AN ELECTRONIC PHARMACEUTICAL DISTRIBUTION SYSTEM A CASE STUDY OF CORNERSTONE PHARMACEUTICALS LIMITED MBALE DISTRICT

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APPROVAL

This project report has been produced and prepared under my supervision and is to be submitted to the College of Applied Science and Technology of Kampala International University for consideration.

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Date: 04/09/2021

Mr. Asiimwe John Patrick

PROJECT SUPERVISOR

DECLARATION

The researchers **Yapsoyekwo Babra** and **Wamani Fatina** do declare to the best of our knowledge and ability that this project is our original work and has never been presented to any Institution of Higher Leaning or University for any academic award.

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WAMANI FATINA

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DEDICATION

This work is well dedicated to Wamani Fatina's Father Byesigwa Zubairi and my dear Mothers Kyomugisha Betty and Byesigwa Shakila for their commitment towards Educating me, despite their financial constraints, My Sisters Aidati, Rita, Farida, Adija, and my friends for believing in me despite all odds.

This work is dedicated to Yapsoyekwo Babra's lovely Mother Chebotibin Betty, Dear Father kusuro John, loving Dad Chemonges Milton, dear Sisters Cherop Brenda, Cherukut Judith, Aunt Evelyn Uncle Bush and Friends.

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ABSTRACT

This project is aimed at developing an Electronic Pharmaceutical Distribution System for Cornerstone pharmaceuticals that will cover and enable pharmaceutical agents get access to pharmaceutical distribution channels and be able to manage and make delivery arrangements, as well as view current distribution status, check for available drugs, store information on drugs and customers, manage distribution of the drugs and enable online sales.

iPharm, which is the developed online pharmaceutical system, addresses the problem of delayed services, shortage of essential medicines, failure to access the appropriate drugs, very high costs in distribution of drugs as well as lack of proper accountability of drugs, and inefficiency in the distribution system by enabling rapid matching of the drug supply with the high demand through online sales, proper accountability of drugs and drug distribution.

The system was developed using the waterfall model of the system development life cycle critically looking at each phase of development until the system was completed. The research methodology used was a mixture of qualitative and quantitative approaches which called for data collection tools such as questionnaires, observation guides and internet journals as well as Microsoft excel and SPSS for data analysis.

LIST OF ABBREVIATIONS

API	Active pharmaceutical ingredient
MOH	Ministry of Health
MQA	Medicines Quality Assurance
WHO	World Health Organisation
IBM	International Business Machine
CSS	Cascading Style Sheets
PHP	Hypertext Preprocessor
SQL	Structures Query Language
NGO	Non-Government Organisation

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE
INTRODUCTION

1.0 General Introduction

Pharmaceutical distribution system represents the whole set of activities aimed at ensuring the timely availability and appropriate use of safe, effective and quality drugs as well as related products and services in any health care setting. Because drugs have become so important and very scarce resources to come by so easily these days in certain parts of the world, ways have been developed to improve the supply and use of medicines while minimizing costs.

Due to the increased and worrying factors such as misuse of drugs, absence of drug knowledge, drug stocking and delivery problems, lack of patient and supplier information together with lack of transparency, inadequate monitoring and inefficiency in the distribution system, all the above mentioned issues have led to the failure in the Pharmaceutical distribution system.

Speaking of a multi-billion pharmaceutical industry that manufactures and distributes drugs to millions of people every day, failing to notice supply chain issues certainly seems unusual and worth investigating. This calls for the need for more research on the factors affecting the supply chain in the drug distribution system in the country and in the continent at large.

The pharmaceutical distribution system generally reflects the health care system in which it operates. The first step to developing a profile of the pharmaceutical distribution system in a country is to sketch out how the overall health system is organized and how it functions. This will later present all the drawbacks in the pharmaceutical distribution system.

Having noticed that the pharmaceutical industry is a complex enterprise troubled with conflicting objectives and numerous intractable constraints; a highly regulated environment coupled with the life altering nature of the products, portrays the pharmaceutical industry as a uniquely difficult complex system. A preliminary review will suggest that supply chain related issues are not likely to figure among the biggest challenges facing the pharmaceutical industry but it will stand out as one of the major areas affecting the drug distribution system.

1.1 Background of the Study

Drug distribution system is one of the fastest growing healthcare sectors. The goal of drug distribution system is to control the delivery, speed, and release of a drug without facing problems of lack of accountability of drugs, misuse of drugs, failure to access the appropriate drugs and inefficiency in the distribution system.

Successful management of pharmaceuticals is directly related to a country's ability to address public health concerns. Even so, many health systems and programs run into difficulty achieving their goals because they have not addressed issues like how the medicines that are essential to saving lives and improving health will be managed, supplied, and used.

Pharmaceuticals can be expensive to purchase and distribute, but shortages of essential medicines, improper use of medicines, and spending on unnecessary or low-quality medicines also have a high cost, wasted resources and preventable illness and death. Pharmaceutical distribution being so vital to the healthcare sector and to the success of business in many pharmacies around the country, it is only natural that the drug distribution system continuously seeks new ways to configure and handle their supply chains to remain efficient and competitive.

Now, with the aid of breakthrough progress made in the area of Information Technology, companies are deploying increasingly sophisticated solutions to further improve the efficiency of drug distribution system. Since Pharmaceutical Distribution Systems of 21st century have its fingertips on sophisticated desktop and internet technology that has turned around things in the medical sector inform of availability of powerful computers and connection to a wealth of health and drug information found on corporate intranets, web based system and other internet resources, the entire distribution system has picked up and become more effective.

In the recent years circumstances have changed in the health sector where by competition is a basic need. The pressure to provide better health services has never been greater yet the pressure to increase standard and operation costs is equally strong therefore calling for better and more efficient automated drug distribution systems (IBM, 2004).

Cornerstone pharmaceuticals limited is located in Mbale district along Republic Street. The management of cornerstone pharmaceuticals limited Mbale district offer their services manually such as prescription of drugs, supply of their products and making payments. They offer their services to people from within Mable district and also people from the neighboring districts like Manafa district ,Kapchorwa district ,Kween district , Bukwo district and others.

However there is need for improvement since their current way of offering services has led to delayed services, wastage of time and money since other people may travel and find the drugs they wanted unavailable, over congestion of the place while customers are struggling to be served first, misuse of drugs, misplacement of receipts, slow data entry and poor monitoring and control of the distribution of drugs which can be done by putting in place online services which will complement the current services for better services.

1.2 Statement of the Problem

The problem of delayed services in the pharmaceutical distribution system has rapidly grown over the years and now calls for immediate response and attention. Until now, the inefficiencies and failures in the current pharmaceutical distribution system have strongly emerged and threaten the medical sector and all the health centers within different countries.

The main problem is that the current system is manual where receipts are handwritten, clients have no prior information of the drugs in stock as a result they make orders directly at the pharmacy which has led to congestion and delays in delivery of services.

These difficulties in the drug distribution system have been triggered by shortage of essential medicines and spending on unnecessary or low-quality medicines as well as very high costs in distribution and purchasing of the medicines, the lack of proper accountability of drugs, failure to access the appropriate drugs and inefficiency in the distribution system have finally intensified.

1.3 Main Objectives

1.3.1 General Objective

The major goal of this project is to develop an online electronic Pharmaceutical Distribution System for Cornerstone pharmaceuticals limited that will list all the available drugs, enable online sales and manage distribution of the drugs.

1.3.2 Specific Objectives

i. To examine the requirements for the electronic pharmaceutical distribution system
ii. To design the architectural frameworks for the proposed system
iii. To implement the designs for the electronic pharmaceutical distribution system
iv. To test and validate the designed system of cornerstone pharmaceuticals limited Mbale.

1.4 Purpose of the Study

The main purpose of the study is to design and implement an electronic pharmaceutical distribution system for Cornerstone Pharmaceuticals Limited Mbale to enable pharmaceutical agents get access to pharmaceutical distribution systems in order to make distribution arrangements, to be able to view current distribution system and check for clients' lists as well as the electronic pharmaceutical distribution system.

1.5 Research Questions

I. What are the limitations, advantages and disadvantages for using an electronic pharmacetical distibution system in the aviation industry?
II. what are the possible benefits of using an electronic parmaceutical distribution systems in pharmaceutical companies?
III. What are the possible ways of improving the old system of distributing the products of Cornerstone Pharmaceuticals Limited Mbale?

1.6 Scope of the Study

1.6.1 System Scope

The system uses HTML, CSS, PHP and JavaScript to develop the user interface in Adobe Dreamweaver CS 6 at front end and will use Apache and MySQL at the backend. The system output runs across different web browsers such as opera mini, internet explorer, Mozilla Firefox, Google chrome and so on.

1.6.2 Content Scope

The system provides an online catalog displaying available drugs whereby customers will be able to check for the available services, make orders and payments. This ensures timely delivery of services at the possible lowest cost.

1.6.3 Time Scope

The project was completed within a period of three months that is to say from 20th May 2013 to 20th August 2013. All the project activities have been carried out during this time frame such as planning, data collection, data analysis, system design, implementation and testing.

1.6.4 Geographical Scope

The study of the current system and environment has been carried out from Cornerstone pharmaceuticals limited which is located along republic street in Mbale district in the eastern part of Uganda.

1.7 Justification of the study

The system displays all the available drugs online which will help customers be able to view the available stock from wherever they are without going directly to the pharmacy.

The system enables customers to make orders online after viewing the drugs available in the pharmacy through internet banking and online payments.

The system is able to give feedback information to customers who make orders online.

The electronic system enables rapid matching of the supply of drugs with demand since its accessible at all times from everywhere.

1.8 Limitations of the Study

The study ought to face a lot of limitations that affects its smooth running and hence may not be precise and exact. These limitations are;

1) Some of the staff members who are to be interviewed were absent, which delayed the researcher's to move to the next stage of the project therefore the researchers had to make appointments with the staff members on when to interview them.

2) Failure to return questionnaires in time therefore the researcher had to make a follow up.

3) It was also difficult to convince some of the staff members about the needs of developing a new system since most of them had no knowledge about the importance of the information system so the researcher had to explain what the system will do and its benefits.

4) False information given by the respondents hence the researcher had to get information for the respondents who work in that pharmacy.

5) Time factor; there was limited time to keep carrying out an extensive investigation of the current system and the related problems since time for researching was running out.

