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DESIGN OF A DRUG INFORMATION MANAGEMENT
SYSTEM

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Design of a Drug Information Management System

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DEDICATION

I would like to dedicate this project to people whom have lost loved ones from adverse drug reactions and to my family who have given me everything I have needed in life.

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First and foremost, I would like to thank GOD for giving me the strength and will power needed to finish this project. I will not have achieved anything in my life if not by his grace.

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Table of Contents

DEDICATION.....	I
ACKNOWLEDGMENT	ii
ABSTRACT	ix
CHAPTER ONE	1
INTRODUCTION	1
1.1 Background	1
1.2 Statement of the problem	2
1.3 Objective of The Project	2
1.3.1 General Objective	2
1.3.2 Specific Objectives	2
1.4 Scope and Limitations of the Project.....	3
1.5 Significance of the Project	3
CHAPTER TWO	5
LITERATURE REVIEW	5
2.1 Medication.....	5
2.2 Pharmacy Informatics	5
2.3 Health Information Management System (HIMS)	6
2.4 Consumer Health Informatics.....	7
2.5 Web based Drug Information Management System	7
2.6 Smartphone for Healthcare	7
2.6.1 Need for Mobile Devices at the Point of Care	7
2.6.2 How Health Care Professionals Use Mobile Devices and Apps	8
2.7 Related Works.....	8
2.7.1 Literature Research and Review.....	8
2.7.2 News Acquisition	9
2.7.3 Drug References	9
2.7.3.1 Lexi-interact	9
2.7.3.2 MPR.....	10
2.7.3.3 Epocrates.....	11
2.7.4 Drug info.aau.wordpress.com.....	12

CHAPTER THREE	13
METHODOLOGY	13
3.1 Study Design	13
3.2 Study Population and Sampling Technique	13
3.3 Data Collection Tools and Procedure	15
3.4 System Analysis and Design	15
3.4.1 Object Oriented Analysis (OOA)	15
3.4.2 Object Oriented Design (OOD)	15
3.4.3 Object Oriented Modeling (OOM)	16
3.4.4 System Design Approach and Development tools	17
3.4.4.1 System Design Approach	17
3.4.4.2 Development Tools	17
3.4.5 System Testing Approach and Testing Tools	17
3.5 Operational Definitions	18
3.6 Ethical Consideration	19
3.7 Dissemination of Result	19
CHAPTER FOUR	20
REQUIRMENT ANALYSIS	20
4.1 The Current System	20
4.2 Proposed System	21
4.2.1 Functional Requirements	22
4.2.2 Non-Functional Requirements	23
4.3 UML Models	24
4.3.1 Use-case Diagram	24
4.3.1.1 List of Actors	24
4.3.2 Class Diagram	36
4.3.3 Sequence Diagram	38
CHAPTER FIVE	42
SYSTEM DESIGN	42
5.1 System Architecture	42
5.2. System Decomposition	45
5.3 Prototype Implementation	46

5.3.1 User Interface Prototyping	46
5.3.1.1 Web based Drug Information Management System User Interface	47
5.3.1.2 Smartphone Based Drug Information Management Application	53
5.3.2 The Database Layer	57
5.4 System Evaluation.....	58
5.4.1 System Performance Measures	58
5.4.1.1 Average Time on Tasks.....	58
5.4.1.2 Tasks Success Distribution by Participants.....	59
5.4.1.3 Average Time on Task by Participants	60
5.4.1.4 Average Time vs Expected Time	61
5.4.2 System Usability Test	62
CHAPTER SIX	65
CONCLUSIONS AND RECOMMENDATION.....	65
6.1 Conclusion.....	65
6.2 Recommendations.....	66
REFERENCES	67
A.01 Interview questionnaire	69
A.02 Sample Source Code	74
A.03 User Interfaces.....	76
A .04 Interview Questions for Usability Test Participants.....	79
A .05 Task Description.....	80
A.06 Use-case Description	82

LIST OF FIGURES

FIGURE 1: Working model of pharmacy informatics	6
FIGURE 2: MPR smartphone application homepage	11
FIGURE 3: Time taken to respond to enquiries by DIC at TASH	21
FIGURE 4: System Use-case diagram for DIMS	25
FIGURE 5: Class diagram for DIMS	36
FIGURE 6: View information sequence diagram	37
FIGURE 7: Send feedback sequence diagram	38
FIGURE 8: Add information sequence diagram	39
FIGURE 9: Login sequence diagram	40
FIGURE 10: DIMS website system architecture	42
FIGURE 11: DIMS smartphone application system architecture	43
FIGURE 12: DIMS website system decomposition	44
FIGURE 13: DIMS smartphone application system decomposition	45
FIGURE 14: DIMS website Homepage English	46
FIGURE 15: DIMS Website homepage Amharic	47
FIGURE 16: All Drugs by brands	48
FIGURE 17: Detailed description of the selected drug by brand	49
FIGURE 18: List of drug generics	50
FIGURE 19: Detailed description of the selected drug generic	51
FIGURE 20: DIMS smartphone application homepage	52
FIGURE 21: DIMS smartphone application fill reminder	53
FIGURE 22: DIMS smartphone application all drugs with search	54
FIGURE 23: DIMS smartphone application favorites	55
FIGURE 24: All tables in the database	56
FIGURE 25: Average time on task by task	58
FIGURE 26: DIMS website success rate by participant	59
FIGURE 27: DIMS website average time taken by participants to complete the tasks	60
FIGURE 28: DIMS website average time vs expected time	61

LIST OF TABLES

TABLE 1: Use of mobile and application by healthcare professionals	8
TABLE 2: Summary of participant profile	14
TABLE 3: Summary of methodology	18
TABLE 4: list of functional requirements	23
TABLE 5: List of use- cases	24
TABLE 6: View information use case description	26
TABLE 7: Send feedback use case description	27
TABLE 8: Manage favorites use case description	28
TABLE 9: Modify favorites use case description	29
TABLE 10: Add reminders use case description	30
TABLE 11: Modify reminders use case description	31
TABLE 12: Add information use case description	32
TABLE 13: Modify information use case description	33
TABLE 14: Login use case description	34
TABLE 15: Result from Likert scale for website	62

Acronym and abbreviations

CDSS	Clinical Decision Support System
CSA	Central Statistics Agency
DIMS	Drug Information Management System
DRP	Drug Related Problems
FDA	Food and Drug Agency
FMHACA	Federal Medicine, Health, Administration and Control Authority
HSTP	Health Sector Transformation Plan
MOH	Ministry of Health
OOA	Object Oriented Approach
PHP	Hypertext Pre-Processor
SDLC	System Development Lifecycle
UML	Unified Modeling Language
WHO	World Health Organization
XAMMP	Extensible Access Control Markup Language

ABSTRACT

Background - Drug information management system (DIMS) is a system that provides drugs information for the doctors, pharmacists and non-health people. The drug information includes drug categories, trade name, generic name, manufactured company, drug contents, indications, dosage, contradiction, special precaution, and drug adverse reaction and drug interactions. In addition to drug information the users will be able to set reminders on drug intake schedules, get information on events related to medications and get news related to the medication industry.

