because it was a new screen i had not seen yet. I was exactly sure how to select the time period to show the sales that were made.

Suggestions for improvement

I would appreciate it if a solution can be found for the problems I stated above. Also for the payment issue, adding an extra screen that the user can see their total as the products are being added. I would also appreciate it if the sizes of the tables and other things in the system were made slightly bigger, so that it is more visible. Good job.

Appendix C: Cashier's Response to Questionnaire

What is your role in the organization?

○ Adminstrator

◉ Cashier

Which test group were you a part of?

○ Supervised

◉ Unsupervised

If you were part of the supervised group, on a scale of 1 to 5, how easy did you find the system to use?

	1	2	3	4	5	
Easy	○	○	○	○	○	Difficult

If you were part of the unsupervised group, on a scale of 1 to 5, how easy did you find the system to use?

	1	2	3	4	5	
Easy	○	○	○	◉	○	Difficult

Please provide and Feedback you may have about the system. *

This was my first time using a computer. I didn't know how some of the things worked, so I had to ask madam for help. I like the way the system looks.

Suggestions for improvement

Please next time can you show me how to use the system so that I know what to do when i am serving a customer.

Appendix D: Cashier's Response to Questionnaire

What is your role in the organization?

○ Adminstrator

◉ Cashier

Which test group were you a part of?

◉ Supervised

○ Unsupervised

If you were part of the supervised group, on a scale of 1 to 5, how easy did you find the system to use?

	1	2	3	4	5	
Easy	○	◉	○	○	○	Difficult

If you were part of the unsupervised group, on a scale of 1 to 5, how easy did you find the system to use?

	1	2	3	4	5	
Easy	○	○	○	○	○	Difficult

Please provide and Feedback you may have about the system. *

I have worked in a store that has this kind of system before. So even though you showed me how to do some of the things on the system, I was able to find some of the things similar. But when i was serving a customer on the first day i tried searching for a product and it wasn't showing. Then you showed me that i have to type the full name before it will come. Also the customer was telling me that they wanted to see their total whiles i was scanning them but i had to tell him that i have finish and press the payment button before it will show.

Suggestions for improvement

I prefer this system to the other one i was using at the other shop because it is faster. But the searching for a product is not working too well, so if you can fix that one. Then the total should also show when i am scanning the products.

Appendix E: Cashier's Response to Questionnaire

What is your role in the organization?

○ Adminstrator

◉ Cashier

Which test group were you a part of?

◉ Supervised

○ Unsupervised

If you were part of the supervised group, on a scale of 1 to 5, how easy did you find the system to use?

	1	2	3	4	5	
Easy	○	○	◉	○	○	Difficult

If you were part of the unsupervised group, on a scale of 1 to 5, how easy did you find the system to use?

	1	2	3	4	5	
Easy	○	○	○	○	○	Difficult

Please provide and Feedback you may have about the system. *

This is an impressive system. I like the design and how fast it works. But it seems there is a problem with the search bar. It only works when i type the full product name. That is the only problem i had with the system.

Suggestions for improvement

If the search bar can be fixed to take different stuff so the searching will work.