1.9 Conceptual Model

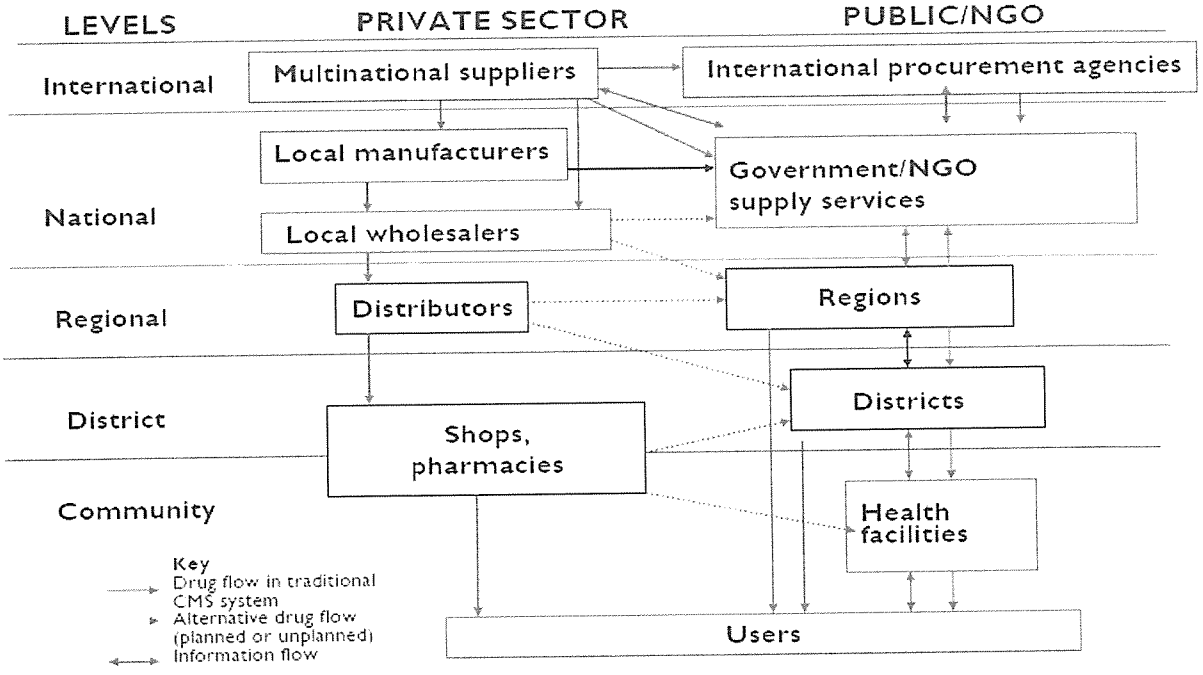


Fig.1 shows the conceptual model of the pharmaceutical distribution system

The pharmaceutical distribution system can be portrayed in terms of the flow of information, funds, and products as shown in the figure above. The activities involved with carrying out each component of the pharmaceutical distribution system can be diagrammed. Perhaps the easiest place to start in developing a profile is by diagramming the distribution system to show how pharmaceuticals or how drugs enter and move through the country via the pharmacies to the final consumer. See Appendix A for more drug distribution channels.

Conclusion

This chapters points out the problem under study, clearly explaining the background of the problem, the statement of the problem, the objectives of the study; both general and the specific objectives, the purpose of this research, justification, research questions and the scope of the study along with the limitations of the study. It also highlights on the background of the organisation in which the research was conducted.

CHAPTER TWO
LITERATURE REVIEW

2.0 General Introduction

The Drug distribution system has remarkably attracted many researchers in recent years from the medical communities. It is one of the fastest growing healthcare sectors. The goal of drug distribution system is to control the delivery, speed, and release of a drug without facing problems of lack of accountability of drugs, misuse of drugs, failure to access the appropriate drugs and inefficiency in the distribution system.

This requires consideration of drug accountability as well as dynamics and stability of the current drug distribution system in accordance to the performance of the different drug suppliers, which may be affected by the chain of supply in drug distribution system. Approaches for drug delivery have advanced from traditional approaches to many new methods that use ICT and new web technologies. This has led to rapid evolution of the drug distribution system.

Recently, the focus of the research on drug distribution system has been moving towards computerization or automation of the drug distribution system. Automation is essential for this new phase of drug delivery, and requires efficient integration of automation principles with medical practices in real life.

2.1 Related Literature

Special attention was paid to the different causes of failure in the current drug distribution system. There is a consideration gap in knowledge about how these Pharmaceutical distribution systems affect the supply and distribution of drugs and provide a strong potential for cost-savings and increase in the efficiency of drug distribution.

Based on the online business dictionary, distribution is defined as the movement of goods and services from the source through a distribution channel, right up to the final customer or consumer. It can also mean in simple terms to divide and give out in shares; deal out; allot, to disperse through a space or over an area.

The researcher subscribes to the view that a Pharmaceutical Distribution System should be considered excellent if it is able to effectively support a business strategy. The business objectives of the pharmaceutical industry include the need to ensure that the drugs are protected from contamination and counterfeiting, should be removed and destroyed in a safe and environmentally friendly manner, and made available to patients at all time.

Clearly, these are not commonly used metrics to assess the performance of a company or a distribution system. Instead, characteristics that have direct impact on the short term financial wellbeing of the Pharmacy, such as reduced lead times , increased flexibility, and lower cost are the ones that take precedence. As a result, there is a huge gap between the actual and perceived capabilities of the pharmaceutical supply chains. Furthermore, there are clear indications that a radical transformation of the pharmaceutical industry is on the horizon which requires further strengthening of its distribution systems, rendering it even more critical to success.

The Different Stakeholders' Perspective on Drug Distribution System

Manufacturers

Manufacturers recognize the importance and contribution of the drug distribution system to ensuring access and availability of medicines to patients. Yet, it is often argued that the cost of distribution is in many cases disproportionate to the value it offers to the general public and, as such, should be reconsidered and become more in-line with the contribution that the pharmaceutical sector makes in terms of bringing new therapeutic alternatives to market.

Wholesalers

Wholesalers operate on the basis of large volume and small margin. They feel squeezed by the nature of competition and the requirements of public service obligation and frequent distribution to retail outlets, the net result being a very low net margin on wholesale distribution of medicines. They also perceive recent changes in the distribution model in a number of Member States, particularly relating to higher cost medicines, as partial and creaming off a significant source of revenue for their operations. Where already experienced, the direct involvement of manufacturers in distribution has changed the way the sector operates and the ability of wholesalers to compete and offer value deals to their customers (HDMA, 2004).

Pharmacies

Pharmacists often feel they are asked to do more for less in the distribution system, that there is reluctance by payers to pay them for additional services rendered such as diagnosis of patient illnesses and prescription of the drugs. Importantly, the changing role of pharmacy in the community does not necessarily seem to be reflected by actions at policy level.

In addition, their ability to negotiate terms with wholesalers is beginning to change in environments where products are delivered directly by manufacturers and where pharmacy is incurring a significantly higher cost in search of product.

Patients and Customers

Patients are largely unaware of the costs of distribution and their primary consideration is the availability and affordability of medicines. Distribution remuneration, particularly at retail level, should capture some of the gaps in availability, particularly in remote or rural areas where such problems seem to be more acute. Patients in some cases argue that the pursuit of profit across pharmacy chains is responsible for problems in the geographical allocation of pharmacies and that this ought to be addressed.

Insurers and payers

Insurers face a significant cost of distribution and taxation. Significant changes have taken place over the past decade in the majority of countries in an attempt to reduce the impact of distribution (but not taxation) and calibrate remuneration structures, often resulting in a reduction of wholesaler and – in some cases – retail costs.

In some cases, health insurers have experimented with "novel" initiatives for the retail market, such as tendering and rebate policies. Apart from the unintended consequences that such schemes may have, these initiatives have revealed, among other things, the reservation price of mature (off-patent) medicines and the cost payers should be paying without it being inflated by discounts.

2.2 System Abstract

The Electronic Pharmaceutical Distribution System is a web based application that covers and enables pharmaceutical agents get access to pharmaceutical distribution systems in order to manage and make delivery arrangements, to be able to view current distribution status and check for available drugs as well as keep information on different drugs and customers.

The developed system is equipped to control the delivery, speed, and release of drugs, monitor the supply of drugs and prevent the distribution of expired and illegal drugs to the market. The online electronic system will enable rapid matching of the supply of drugs with the high demand since it will be accessible at all times from everywhere.

This project was developed using PHP at Front End and MySQL server as backend. Other important languages will include HTML, CSS, and Java Script that will play a vital role in the development of the Graphical user Interface of the system.

About PHP

PHP is a server-side, cross-platform, HTML-embedded scripting language. PHP (recursive acronym for PHP: Hypertext Preprocessor) is a widely-used open source general-purpose scripting language that is especially suited for web development and can be embedded into HTML.

About MySQL

MySQL is an open source Relational Database Management System. MySQL is very fast reliable and flexible Database Management System. It will contain the systems data placed into respective tables for easy arrangement and management of the data. The database will be queried and manipulated to insert and retrieve the necessary information.

Wamp Server :

WAMP is a free and open source cross-platform web server solution stack package, consisting mainly of the Apache HTTP Server, MySQL database, and interpreters for scripts written in the PHP and Perl programming languages.

2.3 Related Software Systems

Recent years have witnessed unprecedented growth of research and applications in the area of nano-science and nanotechnology. There is increasing optimism that nanotechnology, as applied to medicine, will bring significant advances in the diagnosis and treatment of disease. Anticipated applications in medicine include drug delivery, both in vitro and in vivo diagnostics, nutraceuticals and production of improved biocompatible materials (Duncan, 2003)

2.3.1 Automated Drug Dispensing System

The Automated Drug Dispensing Systems used today such as those developed by OmnicellInc and PyxisInc which are American based companies predicated transformation in the drug distribution system due to the aid provided by these Automated Drug Dispensing Systems in ensuring supply, delivery and also prescription of the drugs being sold on the system.

These are knowledge based system that use expert instructions in order to assist nurses to prescribe and administer drugs to patients. The system also keeps record of patients, Drug information, the insurers and customers as well as the prices and quantity in stock of the different drugs available for distribution.

From the researchers' opinion, this Automated Drug Dispensing System is an answer as well as a solution to what is in store for the healthcare sector as well as the Pharmaceutical distribution system. Most of the functions and expert decisions of the automated system are good and perfect but the system is mainly focused on serving patients and distributing drugs necessary for people in the American continent.

2.3.2 Computerized Multi-dose Distribution System

This application attempts to reduce the need for having many nurses distributing and taking on the full responsibility of handling hundreds of patients and customers. It also includes a unit-dose system for effective functionality in dispensing drugs and accounting for them.

With the aid of Computerized Multi-dose Distribution System that has several unit-dose applications reduces the occurrences of medical errors, medication waste, wrong prescriptions and inappropriate use of drugs by medical staff.

Building on these features of the system, Johns Hopkins Hospital introduced an automated feature in to the Unit-dose system making the entire process, from the physician prescription entry to hourly dose administration, computer assisted (Simborg & Derewicz, 1975). As technology has evolved, the pharmacy automation trend that began in the late 1960s has continued, and has been marked by proliferation of the automated drug dispensing system into hospitals and healthcare systems such as the Vancouver Coastal Authority's Vancouver General Hospital in the United States.

The computerized Multi-dose Distribution System may be something of this generation, but it is complex and unfriendly to the unlearned nurses and doctors who may not have any knowledge on how to use computers. The system needs to be simplified and make friendly for all the medical staff to use without needing much computer skills.

2.4 Conclusion

This chapter sums up all the related literature on the Pharmaceutical Distribution System giving an overview of what it involves, who participates in the drug distribution system and the different roles of the stakeholders involved. It also introduces the developed system in the System Abstract section and goes ahead to hint on other related software systems.

All the literature reviewed in this chapter was obtained from both Primary and Secondary resources such as Journals, books, online websites, published articles and all the sources are listed in the reference section of this propose for any further studies on the integration of the Pharmaceutical Distribution system with ICT and internet technologies.

CHAPTER THREE
METHODOLOGY

3.0 Introduction

This chapter focuses on a planned structure or details of how the researchers will carry out their work. It mostly emphasizes on the research methodology including tools and techniques that are used during the development of the new Pharmaceutical Distribution System, the Research Design, the Study Population, Research tools, Data collection methods and System Design.