Objective – This project attempts to develop a drug information management system on website platform and smartphone application.

Methods– To develop the drug information management system, we have used object oriented system analysis and design methodology. UML Tools used for analysis, design phases and for the development of the system programming tool like CSS and PHP were embedded with HTML and MYSQL database language. Integration of development modules and testing was implemented to bring the functionality of the system.

Results - System analysis was done by using functional, object and dynamic models. The functional model is described by use case diagrams, object model is described by class diagram, and the dynamic model is described by sequence diagrams. Both performance and usability tests were conducted to measure the performance of the system. These tests help to describe to what extent the system is usable. The result of system usability testing shows 92% willingness to use the system as a tool to get drug related information.

Conclusion: Generally, the prototype system serves as a drug information reference system. The initial feedback from health professionals and non-health people has been extremely positive. Hence the prototype system has achieved a good performance and meets the objectives of the project. However, in order to make the system applicable in the domain area, there is a need to include some adjustments like including more languages and price of the drugs in the current Ethiopian market.

CHAPTER ONE

INTRODUCTION

1.1 Background

Drug dosing and prescription is one of the critical functions a health professional has to do after diagnosis. Thus, diagnosis should be supported by appropriate drug prescription. otherwise inappropriate drug prescription will void the diagnosis. Inappropriate prescription includes overdosing, under-dosing, incorrect drug-drug interactions and mismatching drug with diagnosis [1].

Inappropriate use of drugs may be harmful and might lead to drug therapy problems [2]. In order to achieve a quality health care service, inappropriate use of drugs that potentially lead to problems should be identified and corrected. The philosophy of optimizing the outcomes of pharmacotherapy and pharmaceutical care leads to the concept of drug related problems (DRPs), indicating some problem in the pharmacotherapy of the patient [3]. Drug related problems (DRPs) therefore are defined as events or circumstances involving drug therapy that actually or potentially interfere with desired health outcomes. An actual problem has resulted in clinical manifestations like adverse drug reaction or therapy failure. A potential problem is not manifest, but if left unresolved, it may lead to drug-related harm to the patient [3].

Some drug therapy problems exist because of the rapidly expanding array of drug products available, the growing number of diseases being recognized and diagnosed, and the growing number of patients entering the health care system. All patient problems involving medications can be categorized into seven types of drug related problems. These are unnecessary drug therapy, need for additional drug therapy, ineffective drug, dosage too low, adverse drug reaction, dosage too high and noncompliance [4].

This system is a computerized system designed to meet the information needs of professionals related with drug dosing and prescription also consumers (clients) that want to acquire information about drugs.

Health professionals require a good understanding of therapeutic action, possible side effects and effectiveness when prescribing medications to their clients and the clients need to know how, why and when they consume the medication that has been prescribed for them by providing generic specific drug facts. Drug information in Ethiopia is currently being distributed to the professionals by mediums like posters, brand books like AFHS.

Even though drug references are disseminated to the professional, they are usually outdated and time taking. As a result, the idea to develop an electronic drug information management system (DIMS) will improve the way they acquire information on medications so as to improving their effectiveness and overall efficiency.

1.2 Statement of the problem

Doctors and pharmacists refer to drug references data in order to know the details about the specific drugs they are prescribing. At the government hospitals, the process of finding drug references data is still being done on a manual basis through drug reference books and by sending queries to the drug information centers in a study done by Fantawork Samuel [5] in 2014 about the utilization of drug information center located in the public hospitals of Addis Ababa 80.9 % of all legitimate queries was about dosage recommendation ,drug interaction ,adverse reaction , pregnancy and lactation, product availability in the Ethiopian market and price .for this queries the drug information center mode of reply was on written reply 28.3% and 18.9 % was by verbal communication. This kind of response is time taking, for the drug information center in TASH 24 % of response to the queries took a minimum of 1 day while 0.7% were responded within 2 days and 2.20% had a response time above 2 days.

According to a study, concerning Drug-related problems in medical wards of Tikur Anbessa specialized hospital, Ethiopia, Drug related problems (DRP) were found in 52% of study subjects. 44.8% of the drug related problem seen at TASH in the study time were due to adverse drug reaction (23.02%), unrelated medical condition (5.2%), inappropriate dosage (10.52%) and prescription of ineffective drug (2.4%) [6].

In a study done in USA 7000 inpatient death occurs directly due to medication error and 106000 deaths occur each year due to adverse effects of medications [7]. Therefore, the use of computerized drug information management system has been seen as a great tool in the avoidance of problems. The project aims to study the current system and come up with a prototype drug information management system tailored to Ethiopia across website platform and smartphone application for easy access by the society at large.

1.3 Objective of The Project

1.3.1 General Objective

To design drug information management system with web-based and smartphone application for health care providers and consumers.

1.3.2 Specific Objectives

The specific objectives of the project are as follows: -

- To describe the existing drug information management system.
- To collect and analyze functional and non-functional requirements.
- To develop a drug information management system website.
- To design a drug information management smartphone application.
- To evaluate the developed and designed prototypes usability.

1.4 Scope and Limitations of the Project

The main focus of the study is to develop a system that can enable health professional and non-health people to gain access to drug information, secondly the focus of the system is to enable the users to get information about scheduled events related to medication, and contact address on pharmacies. Third to set reminders on drug intake schedule and to select favorite drug to be referred by using the smartphone application.

Through the course of conducting this study, it was learned that health information management systems play a great role towards the enhancement of health care service quality. Furthermore, drug information management systems help health professionals to make patient care decisions based on patient specific data. Even though the drug information management website has been developed website, it was intended to develop a drug information management system for handheld application as well but due to time and other constraints this could not come to light.

1.5 Significance of the Project

These days' information technology plays a significant role in every aspect of our livelihood health care also benefits from these advancements. The ministry of health according to the health sector transformation plan (HSTP) has made information revolution one of the focus area and decision support systems and drug information systems are integral part of this focus. In doing so MOH has allocated 1.8% of the budget for the development of ICT in the health sector [8].

The significance of the system is classified into three major groups according to the benefactors. The benefactors are health center, health professionals and patients:

For health center and country.

- The service delivery will be fast and effective by adopting the system consistent and simple management features
- Unlike the current manual system, the system will aid clinical pharmacist or other health professional related to drug prescription increase the efficiency.
- The system will help in eliminating misuse of drugs hence helping the country save money that arises from improper drug usage

For health professionals

- To minimize the work load of the health professionals
- It will increase job satisfaction
- The system will reduce errors made in drug prescription and dosing
- It will increase the efficiency of the professional
- Increase accuracy through automation of tedious task

For patients

- Patients can get correct and reliable information for users of the system
- System will aid in acquiring of better knowledge of drugs to be used
- Improved compliance with best practice leading to improved patient outcomes
- Helps avoid habit and food that affect the healing ability of the drugs
- Saves money
- Aids in the general health of the patients

In short, the proposed system will provide a key solution for most of the problems related to drug information management such improper dosage, mismatched drug interactions and others.