3.1 Analytical Tools and Design

The researchers aimed at carrying out a feasibility study of the system and ensure that the necessary data is collected from the company files and members, organized, analyzed and represented in a format that was good to illustrate the flow of the whole work and even the nature of the project. Layouts were made to ensure that the system is designed in accordance to the specification of the system owners and the specific objectives in place.

3.1.1 Research Approach

The overall design of the research project consists of its methods and procedures. The researcher used both Qualitative and Quantitative approach interchangeably in the research, concentrating more on the different attributes and factors affecting the effectiveness of the Pharmaceutical Distribution System in place. At times it's also possible to have a mixture of the two approaches, both qualitative and quantitative in overall design and in the specific methods used in the investigation. This study was both descriptive and analytical survey in nature.

3.2 Study Population

The study population included all individuals involved and interested in the drug distribution system namely: Wholesalers, Pharmacists, Insurers, and the Customers.

3.3 Sampling Design

The study used both Purposive and Simple random sampling method to select a sample from the target population. Purposive sampling involves getting a sample from the people who work there

and people who have ever bought drugs from that pharmacy. Simple random sampling involved getting participants from the population.

3.3.1 Sample Size

The study involved a purposive sampling research data collection. The first stage involved selecting the population of the study. Secondly the researchers identified the potential respondents which included five Whole sellers, ten shareholders, twenty Pharmacists, and fifteen clients. From each department respondents were selected to constitute a sample size to fifty respondents.

3.4 Data Collection Techniques and Tools

3.4.1 Questionnaire

This method of data collection used a printed document containing logical and standardized questions that were used to answer the research questions and provide data from the users of the current system and some of the staff and stakeholders in the drug ditribution system.

Theresearchers used this method because it can l enable the respondents to answer the questions in their free time and it creates an opportunity for getting accurate information since it is designed using simple statements that are straight forward.

3.4.2 Observation

During observation method, the researcher s observed the important points that may not have been revealed by the respondents in interview such as the difficulties met in the current systems as well as medical errors, occurrences and competitiveness among the supplies and other problems that could be seen within the current Pharmaceutical Distribution system.

3.4.3 Interview

With this method, the researchers visited Mbale Cornerstone Pharmaceutical offices and carried out individual face to face interviews with the staff. This enabled the researchers to get personal views and information about the daily actions and events within the pharmacy. The interview method is one of the most commonly used methods in research.

3.4.4 Internet and Documents Reviews

The growing popularity of the Internet brought a major shift in Electronic Data Reporting and data collection. The researchers took an advantage of the internet being an ocean of information and get more information about Pharmaceutical Distribution System.

With the aid of the modern search engines and information portals such as Google search, Yahoo, Aol, Excite and Bing can be a great resource for most of the journals, articles and websites that contain information on Pharmaceutical Distribution System.

3.5 Data Analysis Methods

Data collected was from different methods and had to be compared so as to give the researchers a clear understanding of data, information and the problem at large. The following are the tools which were used:

SPSS Software

Data was analyzed by using a statistical software program in which the data obtained was input, organized, and arranged statistically. Many conclusions were derived from the statistical results and findings. This information was tallied and analyzed statistically for decision making.

Interview Guides

Data was analyzed using an interview guide between the researcher and the respondents. Twenty respondents were interviewed and the data got was presented inform of pie charts and graphs. Conclusions and decisions were made based on these graphs and charts produced.

Microsoft Excel

Data was collected from the respondents and then it was put in Microsoft excel to be analyzed. The number of people who responded to the interviews and questionnaires were calculated and presented inform of a report.

3.6 System Design and Development

Under system design and development, the system was developed using a waterfall design approach, which is a sequential development approach, in which development is seen as flowing steadily downwards (like a waterfall) through the phases of requirements analysis, design, implementation, testing (validation), integration, and maintenance.

Waterfall Development Model

The Waterfall model is systems design methodology that follows the system's development life cycle, after each phase is finished; it proceeds to the next one. Reviews may occur before moving to the next phase which allows for the possibility of changes and may involve a formal change control process.

Reviews may also be employed to ensure that the phase is indeed complete; the phase completion criteria are often referred to as a "gate" that the project must pass through to move to the next phase or stage:

The basic principles of the waterfall model are:

- Project is divided into sequential phases, with some overlap and splashback acceptable between phases or different stages.
- Emphasis is on planning, time schedules, target dates, budgets and implementation of an entire system at one time.
- Tight control is maintained over the life of the project via extensive written documentation, formal reviews, and approval/signoff by the user and information technology management occurring at the end of most phases before beginning the next phase.

The Waterfall model is a traditional engineering approach applied to software engineering. It has been widely blamed for several large-scale government projects running over budget, over time and sometimes failing to deliver on requirements due to the Big Design Up Front approach.

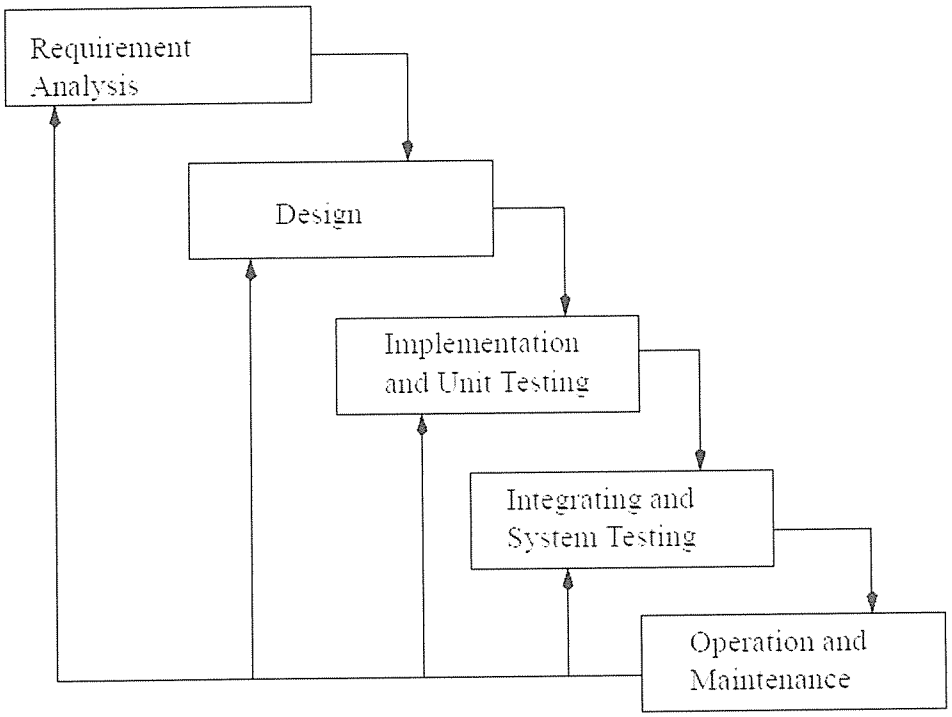


Fig. 3.1: Shows phases of the Water fall Model

Advantages and Disadvantages of the Waterfall Model

Except when contractually required, the Waterfall model has been largely superseded by more flexible and versatile methodologies developed specifically for software development.

Waterfall discourages revisiting and revising any prior phase once it's complete. This "inflexibility" in a pure Waterfall model has been a source of criticism by supporters of other more "flexible" models. This has enabled us complete our project in due time, while thoroughly performing each activity without repeated reviewing of each phase of the waterfall model.

The Waterfall model is also commonly taught with the mnemonic A Dance in the Dark Every Monday, representing Analysis, Design, Implementation, Testing, Documentation and Execution, and Maintenance.

The main objective in system design and development is to make a preliminary (logical) design and then a detailed Physical design. The logical design describes the functional capabilities of

the new system as well as the requirements specifications. The physical design illustrates how the system delivers the general capabilities, the output and input requirements, the processing requirements as well as the security control and backup.

3.6.1 Functional capabilities of the new system

These are the system functionalities that must be achieved or aimed at during the development of the system using the waterfall model. They are they the capabilities the system must contain or perform and they include the following:

- Allows making orders online for particular services.
- Allows checking for the available services online without moving up to where the pharmacy is.
- Provides better services to the clients and patients.
- Allows regular updates.
- Provide accurate and timely information needed by the clients.
- Increase throughput and decrease the response time when making delivery of services.

3.6.2 Conclusion

The research methodology presented in this chapter accounts for the development of the system using waterfall approach of the System Development Life Cycle. This system development mostly emphasizes on the phases of the waterfall model to come up with each module necessary for the system following a bottom-up approach. Therefore the research methodology including tools and techniques to be used during the development of the new Pharmaceutical Distribution System all aim at developing the system at a cheaper cost with less development time.

CHAPTER FOUR
SYSTEM REQUIREMENTS ANALYSIS AND DESIGN

4.0 Introduction

This chapter presents the general details of the system design and shows a clear architectural diagram of the system with the different components that make up the system. It places much emphasis on logical representation of all the system functionalities, database design and the user interface design using structural, behavioural and data modeling methods.

4.1 System Design

This system was designed using a standard three layered architecture, with a Presentation layer, Application layer and Data layer. The Presentation layer contains all of the visible web pages and handles all input from, and output to the user and the Application layer handles all of the business logic and provides an abstraction to the database. The Data layer consists of the Database and stored procedures contained within the database system.

4.1.1 Architectural Model

Architectural model describes how the system works, the different modules of system, what they are for, the main interfaces, inputs and outputs. It further shows the main relationship between the frontend and backend of the system.

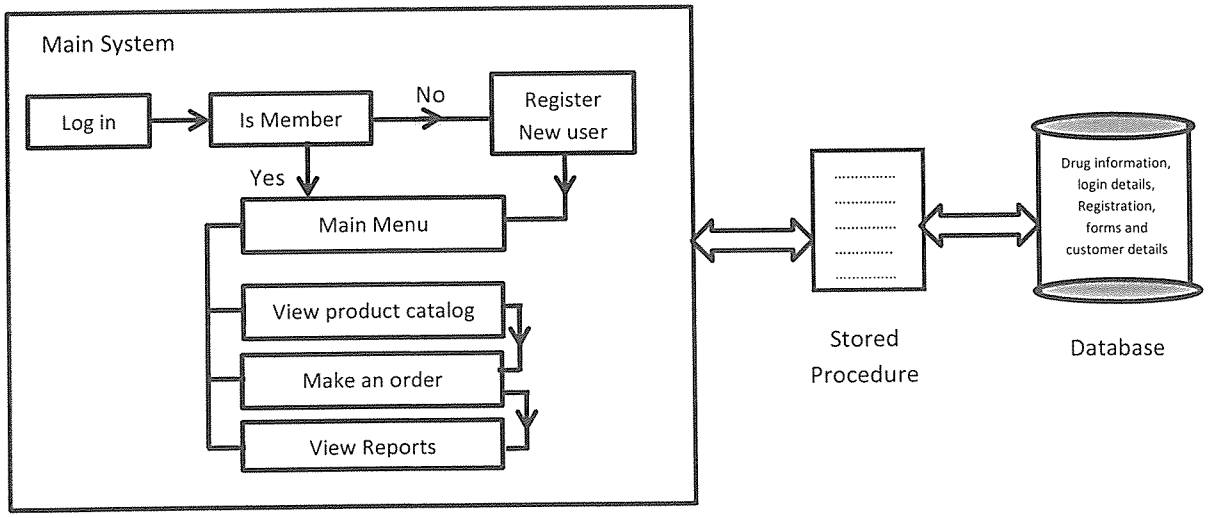


Fig. 4.1 An architectural diagram showing the system layout and design

4.2 System Requirements

The system requirements were captured, analyzed and categorized into functional requirements and non-functional requirements as the first phase of developing the online electronic pharmaceutical distribution system based on the specific objectives stated.

4.2.1 Functional Requirements

- The system should display a list of the available stock online.
- The system must allow customers make orders online.
- It should provide feedback information to the clients in form of reports
- The system allows clients make online payments.
- It allows customers to be able to print out payment bank slips.
- The system must allow printing, download and copying of the product information.
- It should allow and support administrator functions such as database configurations.
- It should be able to process and return reports, downloads and search results as output
- The system should maintain data security, integrity and availability.

4.2.2 Non - Functional Requirements

1. The system should respond fast and in a short time.
2. The system should be reliable and accessible at all times online.
3. It should be friendly, easy to use and familiar in general structure and layout.
4. The system must be compatible, robust and usable.
5. It should be interpreted, displayed and supported across several web browsers
6. The system should allow inserting, updating and deleting of supplier & drug records
7. The system should allow multiple downloads without degrading the performance.
8. It must accommodate several users at the same time without shutting down.
9. It should provide a friendly and familiar graphical user interface

4.2.3 Hardware Requirements

Hardware requirements are the tangible or hardware components that are required for the system to fully function and include a functional computer, with a mouse, keyboard, printer and a display screen. Other minimum requirements for internal hardware components include the following components:

- Pentium 4 processors and higher versions (300 MHz is recommended)
- At least 64MB of RAM (128 MB is recommended)
- 1.5GB of available space on the hard disk
- CD-ROM or DVD-ROM drive
- Video adapter and monitor with Super VGA (800 x 600) or higher resolution
- Sound card
- USB Printer

4.2.4 Software Requirements

The software requirements include all the software necessary for the system to perform as desired. These will include the following software packages:

- A web browser such as Google chrome, Mozilla Firefox, Internet Explorer
- An Operating system – Windows Server 2003, XP,7,8, and Mac OS
- Database Management Rational System – MySQL database
- Adobe flash Player

4.3 Structural Modeling

Structural modeling captures the static features of a system. It represents the framework for the system and this framework is the place where all other components exist. So the class diagram was the most widely used structural diagram and is the part of structural modeling.

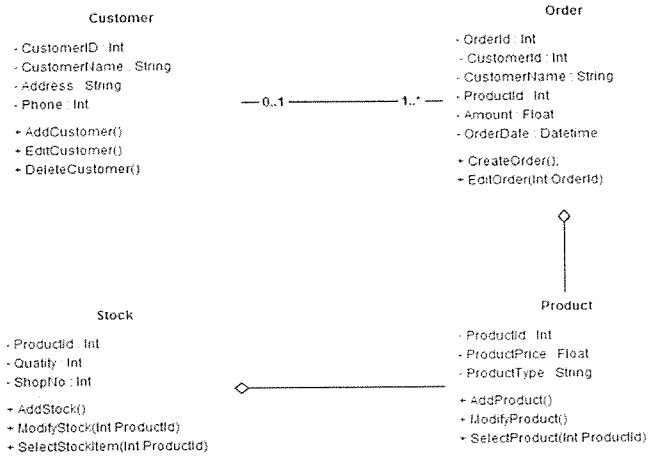


Fig. 4.2 A class diagram of the electronic system

Class diagram above represents a static illustration of the developed system and it is used to model static view of the system. The class diagram is widely used at the time of construction or implementation to coordinate the different processes in the system.

4.4 Behavioural Modeling

Behavioral modeling basically captures the dynamic aspect of a system. Dynamic aspect can be further described as the changing/moving parts of a system. In behavioural modeling we shall represent the system using use-case diagrams and sequence diagram as shown below.

Use Cases

Use Case 1: Register Customer	
Description	Allows a new customer to create a user account by obtaining a new username and password that will grant him access to the entire system
Actor(s)	Customer, Suppliers
Pre-conditions	System initializes; displays a link for creating new members, which in turn will prompt the customer to enter his/her details.
Post-conditions	The user is re-directed to the main menu
Scenario	Customer is prompted to enter his account details and then details are captured on submitting the full form.

Table 4.1 Shows Use Case 1: Register new customer

Use Case 2: Login user	
Description	Prompts user to input his username and password obtained during registration from where the user will be re-directed to the main menu
Actor(s)	Customer, Suppliers, Administrator
Pre-conditions	User is presented with an option for inputting the username and password after which he will need to click on the sign in button.
Post-conditions	The user is re-directed to the system's main menu
Scenario	User inputs correct Username and Password. User is confirmed and given full access to the system

Table 4.2 Shows Use Case 2: Login user

Use Case 3: View Product Catalog	
Description	Permits the user to view all the available pharmaceutical products in the pharmacy store by displaying a list of the products.
Actor(s)	Customer, Suppliers, Manufacturer, Administrator
Pre-conditions	System should contain a list of all the currently available drugs or pharmaceutical products with an option for making an order.
Post-conditions	Returns a product catalog with product names, description and prices.
Scenario	User clicks on view product catalog, the system returns all the drugs available in the store with their names, prescriptions and prices.

Table 4.3 Shows Use Case 3: View product catalog

Use Case 4: Make Order	
Description	This use case presents an order form that the user will use to make an order for a specific product or a group of chosen products.
Actor(s)	Customer.
Pre-conditions	Product must be available, customer should be registered with a valid customer ID and the product should have a product ID
Post-conditions	Fully filled form is submitted and the order is confirmed.
Scenario	Customer fills in an order form, provides his shipping or delivery address and phone, chooses specific form of payment and makes an order

Table 4.4 Shows Use Case 4: Make Order

Use Case 5: View Reports	
Description	Provides user with all the business reports, update reports and customer reports detailing all the system's major activities
Actor(s)	Administrator, Customer.
Pre-conditions	The system displays a list of the all the different reports. The reports are generated each time an activity is performed within the system.
Post-conditions	Displays a list of details pertaining to that particular report.
Scenario	User clicks on the report of his choice, the report is generated and return. All the report details are displayed relating to that activity.

Table 4.5 Shows Use Case 5: View Reports

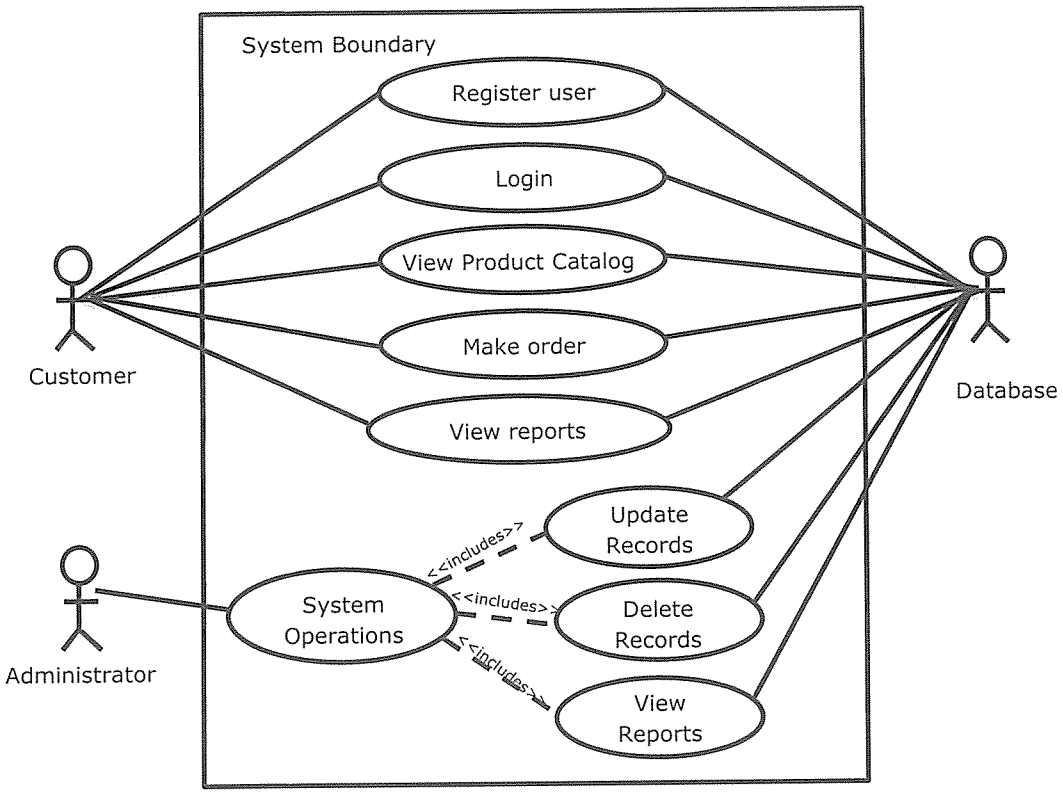


Fig. 4.3 Use case diagram showing Actors and main processes

Sequence Diagram

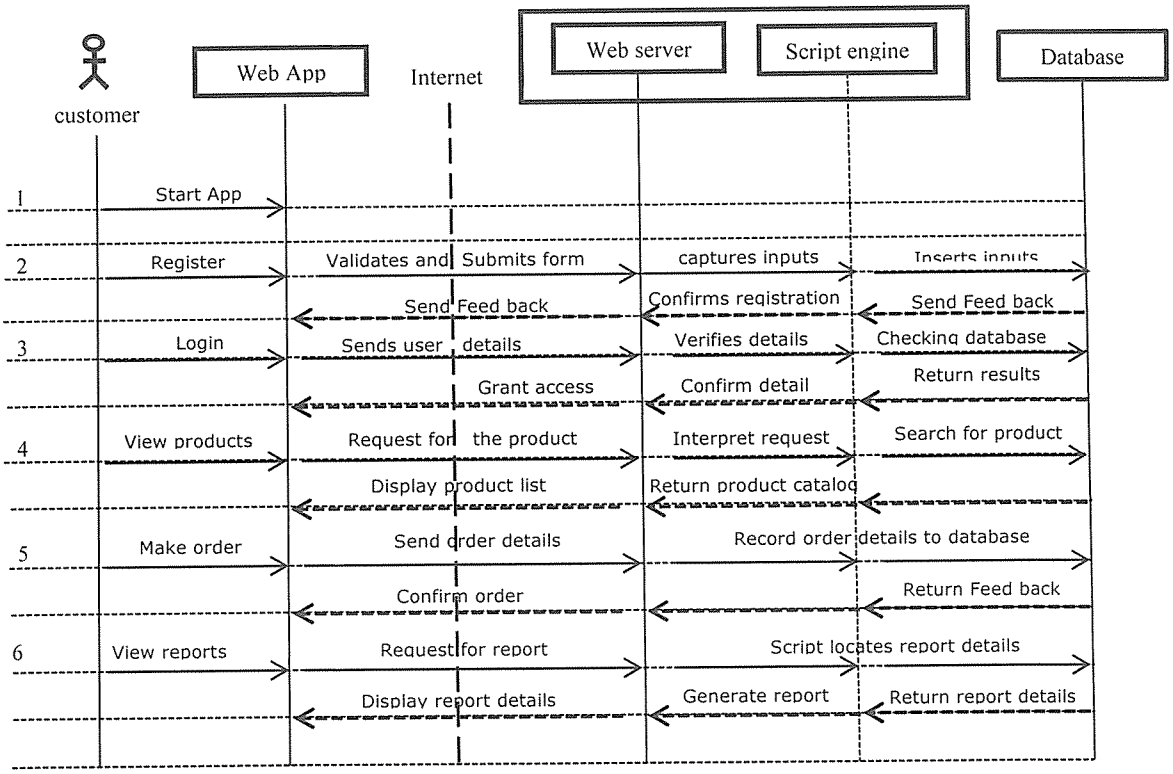


Fig. 4.5: A Sequence diagram of the Pharmaceutical Distribution system

The sequence diagram above illustrates how different objects of the system interact with each other and the order in which those interactions occur. It also presents the six main scenarios in which the customer interacts with the system from the point of registration, logging in to the point of making orders and viewing reports.