CHAPTER TWO

LITERATURE REVIEW

Conducting an effective literature review enables one research or a particular endeavor to build a solid theoretical foundation [9]. This can provide a firm foundation to the selection of the methodology for the study and additionally it also enables researchers to better explain as well as understand requirements of the project. The literature review part of this project provides theoretical and empirical reviews from different journals, books and electronic sources.

2.1 Medication

Medication is an important part of health care and enabling the cure and prevention of many conditions using the appropriate drugs [10]. The word medication can explain both an act and an item. But here, medication is used to describe the detail of drugs in medicine. The most frequent and cost-effective medical intervention performed by General Practitioners is prescribing drugs, which can prevent or cure many diseases and increase the quality of life. Prescribing drugs represent the vast majority of all drugs being used but drugs is also administered in hospitals. Rational use of medications can be described as General Practitioners prescribing appropriate drugs to the patients according to the patients' clinical needs, in doses that meet individual requirement, for enough duration and convenient for patients and communities [10].

Most patients do not remember their entire medication routine and they also occasionally forget to take their medication [11]. Outpatients with chronic diseases, especially those who have to manage more than one medication or take medication more than once a day, may not take their medications properly. Patient adherence to medication is clinically essential in reducing mortality of serious disease and total health care costs [10].

2.2 Pharmacy Informatics

“Pharmacy informatics” has been defined in some contexts as the pharmacy specialty dealing with pharmacy computerization. These systems are developed in accordance with the clinical pharmacy guidelines and protocols which are developed by the WHO (world health organization). This system is developed for smartphone, tablets and computers in order to guide health workers though the full drug dosing and prescription process to deliver the service with quality. It can also help drug takers to get information's on the drug they take so as to check for side effects, check for danger sign, drug-drug interactions and drug-food interactions [12].

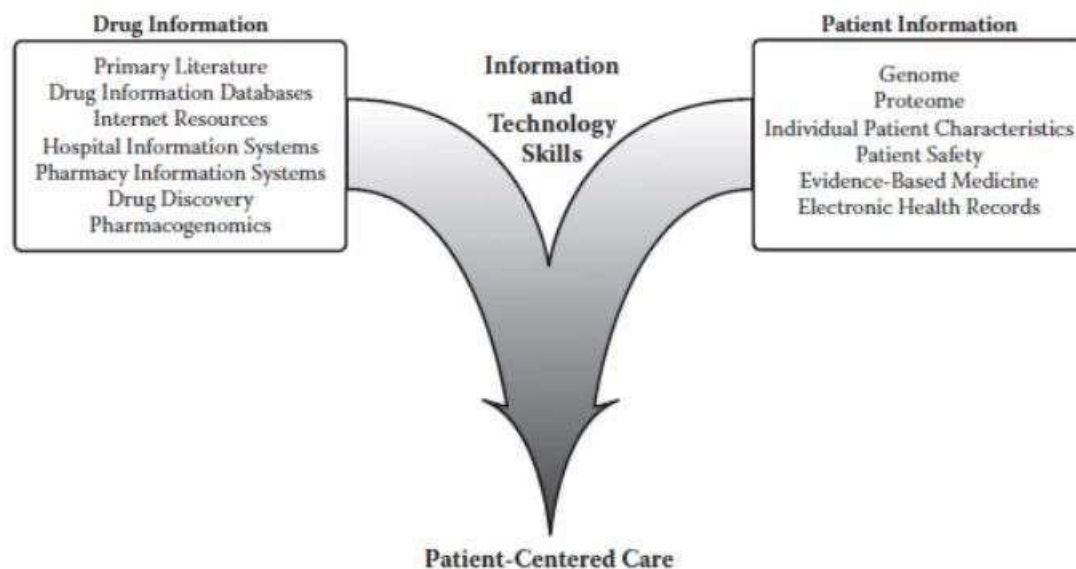


FIGURE 1: Working model of pharmacy informatics

2.3 Health Information Management System (HIMS)

Information Management system is an integrated user-machine system for providing information to support the operations, management, Analysis, and decision making functions in an organization [13]. The system utilizes Computer hardware & software, communication facilities, manual procedures Models of analysis, planning, controlling, and decision making and a database.

Healthcare organizations are increasingly operating in data -rich and information poor environments. In today's high-tech era, constantly gathering and storing data, only to never use it, because it is inaccessible, improperly formatted or presented in an irrelevant way [14]. Technology transfer and capacity building in healthcare systems is required in the developing countries. Apart from financial constraints the other important thing is the reforms in healthcare policy and a social change which is more difficult to overcome as compared to financial crisis. Information and Communication Technology (ICT) have proven to be a tremendous accelerator of economic and social progress. The speed at which ICTs are diffusing has taken many observers by surprise. Interestingly, the developing countries are ahead of the developed ones in the mobile telephones subscriptions [15].

Healthcare management is the intersection of information science, computer science, information technology and healthcare. It deals with the resources, devices, and methods required in optimizing the acquisition, storage, retrieval, and use of information in health and biomedicine. This includes not only computers but also clinical guidelines, formal medical terminologies, and information and communication systems.

2.4 Consumer Health Informatics

Consumer health informatics is the integration of consumer health information and information technology in an environment of shared health care decision- making that supports effective self health action [12].

Consumer health informatics products are designed to interact directly with the consumers with or without the presence of health care provider. This enables the user to get access to vital healthcare information without going to healthcare providers.

2.5 Web based Drug Information Management System

In general, the drug information management system is a system that provides drugs data for the doctors and pharmacists to be referred. The drug data include the drug categories, trade name, generic name, manufactured company, drug contents, indications, dosage, contradiction, special precaution, and drug adverse reaction and drug interaction. All these data are useful for doctors and pharmacists [16].

2.6 Smartphone for Healthcare

The introduction of mobile computing devices (personal digital assistants [PDAs], followed by smartphones and tablet computers) has greatly impacted many fields, including medicine. Health care professionals now use smartphone or tablet computers for functions they used to need a pager, cellphone, and PDA to accomplish [16]. Smartphones and tablets combine both computing and communication features in a single device that can be held in a hand or stored in a pocket, allowing easy access and use at the point of care [16]. In addition to voice and text, new mobile device models offer more advanced features, such as web searching, global positioning systems (GPS), high-quality cameras, and sound recorders[17]. With these features, as well as powerful processors and operating systems, large memories, and high-resolution screens, mobile devices have essentially become handheld computers [17].