4.5 Data Modeling

Data modeling is a data-centered technique used to model business data requirements and design database systems that fulfill those requirements If a data model is used consistently across systems then compatibility of data can be achieved. There are several notations for data modeling which include "Entity relationship model" that was used to depict data in terms of the entities and relationships.

4.5.1 Entity Relationship Diagram (ERD)

Entity-relationship modeling is a relational schema database modeling method, used in software engineering to produce a type of conceptual data model (or semantic data model) of the system. An entity-relationship model (ERM) is an abstract conceptual representation of structured data.

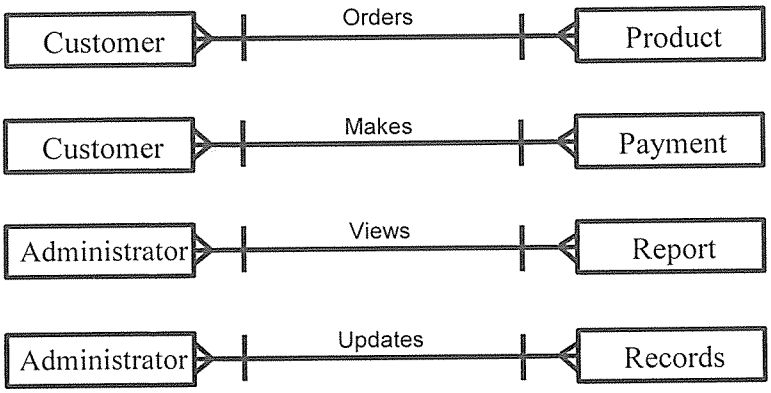
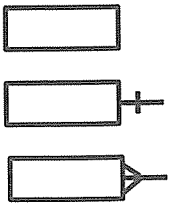


Fig. 4.6: Shows specific Relationships between different Entities

Key



Represents an Entity

Represents one to one relationship

Represents many to many relationship

e.g. Entity diagram represents: One or more customers order one product or many products

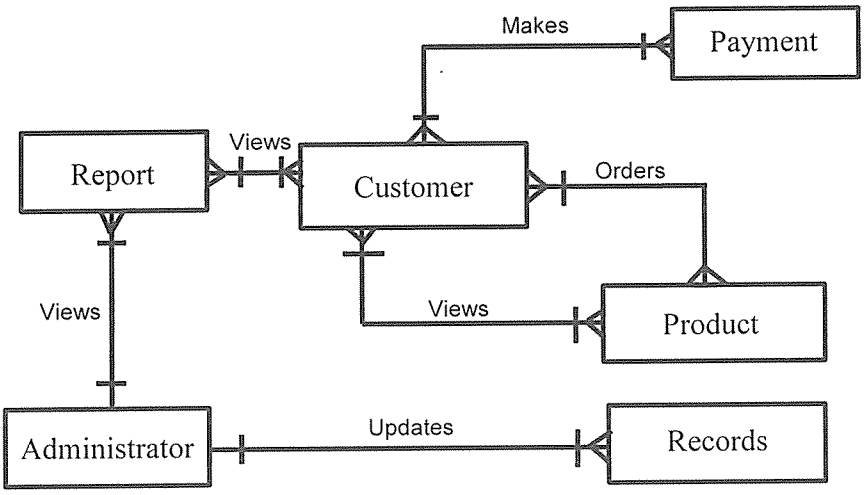


Fig. 4.7: Entity Relationship Diagram of the online system

The figure 4.7 above shows an Entity Relationship Diagram of the system that uses Crow's Foot notation as the data modeling technique to represent different entities, and the relationships as lines between the boxes. Different shapes at the ends of these lines represent the cardinality of the relationship. In the figure above, the customer can view a product or a group of products, make an order or several orders and view the corresponding reports and notices. The relationship between the different entities is clearly shown.

4.5.2 Database Schema

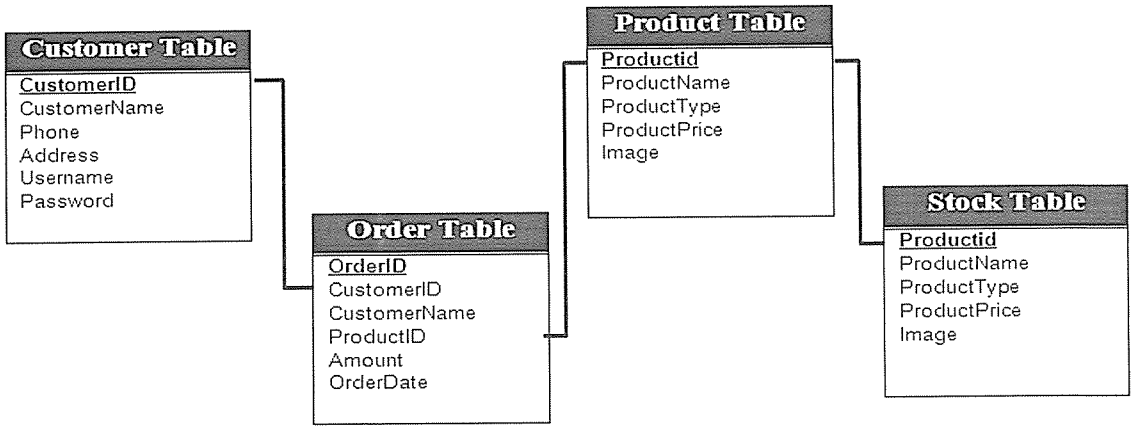


Fig. 4.8: Database Schema representing major tables

4.6 User Interface Design

The user interface design illustrates all the system layouts of the different pages of the web application. It provides a guide for building the system interface that will be used by the customer and other system users.

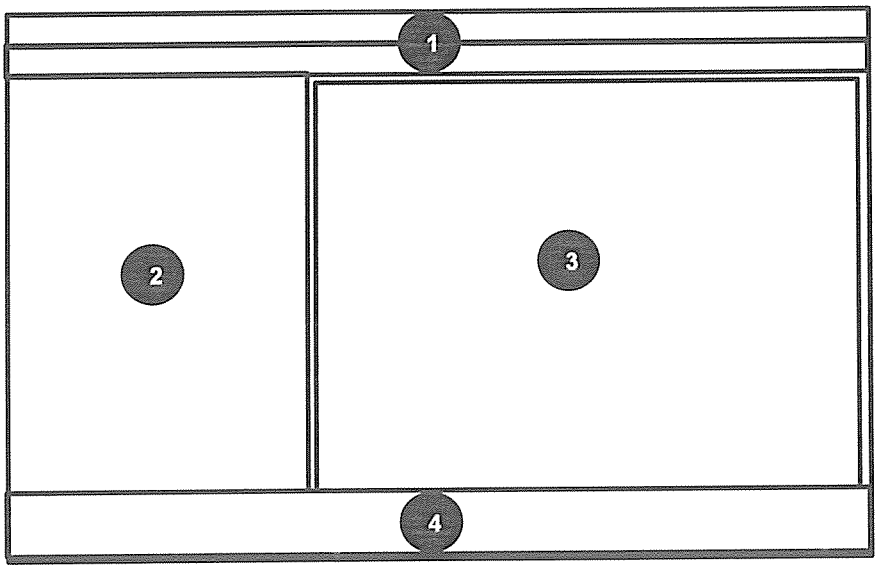


Fig. 4.9: System site map

Based on the figure above which shows the entire layout of the system interface in which it contains a top menu bar, that has the system title, search bar, help button and a shortcut menu, a main sidebar, that has all the main system links and menu, main content section which is where all the system on that page goes, and finally the footer section of the system.

CHAPTER FIVE
SYSTEM IMPLEMENTATION RESULTS

5.0 Introduction

This chapter highlights and shows the results of the system implementation mainly the snapshots for each of the activities in the system along with the discussion of each activity describing users and how it works. Each snapshot describes every single step of the iPharm Application.

5.1 Snapshots of the inputs:

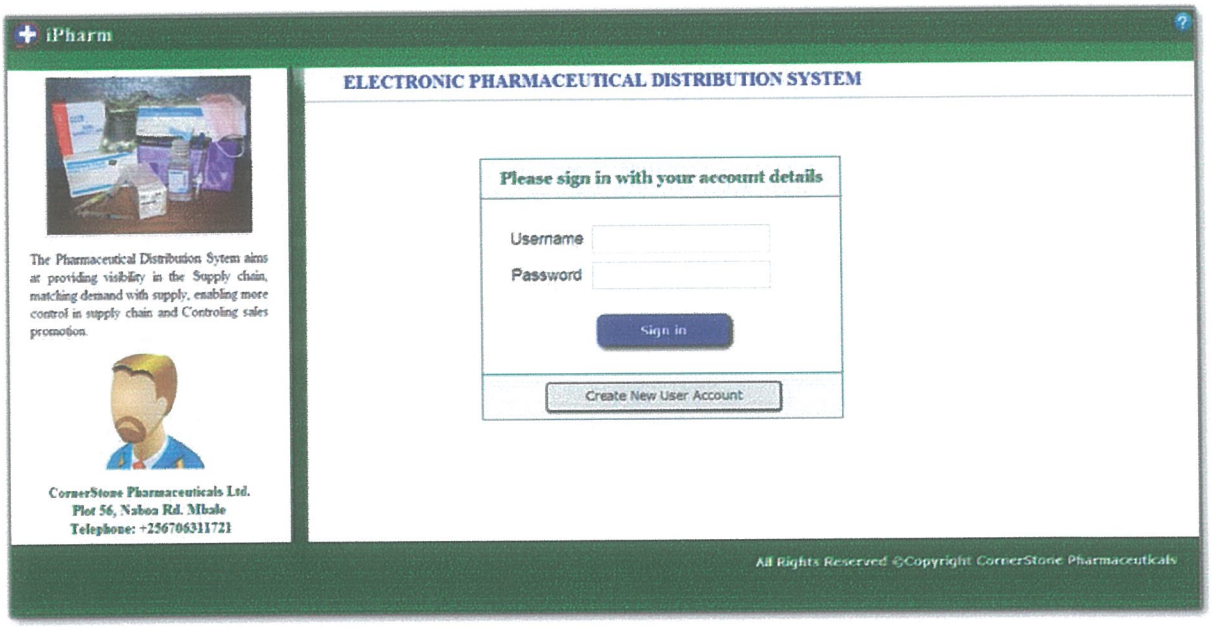


Fig 5.1: System login page

The snapshot in fig. 5.1 represents the system login page which is the first screen activity performed by the user. The system users who include the customer, suppliers and Administrators are prompted to enter their username and password for existing users in order to log into the system, while new members or users are supplied with an option of registration in order to create a new user account.

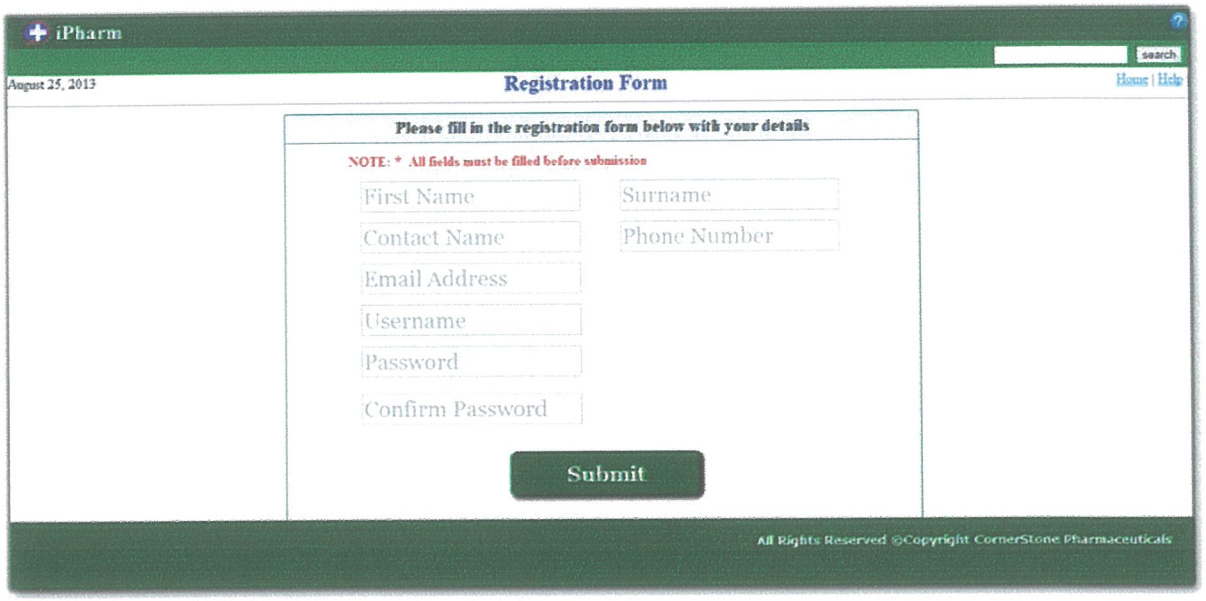


Fig. 5.2: Registration form

The screenshot in fig. 5.2 represents the second activity snapshot that presents a registration form for creating a new user account. This page is used by a new member to the system, to add or fill in their account details so as to gain access to the system. The user is the directed to Home page on submitting the registration form.

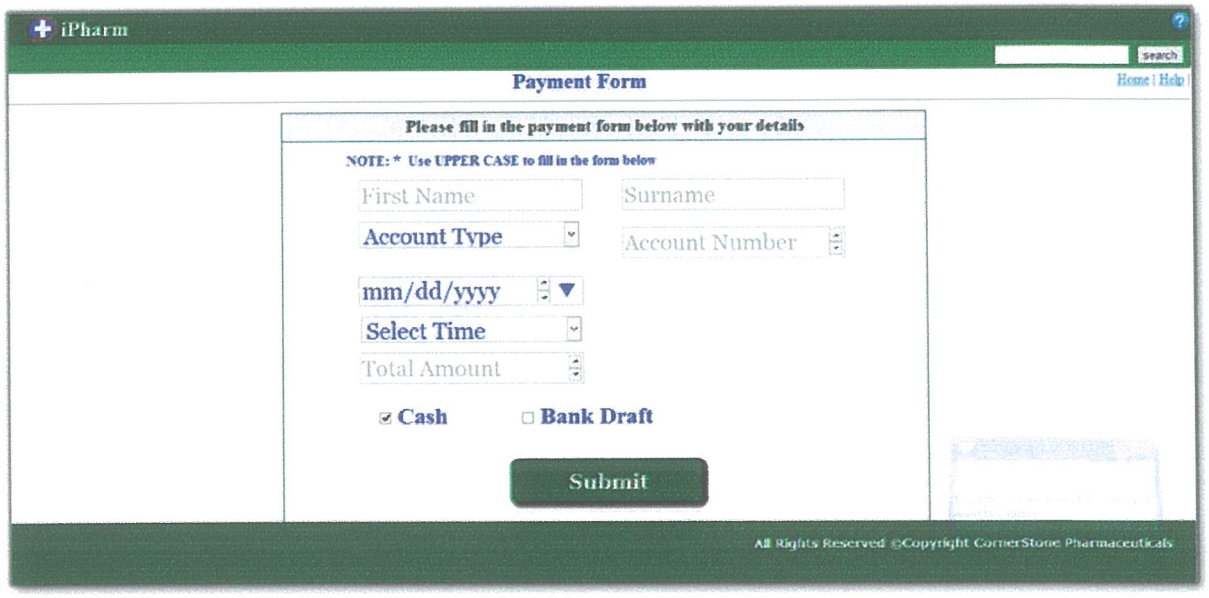


Fig. 5.3: Snapshot of an order form

The screenshot in fig. 5.3 shows an order form for CornerStone Pharmaceuticals. The form above is used by customers to make orders for drugs and other products. Before filling in the form, the customer is asked to choose the mode of payment and is re-directed to confirmation page.

5.2 Snapshots of the outputs:

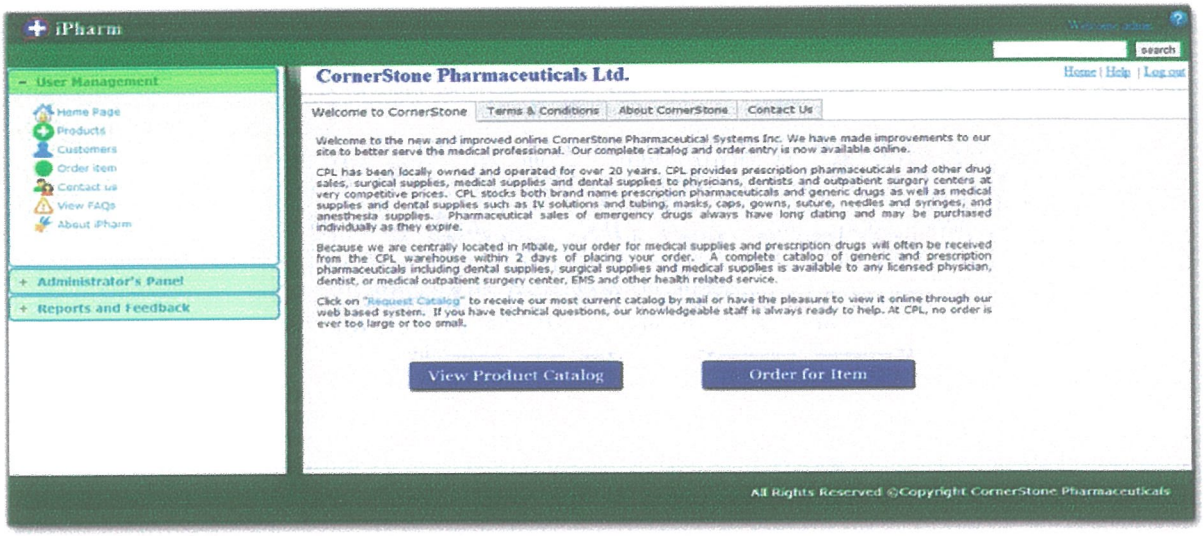


Fig. 5.4: Shows the system's Home page

The snapshot in fig. 5.4 shows the system's main page that contains a left sidebar having a collapsible menu linking to all the system's pages. The screenshot is used by both customers and administrators to navigate and use the system for the various functions. It also displays four main tabs that contain a welcome message, terms & conditions, about the organisation and the organization's contacts.

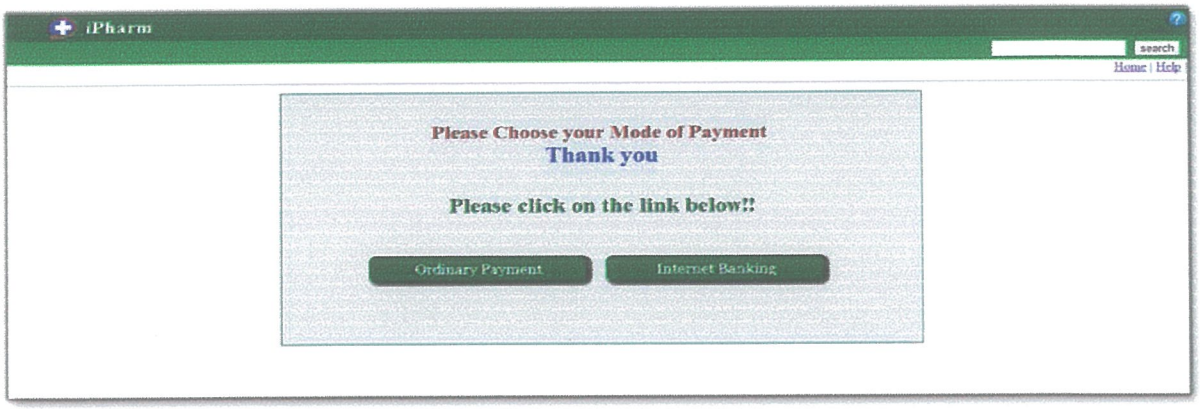


Fig. 5.5: Shows Choose mode of payment page

The snapshot in fig. 5.5 shows an output screen that is used by the customers to choose the mode of payment when purchasing for the drugs online. On selecting an option, the customer is directed to the order form shown in figure 5.3.

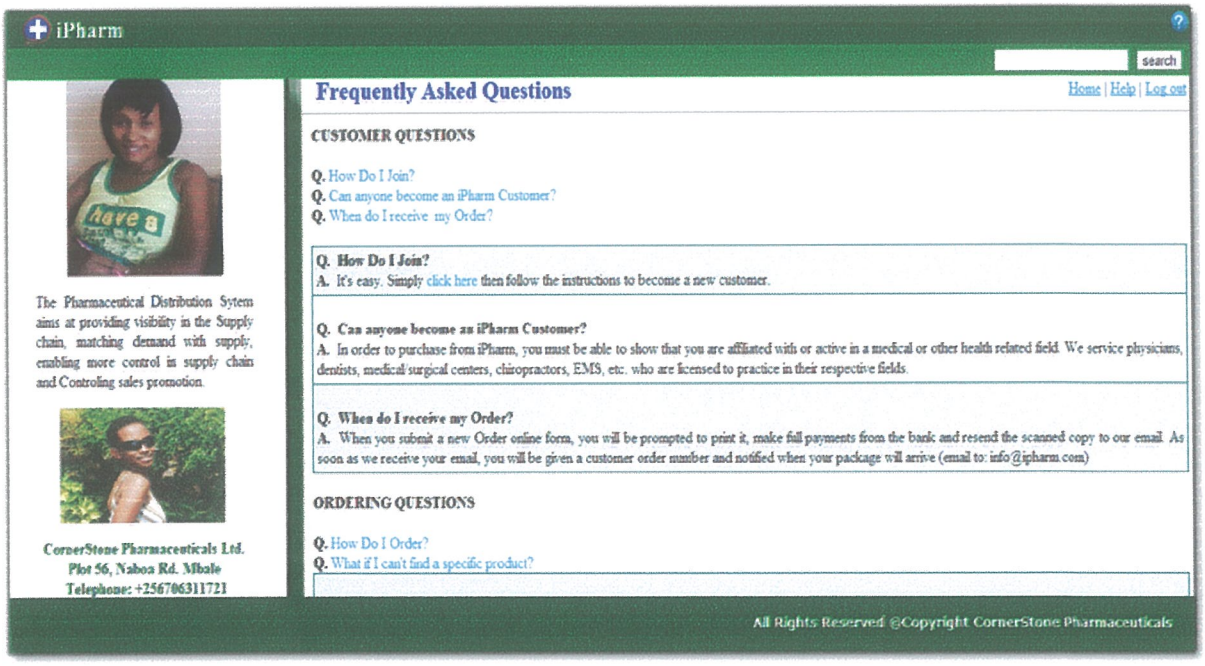


Fig. 5.6: Shows Choose mode of payment page

The snapshot in fig. 5.6 shows the help page that contains the frequently asked questions that help new members and existing users to use the system with ease. It provides a list of most

commonly asked questions and their answers. This page is very helpful because it also contains the search tool that is used to find products and other items on the system as shown below.