2.6.1 Need for Mobile Devices at the Point of Care

One major motivation driving the widespread adoption of mobile devices by HCPs has been the need for better communication and information resources at the point of care [16] [18]. Ideally, HCPs require access to many types of resources in a clinical setting, including:

- Communication capabilities—voice calling, video conferencing, text, and e-mail [16]
- Hospital information systems (HISs)—electronic health records (EHRs), electronic medical records (EMRs), clinical decision support systems (CDSSs), picture archiving and communication systems (PACSs), and laboratory information systems (LISs) [16].
- Informational resources—textbooks, guidelines, medical literature, drug references [16].
- Clinical software applications—disease diagnosis aids, medical calculators [16].

2.6.2 How Health Care Professionals Use Mobile Devices and Apps

Health care professionals use medical devices and apps for many purposes, most of which can be grouped under five broad categories: administration, health record maintenance and access, communications and consulting, reference and information gathering, and medical education. The many uses for mobile devices and types of medical apps that fall under these categories are discussed in the following section, and are also listed in Table 1.

Information Management • Write notes • Dictate notes • Record audio • Take photographs • Organize information and images • Use e-book reader • Access cloud service Time Management • Schedule appointments • Schedule meetings • Record call schedule Health Record Maintenance and Access • Access EHRs and EMRs • Access images and scans • Electronic prescribing • Coding and billing	Communications and Consulting • Voice calling • Video calling • Texting • E-mail • Multimedia messaging • Video conferencing • Social networking Reference and Information Gathering • Medical textbooks • Medical journals • Medical literature • Literature search portals • Drug reference guides • Medical news Clinical Decision-Making • Clinical decision support systems • Clinical treatment guidelines • Disease diagnosis aids	• Differential diagnosis aids • Medical calculators • Laboratory test ordering • Laboratory test interpretation • Medical exams Patient Monitoring • Monitor patient health • Monitor patient location • Monitor patient rehabilitation • Collect clinical data • Monitor heart function Medical Education and Training • Continuing medical education • Knowledge assessment tests • Board exam preparation • Case studies • E-learning and teaching • Surgical simulation • Skill assessment tests
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TABLE 1: Use of mobile and application by healthcare professionals

2.7 Related Works

Various Studies and projects have been undertaken by different scholars internationally and locally regarding drug information management system. Review of software's for healthcare and no health care personals that directly or indirectly related to drug information management system have completed. some of these projects in accordance with their type are listed as follows:

2.7.1 Literature Research and Review

Mobile devices are invaluable tools for health care professionals to use to search or access medical literature, as well as other information sources [19]. The survey of medical school health care professionals and students found that mobile devices were often used to access medical journal websites (60%) or medical news online (74%) [19]. Several. medical journals, such as the *New England Journal of Medicine*, *he Lancet*, and *BMJ* (formerly the *British Medical Journal*), provide apps that allow articles to be viewed on mobile devices [20]. However, journals rarely provide free access to articles without the purchase of a subscription [20]. Search applications for health care professionals, such as PubMed/MEDLINE, also facilitate searches of medical literature databases to identify published medical information [16]. Mobile medical literature search apps used by

health care professionals include: Pub Search, PubMed on Tap, Medscape, MEDLINE Database on Tap (MD on Tap or Dot), Dolphin, Dowse, read by QxMD, ask MEDLINE, PICO, and Disease Associations. Pub Search is available for free, while PubMed on Tap is available for several dollars [21] [16].

Both applications work with the iOS platform to facilitate PubMed/ MEDLINE searches using the iPhone, iTouch, and iPad.⁷ The free application MD on Tap is provided by the National Library of Medicine to help HCPs using PDAs access medical information at the point of care through three search engines: PubMed, Essie, and Google [16].

2.7.2 News Acquisition

Med Page Today is one of the most popular apps among HCPs for accessing breaking medical news, organizing news by interest, and earning CME credits [23]. The Med Page Today app provides information about drugs, diseases, and medical procedures, as well as daily podcasts, videos, and news updates. It encompasses 30 medical specialties and provides annual coverage of more than 60 meetings and symposia [21]. Other medical news apps are available for example, the “Outbreaks Near Me” app for users of either Apple or Android mobile devices provides real-time information regarding disease outbreaks according to geography [23]. This information is gathered from multiple resources, including online news, eyewitness accounts, and official reports.⁴ The Outbreaks Near Me app was funded by Google and developed in collaboration with the Centers for Disease Control and Prevention, as well as other organizations [23].

2.7.3 Drug References

Drug reference applications are generally used to access information including: drug names, indications, dosages, pharmacology, interactions, contraindications, cost, formulary status, identification guides, and dose by weight calculators [22] [16].

The most frequently used mobile drug reference apps include: Epocrates, Skyscape RxDrugs/Omnio, Micromedex, FDA Drugs, and DrugDoses.net [21] [23] [16]. Epocrates, Skyscape RxDrugs/Omnio, and FDA Drugs allow users to check multiple drug–drug interactions at the same time [16]. FDA Drugs, which includes official FDA labeling for prescription and over-the-counter drugs, permits searching by active ingredients [16]. The authors of Epocrates, the most commonly used drug reference app, found that 90% of physicians use mobile device apps to access drug information [16].

2.7.3.1 Lexi-interact

Lexi-interact can perform an analysis of a patient’s entire drug and natural product profile and identify possible interactions. Fully referenced and evidence based, this application facilitates a patient-specific risk-to-benefit assessment [24].

- Detailed patient management suggestions and monitoring guidelines
- Includes over 1800 generic drugs covering over 5400 brand names
- Data on the most commonly used natural products
- Includes integration of extensive Cytochrome P450 knowledge
- Each interaction monograph contains the following ratings:
 - Reliability Rating: Indicates the quantity and nature of documentation for an interaction.
 - Risk Rating: Reflects both the *level of urgency* and the *nature of actions* necessary to respond to an interaction:

Benefits with Lexi-Interact, analyzing a patient profile is as easy as Select, Analyze, and Review:

- **SELECT** - A patient-specific drug profile may be entered into Lexi-Interact by either generic or brand name as well as any known drug. The rapid-find name search allows for efficient selection of drugs and known drug allergies, where applicable. The Current Selections screen will provide a list of selected medications and allergies. Once the list is complete, the analysis is just a "tap" away. Duplicate therapy screening is automatically performed unless the option is unselected.
- **ANALYZE** - The Analysis Results screen provides a summary of drug interactions identified from the selected profile. Results are displayed by interaction type drug-drug, drug-allergy, and duplicate therapy each interaction displayed includes a risk rating to help you quickly grasp the nature of the action that may need to be taken.
- **REVIEW** - Each of the more than 1370 Lexi-Interact monographs provides a summary statement of the interaction, a scientific and clinically-relevant review of applicable literature, and a list of strategies for preventing and/or managing the interaction. The potential for pharmacologically similar drugs to be involved in the same interaction is discussed.