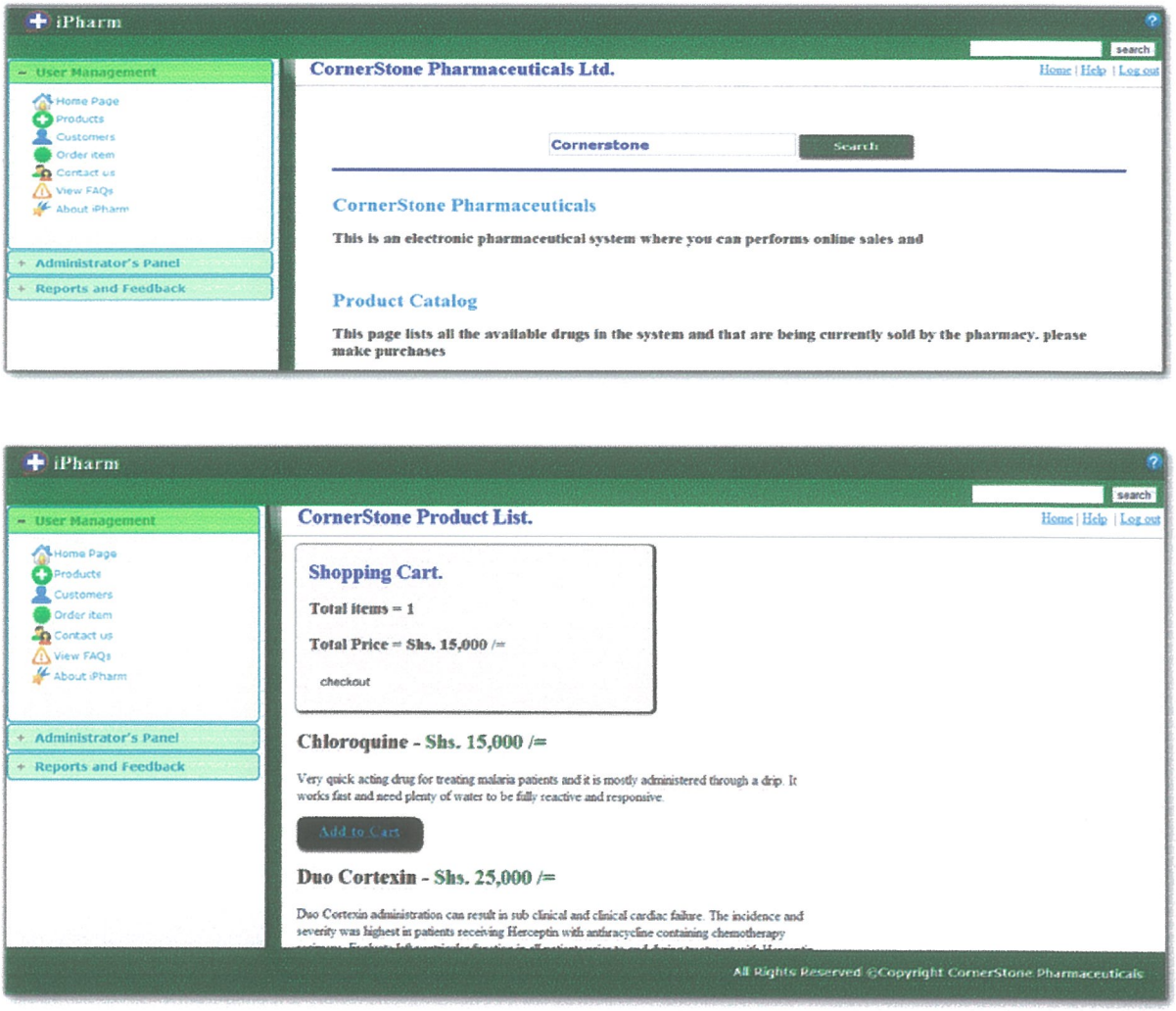


Fig. 5.9: Presents the products page for making online orders

The snapshot in fig. 5.9 represents the products page that is used by the customers to order for pharmaceutical products online. The products and their names, prices and details are displayed on the page. The customer keeps adding products to the cart and checkout once his finished.

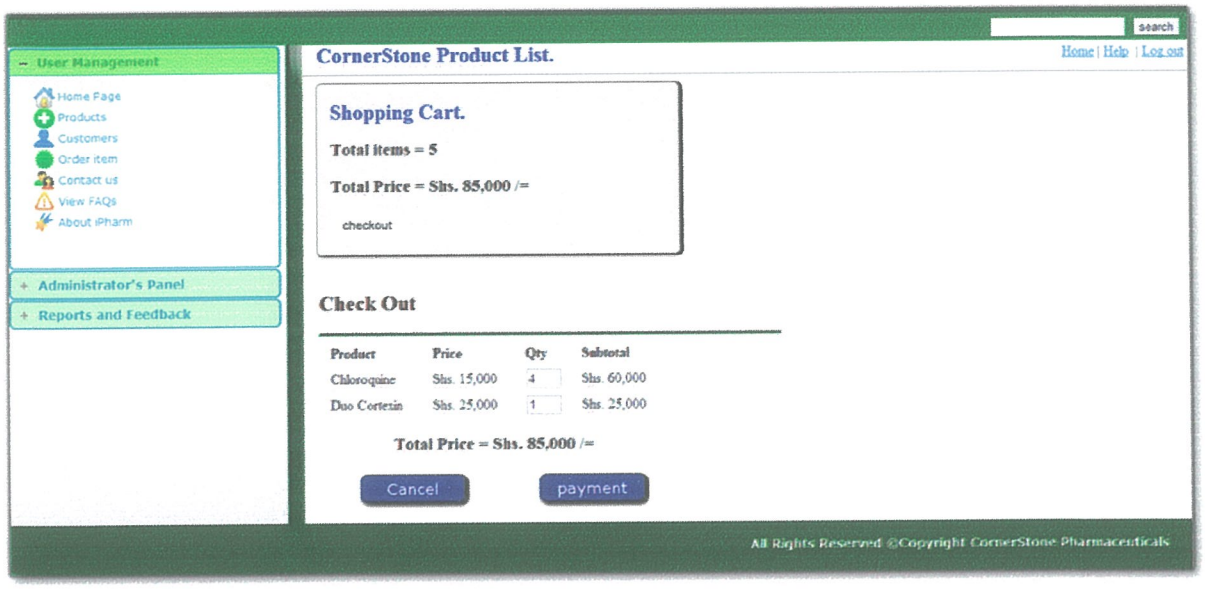


Fig. 5.10: Presents the checkout page for making online orders

The screenshot in fig. 5.10 shows the next activity screen displayed once the customer has already selected the products to purchase. The customer has an option to cancel or make online payment.

5.3 Snapshots of the Reports

The snapshots of the reports include all the pages that have been returned with content from the database or notifications concerning certain activities within the system. These screenshots return important messages to the user informing him/her as well as giving them a feedback from an already performed action or event.

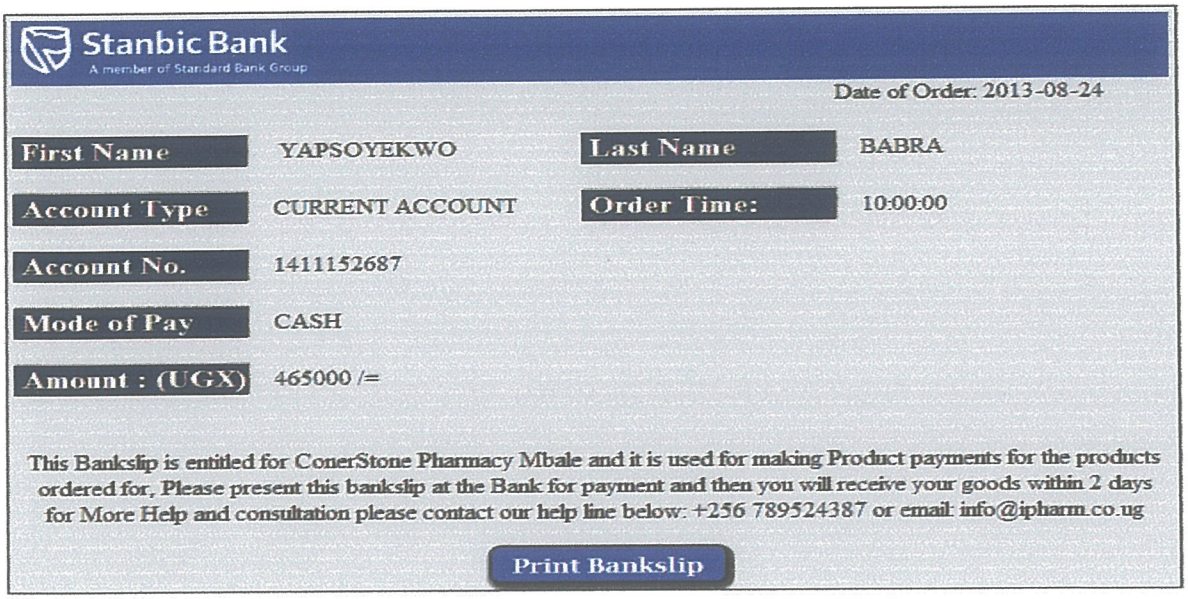


Fig. 5.11: Shows Bank slip for making payments

The screenshot in fig. 5.11 shows a report of the customer's Order details inform of a bank slip that should be presented at the Bank after printing it out. It is after making this payment that the order will be proceed and the products delivered to the customer's doorstep.