2.7.3.2 MPR

This app is a go-to for comprehensive charts that consolidate many varied treatment options such as asthma inhalers and oral contraceptives. MPR includes a frequently-updated drug database, medication charts, commonly-used clinical calculators, and current medical news.



FIGURE 2: MPR smartphone application homepage

MPR has a drug database that is searchable from the homepage. Drugs may be searched by either brand or generic name. By selecting the Drugs section from the dashboard, users may search for medications by condition also. Each drug monograph contains information regarding medication class, how it's supplied, indications and dosing for adults and children, contraindications, warnings/precautions, interactions, adverse effects, some pharmacokinetics, generic availability, and manufacturer info including address, phone number, and manufacturer's website as well as a list of other drugs made by the company. The major drawbacks of the system are that it is expensive, the advertisements in the application distract the user because their animation and presentation cover the whole screen. The frequency of advertisements that pops up is one in every four minutes.

2.7.3.3 Epocrates

Epocrates is best known for its extensive drug database. Users can search for medications by generic name, brand name, or using a list of conditions. Searching by condition yields a list of medications by drug class that can be used. Treatment options are listed in alphabetical order rather than by first or second-line usage [25].

Drug information in Epocrates includes adult and pediatric dosing, contraindications/cautions, side effects, drug interactions, safety and monitoring recommendations, pharmacology, and photos for easy identification of the medication. Indications are included in the dosing section. There is a section on Black Box Warnings where an exclamation point will appear if the drug labeling contains a warning. Manufacturer and pricing information is also listed. One nice feature is a section of 'alternatives', medications that can be substituted for the specific drug [25].

Epocrates Plus contains a useful compilation of guidelines, an alternative medication database, a general medical disease monographs with suggested treatments, and recommendations on infectious disease treatments with links to the drug database entries, a small section on lab interpretations, and an ICD-10 code lookup [25].

2.7.4 Drug info.aau.wordpress.com

This druginfo.aau.wordpress.com website serves as the official website drug information center. the website provides drug information by using external links. By external links it is meant to describe that hyperlinks to websites like WebMD,drugs.com and other websites related to drug information.

The major functional that we have observed is that there is a send us your Drug Information request form which enables the users to send request to the drug information center. Hence after sending a request he is required to wait a minimum of eight hours to get a drug information about the requested drug. It is within the observers' judgment that the system lacks the standard properties of a drug information website specially at national level.

CHAPTER THREE

METHODOLOGY

To develop the drug information management system a set of methods and techniques were used. Primarily it is mandatory to have a clear and precise drug information facts and understand what is in demand. For the development of the project qualitative data collection was deployed hence interviews were conducted. Object oriented methodology was used to model the proposed system. Microsoft Visio 2016 was used to develop the unified model language (UML), NetBeans 7.4.1 has been used to design the web based platform, just in mind prototyping software was used for the smartphone prototype and Morea Tech smith software has been used for the system usability testing.

3.1 Study Design

Object oriented approach was deployed for the completion of this project as well as for the design of the prototype of the system. This approach was chosen so as to decrease the amount of resource and time spent on the design of the system. In addition, traditional system design method is not able to adequately incorporate changes in the design of the system but oriented approach used phase which has enabled the design team identify requirements in the design. Object oriented approach has three major tasks; the first phase being the requirement analysis phase, in this phase the elicitation of system requirement has been completed. The second is the system design phase which involves designing the system graphical user interface and the system model will be designed. The final phase is to evaluate the performance of the system and conduct user acceptance testing.

3.2 Study Population and Sampling Technique

For this project the study population are health professionals related to drug dosing and prescription and consumer's that want to acquire information about medications. To select proper samples a purposive sampling was deployed. The inclusion criteria to undertake the interview have been: -

- Both the health care professionals and the clients should have basic computer and smartphone skills
- Both the client and health professionals should live in Addis Ababa.
- Both the client and health professional must be able to understand English language

The sample size for this project were 25 people from which 15 healthcare professionals related to drug prescription from private and public institutions in Addis Ababa city and 10 clients or drug users from Addis Ababa.

For the usability testing of the system 10 participants were selected to perform predefined tasks on the Drug Information Management System. All the participants did not have any previous

experience on the Drug Information Management System. All the participant has a minimum of degree from respective higher education institutions in various fields.

The sampling of the participant was purposive sampling. The typing speed and computer skill are included in the participant description because this attributes affect the performance and ease of use of the system because some tasks in the system require the user to input data into the database the average time it takes to compete the task will be affected by the user's typing speed. The participant's information was collected before the tasks were handed out using questionnaire (see annex 4). The system usability information was collected using a Likert scale questionnaire (see annex 5).

Computer skills: Beginner: typing, mouse use, basic computing and application, Good: intermediate computing and applications, Very Good: proficient computing, application, Excellent: proficient computing, applications and programming.

Typing speed: Beginner: less than 80 characters per minute, Average: 80- 190 characters per minute, Advanced: more than 190 characters per minute

	Age	Computer skills	Typing skills	Education status	Health professional or Related
P1	29	Beginner	Beginner	BSc	No
P2	35	Good	Intermediate	BSc	No
P3	30	Very Good	Advanced	BSc	Yes
P4	26	Good	Advanced	BSc	No
P5	32	Excellent	Advanced	MSc	Yes
P6	22	Excellent	Intermediate	BSc	No
P7	40	Good	Advanced	MSc	Yes
P8	32	Very good	Advanced	BSc	Yes
P9	39	Excellent	Advanced	BSc	No
P10	31	Good	Intermediate	MSc	Yes

TABLE 2: Summary of participant profile

3.3 Data Collection Tools and Procedure

In this phase requirement was identified and further analyses have been carried out and for this purpose the following have been performed:

- **Interviews** - to clinical pharmacists, health workers related to drug perception and dosing and consumers of medications. Structured interview was conducted. The interview was conducted in the English language.
- **Document analysis** – different journals and books were assessed so that to acquire in-depth knowledge for the project. Drug information reference systems were chosen and have been assessed.
- **Brainstorming sessions** – for the design phase of the system, brainstorming sessions were organized with software engineering experts and health professionals.

The data was collected by the principal investigator.

3.4 System Analysis and Design

The project structure is comfortable for using object oriented methodology and for that reason unified modeling language was used on analysis and design phase of the project.

3.4.1 Object Oriented Analysis (OOA)

Three steps of requirement analysis were followed the first step is understanding the existing situation, the second being identifying gaps in the existing situation and the third is defining functional and non-functional requirements of the system.

Object Oriented Analysis emphasizes an investigation of the problem and requirements, rather than a solution. It concerns with determining the system requirements and identifying classes and their relationships that make up an application. This phase also called requirement analysis. The classes identified in this phase represented using the domain model or conceptual model class and also their attributes and relationship are express [26].

Finally, the response for interview will be summarized and used in requirement document. Then it was described using essential use case modeling that helped the researcher to understand the existing system very well, helps to identify difficulties for current system detailed and helps identify gaps to be filled by the new design system. This requirement serves as an input for the next stage of system development [26].

3.4.2 Object Oriented Design (OOD)

The study uses Object Oriented Design to define objects and how they collaborate to fulfill the requirements independent of implementation. During object oriented design phase of the system

in this study emphasizes on designing web based system objects, classes with their attributes, methods, and interfaces using UML artifacts class diagram [26]. Then designing entity objects in the system database with their attributes and association between entity objects and designing/prototyping user interface for the system where a user in the health facility interacts. More over the design prototype user interface was evaluated based on heuristic evaluation method and also used prototype and usability tests [26].

3.4.3 Object Oriented Modeling (OOM)

Object oriented modeling (OOM) is the construction of objects using a collection of objects that contain stored values of the instance variable found within an object. unlike models that are record oriented, object oriented values are solely objects [26].

The object oriented modeling approach creates the union of the application and the database development and transforms it into a unified data model and language environment. Object oriented modeling allows for object identification and communication while supporting data abstraction, inheritance and encapsulation [27].

Use case diagrams -It is a modeling tool used to capture the intended behavior of the system under development. It is used to identify the primary element and process that form the system. A use case represents a particular functionality of a system and a set of actions performed by the system for a specific goal.

A use case diagram contains four components [28].

- The boundary, which defines the system of interest in relation to the world around it.
- The actors, usually individuals involved with the system defined according to their roles.
- The use cases, which are the specific roles played by the actors within and around the system
- The relationships between and among the actors and the use cases.

Class diagram - is a modeling tool used to understand what the data elements are and to specify abstraction method, operation and relations between object of the system. Basically it represents the objects oriented view of the system which is static in nature. The use of active class to show concurrency of the system [28].

Sequence diagram – Sequence diagram shows the sequences of events that occurs while objects interact with in the system. Interactions are in the form of message recipients [28].

3.4.4 System Design Approach and Development tools

3.4.4.1 System Design Approach

Collecting all the requirements from the user at the beginning of project development is very difficult. Users typically have difficulty explaining what they need, and the problems increase when developers fail to translate requirements into working programs. The users may change the requirements depending on their needs through time. So to manage those upcoming requirements is very necessary. Hence, to handle such kind of uncertainties spiral SDLC methodology was used for the development of the project. A software development life cycle promotes sustainable development by using different methods which attempts to minimize risk by developing software in short time boxes called iterations.

3.4.4.2 Development Tools

After collecting and analyzing the necessary information the next step was the design of the system using the following software's:

- **Microsoft Visio** – this software has been to draw unified modeling language diagrams.
- **XAMMP** – this software has been used to design the database on SQL and for apache server.
- **NetBeans 7.4.1** – is a software designed by NetBeans.org. It was used for the design of the website prototype.
- **Justin mind prototype** – is a prototyping tool used to make high fidelity prototypes for website and smartphone application. This tool was used to create the smartphone user interfaces of the system.

These tools were chosen because they are readily available and the developer have adequate knowledge necessary to use them.

3.4.5 System Testing Approach and Testing Tools

For the system testing 10 participants were selected to perform a list of tasks using DIMS before doing so short user training was provided on the system. Observations were made while they were performing the task and notes were taken. After the tasks were completed, interview and group discussions were conducted so as to get comments about the developed system. Participants were asked to provide data on their likes and dislikes of the system. They were also allowed to view their own performance on video this was done to get responses on specific reaction observes while the participants where using the system to describe in more detail their performance and perceptions of the application.

The testing for the DIMS software was done at Addis Ababa university facility of business and economics Eshetu chole building and at participant's homes.

In summary, this projects phases, methods and tools are described in table below;

Software design phase	Methods and techniques	Tools	Method
Requirement gathering and data collection	* Interview * Document analysis	* Interview *Literature review	Spiral approach
Qualitative data analysis	*Interview *Software specification	*In depth interview	
Design	*Object-oriented approach	*Microsoft Visio *NetBeans 7.4.1 *Xampp *Justin mind	
Testing and evaluation	*Low fidelity prototype * Morea Tech Smith	*Likert scale	

TABLE 3: Summary of methodology

3.5 Operational Definitions

Adverse drug reaction – is an injury caused by taking a medication, whether or not it is identified as a cause of the injury.

Consumer health informatics - examines the patient's information from the point of view such as health literacy, consumer knowledge and education

Drug – is any substance other than food that provides nutritional support that when inhaled, injected, smoked, consumed, absorbed via a patch on the skin or dissolved under the tongue, causes a physiological change in the body.

Drug dosing -the amount of a medicine or drug that you should take at one time, especially regularly

Drug interactions - Interactions may occur between drugs which compete for the same receptor or act on the same physiological system

Drug related problem- is a categorization of drug problem in the field of pharmaceutical care that happen between physicians, pharmacists and patients.

Drug information service – the activities function and projects through the centers achieve their objectives and which constitute their programs of work.

Health professionals- clinicians including medical doctors, nurses, midwives, pharmacists and the like who have professional license and resisted to practices medicine

Health information management system - it is the practice of acquiring analyzing and protecting digital and traditional medical information vital to providing quality patient care

Smartphone – It is a mobile phone with an advanced mobile operating system that combines features of a personal computer with other useful features of mobile phones

Web based system - it is a system that is installed from and on the internet

Web based information system - it is an information system based on the internet and that allows its components to communicate using browsers.

3.6 Ethical Consideration

Ethical clearance has been given from Addis Ababa University School of Public Health. Data was collected after getting permission from the ethical committee and informed verbal consent was obtained from all study participants. Each respondent was informed about the purpose of the study and privacy during data collection.

3.7 Dissemination of Result

Being an academic project, the output of this project will be submitted to Addis Ababa University School of Information Science and School of Public Health as a partial fulfillment of MSc in Health Informatics. Furthermore, the result of this project will be disseminated to the concerned bodies like Ministry of Health, Addis Ababa Health Bureau and other organizations as requested.

CHAPTER FOUR

REQUIRMENT ANALYSIS

4.1 The Current System

Requirement collection and analysis is part of the basic and essential step preceding the design of the system in the software development life cycle. A deep look into the previously existing system in use is essential for predicting and identifying the basic functionalities for the proposed system. The designing of the system is dependent on the types of requirements identified and addressed. They are crucial in identifying who needs which information in what way. This chapter focuses on identifying the requirements, modeling the business process and the design of the new system.

The current systems have been delivering drug information to the public and health professionals in an organizational level by the FMHACA in an organized form for the promotion of rational drug use. Even though the current system has its own limitations the work it has been doing to disseminate drug information is vital to the health professionals.

The current Ethiopia patient treatment guideline set up by ministry of health states that a clinical pharmacist must be present during prescription phase of the medication process. During this phase the doctor completes the diagnosis and presents his/her conclusions where the clinical pharmacists prescribe drugs according to the drug administration guideline, general knowledge or drug references hand books available to him/her. Most of the sample population uses a manual paper based publication from the DIC center or prescribe drug from their own knowledge without any reference mechanism. DIC has its own website but this website shows drug information by using external links which was found to be time consuming and not efficient.