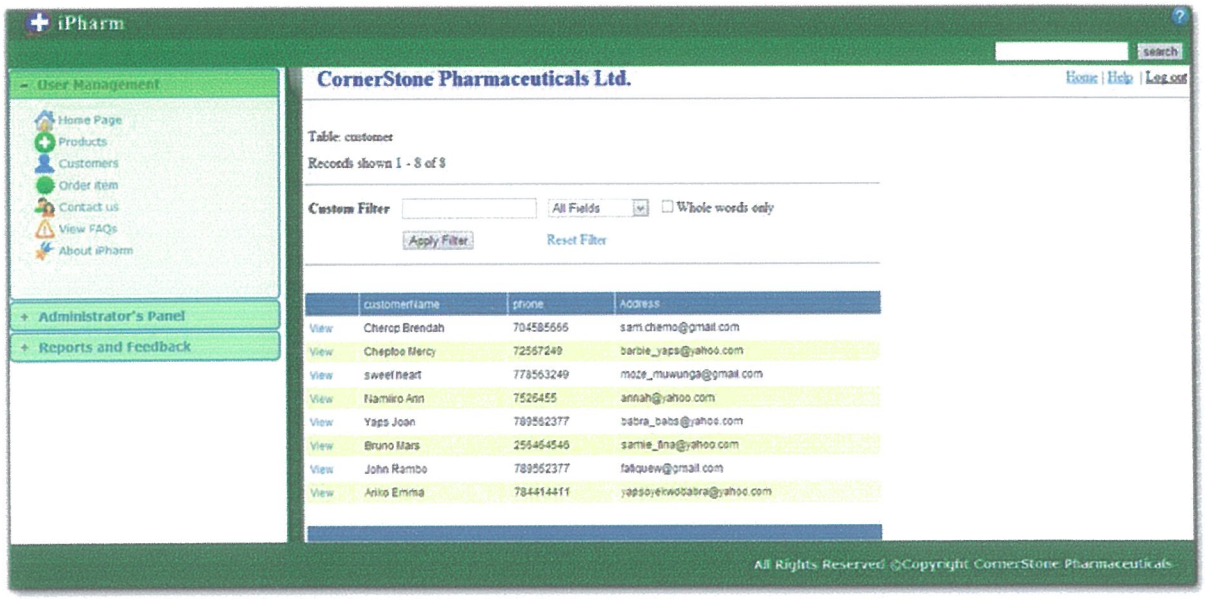


Fig. 5.12: Shows a report of the list of customers

The screenshot in fig.5.12 shows a list of all the available customers, the page is used by suppliers to find customers for their products and also receive details of the different customers. This page is also used to view the number of system users.

CHAPTER SIX
DISCUSSIONS, RECOMMENDATIONS AND CONCLUSION

6.0 Introduction

This chapter marks the end of the research report and highlights on the system overview, the limitations of the system and future recommendations for better systems as well as stating a general conclusion. It also attempts to mention the challenges faced during system development and design as well as the possible solutions in among the discussions.

6.1 System Overview

Electronic Pharmaceutical Distribution System is a web based application that is equipped to control the delivery, speed, and release of drugs, monitor the supply of drugs and prevent the distribution of expired and illegal drugs to the market. The online electronic system will enable rapid matching of the supply of drugs with the high demand since it will be accessible at all times from everywhere. The system covers and enables pharmaceutical agents get access to pharmaceutical distribution systems in order to manage and make delivery arrangements, to be able to view current distribution status and check for available drugs as well as keep information on different drugs and customers.

This project was developed using PHP at Front End and MySQL server as backend. Other important languages will include HTML, CSS, and Java Script that played a vital role in the development of the Graphical user Interface of the system. Main system functions such as viewing product lists, making orders, generating reports where all spawned with PHP functions.

6.2 System Limitations

- Insecurity and threats to the entire system led to restricted use and access to the database since full access to the database may increase chances of the hackers breaking into the system using system flaws and links to the backend.
- Compatibility problems such as failure to display certain web elements and difficulty displaying on older browsers because of other features that are developed in latest technologies such as HTML 5 and CSS 3.

- Internet speeds and network capacity or bandwidth also greatly affect the performance of the system limiting it from displaying faster or from loading all the system elements that complete the online system
- Database management System may also limit the number of users accessing it at a time depending on its capacity to hold several users or not.

6.3 Recommendations

- Pharmaceutical Distribution system should in future implement mobile payments to ease and increase the payment options within the system.
- The developed system should also be extended to be available on both large screen devices and small screen devices such as tablets and the mobile phones for ease of access to the pharmaceutical distribution system.
- In the presence of enough funds, a trust-worthy third party organization should be consulted to be used for outsourcing some system parts like the database that need full restriction and high data security.
- Inclusion of an online telephony or internet calls could be an added option to making orders online to save much time and struggle for those customers who wish not the fill in order forms again and again.
- Recommend the use of data entry devices to input and update the products and records such as bar code readers as opposed to the current form of updating the drug products.

6.4 Discussions

From the results obtained during the research study showed that the current system which revolves around manual issuing of receipts, record taking and cash on delivery led to so many expenses on books for record keeping, loss of records, difficulty in locating and tracing drugs, and customer information as well as delayed services, overcrowding and congestion at the pharmacy premises.

The electronic pharmaceutical distribution system developed focuses on solving most of the problems faced by the current system by providing quick search for drugs, customers, receipts and pharmacy information, as well as providing quick services and delivery of rpoducts in time to the right customers and medical centers.

6.5 Conclusion

The research study was based on the current system used at CornerStone pharmaceutical Limited that involved distribution of drugs and medical products. The findings obtained from the different data collection methods, were analyzed and presented in formal matter, in which both staff and customers participated showed a lot of weaknesses in the current system therefore calling for a profound solution such as the online pharmaceutical distribution system developed.

The developed solution, which is the online electronic pharmaceutical system, iPharm, performs online sales and orders using the ordinary mode of payment with an extra option for internet banking that is yet to be implemented since most banks in Mbale and Uganda at large have intentions of implementing internet banking in the near future.

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APPENDICES

Appendix A: The Research Budget

S/No.	Items	Qty	Unit Cost (UGX)	Total (UGX)
01	Printing Proposal documents	2	30,000	60,000
02	Data Collection process	-	150,000	150,000
03	Buying Data Analysis software	2	50,000	100,000
04	Hiring computers for designing the system	2	300,000	600,000
05	Internet services for research and terminologies	1	100,000	100,000
06	Rewriting Comprehensive report of Findings	2	30,000	60,000
07	Transportation and Airtime	2	30,000	60,000
08	Final Thesis Correction and Binding	2	50,000	100,000
	TOTAL			**1,230,000**

Appendix B: The Work plan and Timeframe

S/No.	Activity	1	2	3	4	5	6	7	8	9	10	11	12
01	Feasibility study												
02	Prepare, and Produce Proposal												
03	Field Work- Data Collection												
05	Investigating the current system												
06	Rewriting Comprehensive report												
07	System design												
08	System implementation												
09	Testing and integration												
10	Final report writing												

Appendix C: The Questionnaire

PHARMACEUTICAL DISTRIBUTION SYSTEM QUESTIONNAIRE

This research is conducted by students of Kampala International University to determine the problems of the current system, pharmacy regulations, and policies needed by CornerStone Pharmaceutical Distribution System to ensure supply and good drug delivery services. You are requested to assist in answering the following questions to the best of your knowledge.

Please Tick the correct option or choice where applicable

All responses given in this questionnaire will be confidential and only used for research

Q1: Does the pharmacy have drug laws and regulations that cover pharmaceutical management and quality?

☐ Yes ☐ No ☐ Don't know ☐ Not applicable

If yes, provide additional information below to support your answer by checking any of the boxes shown below.

.....

.....

.....

Q2: Since you joined CornerStone Pharmacy Ltd to the present day, what problems have you faced as an employee of the above company? (Choose Two)

A. Difficulty in tracing and finding requested drugs within the pharmacy ☐
B. Finding and tracking regular customer records and old receipts ☐
C. Congestion and crowding of customers at your station ☐
D. Failure to detect expired drugs within the pharmacy store in time ☐

Q3: Does the pharmacy have enough qualified personnel to serve customers, issue medical prescriptions and give the correct drugs and information?

☐ Yes ☐ No ☐ Not sure ☐ Don't know

Q4: How has the pharmacy management ensured proper delivery of drugs, accountability and consistent track and recording of available drugs?

A. Enforce proper record keeping and management at the pharmacy ☐
B. Perform regular checks and weekly assessment of the drug records ☐
C. Have daily transportation and delivery of drugs to medical centers ☐
D. Strict supervision and monitoring of the staff to ensure good performance ☐

Other, Specify:

.....

.....

.....

Q4: What are the different payment-modes accepted at the pharmacy and used by the customers to purchase products from CornerStone Pharmacy Ltd?

A. Cash Only ☐
B. Bank Cheque ☐
C. Mobile Money ☐
D. Western Union ☐

Q5: Are there regulatory requirements that CornerStone Pharmacy must follow to select reliable suppliers for pharmaceutical procurement or purchasing to ensure product quality?

A. There is an officially appointed committee responsible for the supplier selection ☐
B. Carry out reference checks and information exchange between other pharmacies where the products were produced or supplied or marketed took place ☐
C. Ensure that all the drugs and items supplied have product certification ☐

Other, Specify: .....

----------END----------

Appendix D: The Sample Codes for the System

```
<?php

 /**
  * connects to database server and selects database
  * @return bool
  */
 function db_connect()
 {

   $connection = mysql_pconnect('localhost', 'root', '');

                 if(!$connection)
                 {
                  return false;
                 }

                 if(!mysql_select_db('pharm'))
                 {
                  return false;
                 }

                 return $connection;

 }

        /**
         * Turns MYSQL resource into array
         * @param resource $result
         * @return array
         */
        function db_result_to_array($result)
        {
                $res_array = array();

   for ($count=0;  $row = mysql_fetch_array($result); $count++)
   {
    $res_array[$count] = $row;
   }

                return $res_array;

        }
```

```
/**
 * finds products and lists them in DESC order
 * @return array
 */
        function find_products()
        {
         db_connect();

                $query = "SELECT * FROM product order by product.productid DESC";

                $result = mysql_query($query);

                $result = db_result_to_array($result);

                return $result;
        }

/**
 * finds one product by id
 * @return array
 */
        function find_product($productid)
        {
         db_connect();

                $query = sprintf("SELECT * FROM product WHERE product.productid = '%s'",
                                mysql_real_escape_string($productid));

                $result = mysql_query($query);

                $row = mysql_fetch_array($result);

                return $row;
        }


?>

<?php


 function add_to_cart($productid)
 {
  if (isset($_SESSION['cart'][$productid]))
```

```
 {
  $_SESSION['cart'][$productid]++;
                        return true;
 }
                else
                {
                        $_SESSION['cart'][$productid] = 1;
  return true;
                }

                return false;
}


        function update_cart()
        {
         foreach($_SESSION['cart'] as $productid => $qty)
                {
                        if($_POST[$productid] == '0')
                        {
                                unset($_SESSION['cart'][$productid]);
                        }
                        else
                        {
                                $_SESSION['cart'][$productid] = $_POST[$productid];
                        }
                }
        }




function total_items($cart)
{
  $num_items = 0;

                if(is_array($cart))
          {
                        foreach($cart as $productid => $qty)
                        {
                                $num_items += $qty;
                        }
                }

                return $num_items;
```

```
}

function total_price($cart)
{

  $Price = 0;

            $connection = db_connect();

            if(is_array($cart))
        {
                    foreach($cart as $productid => $qty)
                    {
                            $query = "SELECT productPrice FROM product WHERE
product.productid = '$productid'";
                            $result = mysql_query($query);
                            if($result)
                            {

                                    $item_price = mysql_result($result, 0, 'productPrice');
                                    $Price += $item_price * $qty;
                            }
                    }
            }
             return $Price;
}


?>
```