Benefit of the current system is that even though it is not fast the system is disseminating much needed drug information at an institutional level. The system's drawback is that it is health professional centered and time taking also the consumers according to Fantawork Samuel [5], it takes a minimum of 1 day and more to process a drug information request the drug information center a TASH receives (see figure 3)

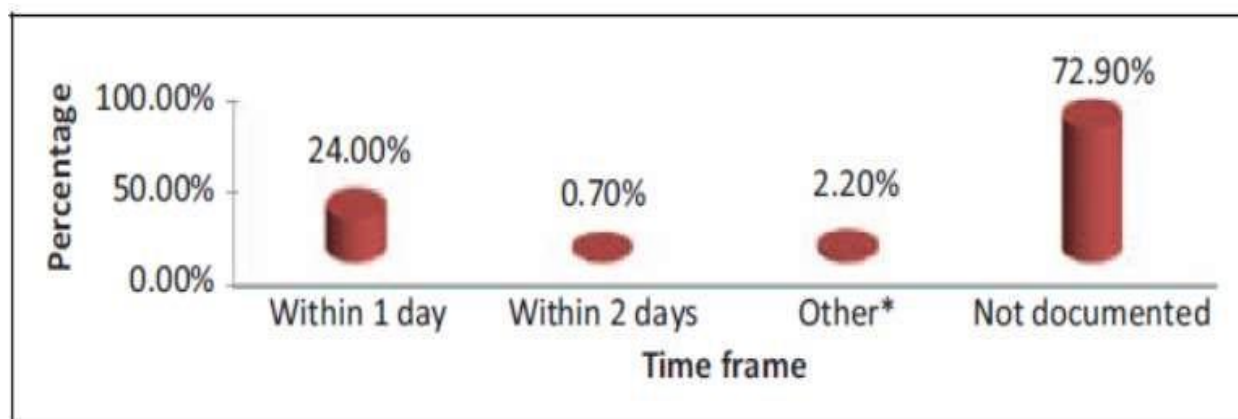


FIGURE 3: Time taken to respond to enquiries by DIC at TASH

The most important areas of drug information are therapeutic use, general product information, product availability, pharmacology, and adverse effects and these areas cover more than 65% of enquires to the drug information center. by automating the drug information system these enquires can be handled in a faster time than that (seen on figure 3). The majority of inquirers were physicians from public hospitals. The main sources of drug information used by the respondents were textbooks and other publications.

Due to the time it takes to refer information from these publications healthcare professionals usually prescribe drugs from existing knowledge but human knowledge is prone to mistakes; due to lack of proper knowledge and due to stress that arises from mismatched number healthcare professionals to healthcare service demands.

4.2 Proposed System

The proposed system of drug information management system across web based and smartphone platform can be used as a tool to enhance accessibility of drug reference to both the healthcare professional and for the everyday person. The system has the same basic dosing and reference guidelines that have been implemented by WHO in line with the guidelines currently being used by health professionals in Ethiopia. The proposed system provides:

- Accurate and compressive information on drugs with a view to enhance proper usage of medications via website and smartphone application.
- News on events nearby so that the health professionals can update the knowledge
- A reminder system for medication takers to schedule their drug intake
- Easily searchable interface
- A website so as not to exclude people's without smartphone.
- A smartphone application that can provide drug information without internet connection.
- An administration page to manage major system functionalities that facilitate viewing, adding, editing and deleting data.

4.2.1 Functional Requirements

Functional requirements define what the system needs to do, these are the essential subject matter of the system; they can be measured by concrete means like data values, decision making logic and algorithms [29]. Most functional requirements were elicited during interviews, document analysis and brainstorming session with sample population.

The project has two major parts: a web based part and a hand held device application; so the functional requirements are divided in accordance:

Remark RQ = requirement id

Req. ID	Description of the website requirement	Platform
RQ-01	The system should provide searching facilities and display the result of the search with the link recommendation	Both
RQ-02	The system should have the facility to navigate drugs by diverse category.	Both
RQ-03	The system should make available validation mechanism for user inputs.	Both
RQ-04	The system should grant the facility to create, edit and delete user account.	Website
RQ-05	The system should grant the facility to view detail information, add, edit and delete dictionary data.	Website
RQ-06	The system should provide current news related to drugs	Website
RQ-07	The system should provide information events ,seminars , conferences and others related to drugs	Website
RQ-08	The system should display the administration page menu according to the assigned user`s right and so on.	Website
RQ-09	The system must enable the user to send feedback and requests to the administrator	Both
RQ-10	The system should have a facility to navigate events	Website

RQ-11	The system must have a facility to set reminders for the drug intake schedule	Smartphone application
RQ-12	The system must enable the user to have list of pharmacy.	Both
RQ-13	The system must be able to work without internet connection after installation	Smartphone application
RQ-14	The system must enable to select favorite drug (frequently referred drugs information)	Smartphone application
RQ-15	The system must enable the user to search for drugs by generic name, indications and listed format.	Both

TABLE 4: list of functional requirements

4.2.2 Non-Functional Requirements

The non-functional requirements are the behavioral properties that the system must have like performance, usability, error handling, availability, reliability and efficiency (29).

User interface: The system must have an interactive, dynamic and consistent graphical user interface. The interface should not be distractive. Most inputs should be done by using list box and drop box hence saving time and making it user friendly.

Performance consideration: The system shall have acceptable performance with regard to response time. At the same time, the system must provide accurate, consistent and reliable data to the system users. User interface screens shall respond with speed so as to ensure fast data entry to the system.

Error handling: It should be able to respond descriptive error messages. Appropriate error message must be displayed when the users inserts unexpected/wrong data. With this features, users will be informed about the errors they have committed and what to do to rectify the problem in easy way.

Availability: the website and handheld application will be available throughout the day 24 hours and seven days a week.

Security issues: Administration part of the system is handy only for the authorized Administration staffs as per their assigned rights. An unauthorized user of the system ought to not access the administration page by any means. Some of the resources and activity shall be restricted

and allowed for authorized users. Consequently, the system must use authorization methods and it must render or deny accesses to users as per their assigned privileges.

4.3 UML Models

4.3.1 Use-case Diagram

A use case diagram is a representation of a user's interaction with the system and depicting the specification of a use case. Its main purposes are gathering requirements of a system, to get an outside view of a system, to identify external and internal factors influencing the system and Show the interacting among the requirements and actors [29].

4.3.1.1 List of Actors

System administrator – is the one who manages the system by providing updates on the database, assigning privileges and receiving feedbacks from the users.

System – this actor is used to describe the handheld application. After installation the handheld application will only react to the user inputs this system does not have any backend manipulation by administrator because of its static nature.

User – this actor describes the person who uses the drug information management system on both platforms.

Id	Use case name	Description	Requirement
UC-01	View information	The system should have the facility to navigate drugs by diverse category.	RQ-02, RQ-08, RQ-15, RQ-06, RQ-07 ,RQ-10
UC-02	Send feedback	It is used to send feedbacks and recommendation for the administrator and developer	RQ-09
UC-03	Add favorites	It is used to add, favorites table in the database	RQ-14
UC-04	Modify favorites	delete favorite drugs or change from the favorites table in the database	RQ-14
UC-05	Add reminders	It is used to add reminders	RQ-11
UC-06	Modify reminders	It is used modify reminders	RQ-11
UC-07	Add information	It is used to add drug, event ,pharmacy ,news into the system	RQ-05, RQ-03
UC-08	Modify information	It is used to modify information like drug, event ,pharmacy ,news in the system	RQ-05
UC-09	Login	It is used to login to the system as an administrator	RQ-04
UC-10	Notify updates	It is used to notify the user that there is a new updated database	

TABLE 5: List of use- cases

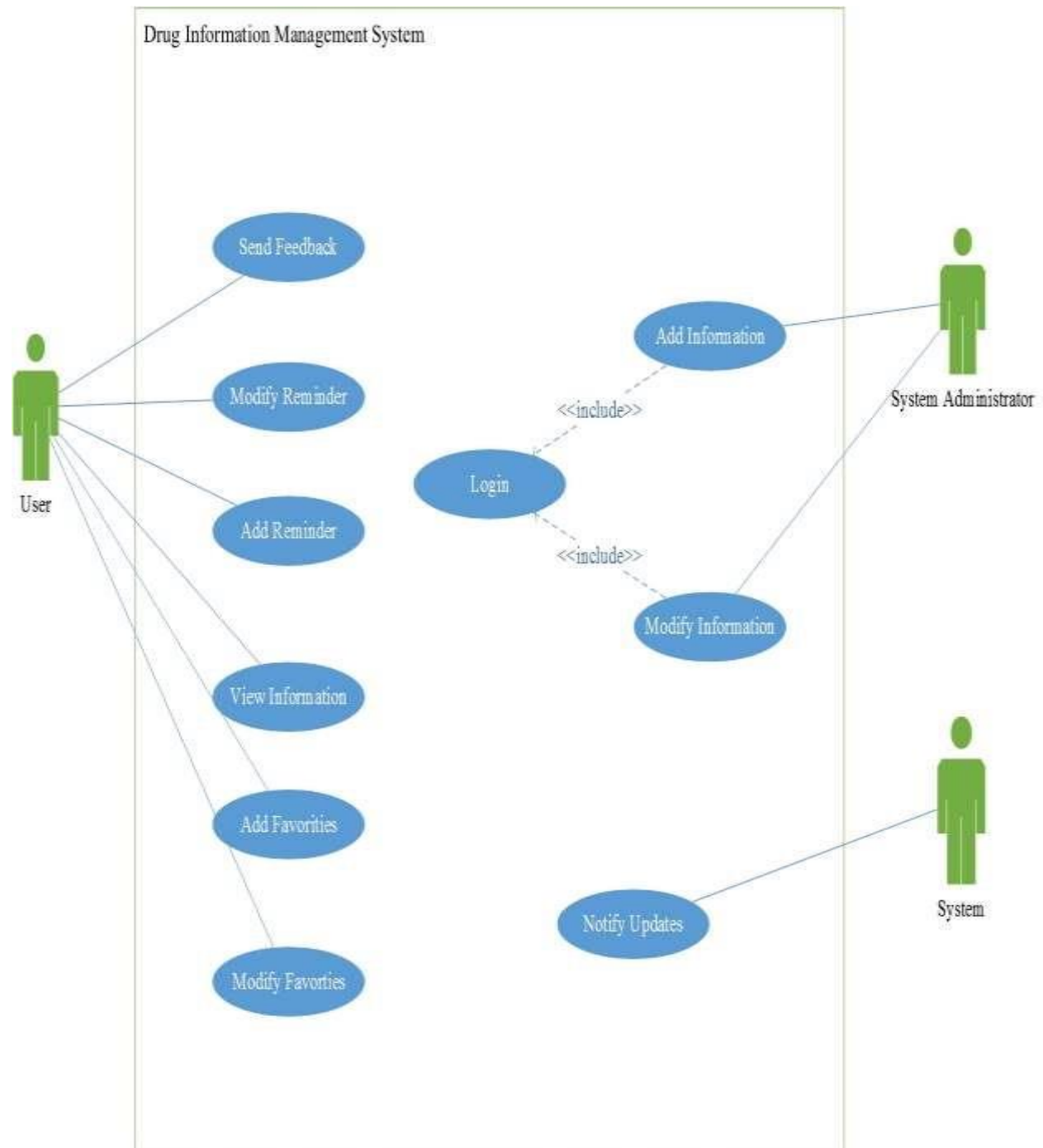


FIGURE 4: System Use-case diagram for DIMS

Use case id:	Uc-01
Use case name :	View information
Use case description	It is used to view information
Primary actor(s):	User (health care professional or consumer)
Include	None
Extends	None
Trigger	User opens the website
Pre-condition:	The system is successfully opened
Post-condition:	User views desired information
Basic scenario:	The use case starts when: 1) DIMS responds by presenting the home page along with the different menus and tabs as well as link. 2) The user views the information and click on his/her preference tab/link. 3) DIMS presents the clicked tab/link The use case ends
Alternative scenario	None
Special conditions	None
Frequency of use	Throughout the day

TABLE 6: View information use case description

Use case id:	Uc-02
Use case name :	Send feedback
Use case description	It is used to send feedbacks and recommendation for the administrator and developer
Primary actor(s):	User
Include	None
Extends	None
Trigger	The user open the contact us page
Pre-condition:	None
Post-condition:	User sends feedback to the administrator or developers
Basic scenario:	The use case starts when: 1. The user clicks on the contact us tab 2. The system displays contact us form 3. The user fills the contact us form 4. The user clicks on the send button 5. System validates input 6. “System displays feedback successfully sent” Use case ends
Alternative scenario	Alt.1 (5) the user fills invalid input 5.a) Goes back scenario to 3 fills corrects entry
Special conditions	The user is registered

TABLE 7: Send feedback use case description

Use case id:	Uc-03
Use case name :	Add favorites
Use case description	It is used to add drugs to the favorites data table
Primary actor(s):	User
Include	None
Extends	None
Trigger	The user selects drug and clicks add to favorite button
Pre-condition:	The user is using the handheld device
Post-condition:	Updated favorite table in the database
Basic scenario:	The use case starts when: 1. The user selects drug menu. 2. Clicks on the add to favorite icon. 3. System displays new drug added to favorite. Use case ends
Frequency of use	On demand
Special conditions	None

TABLE 8: Manage favorites use case description

Use case id:	Uc-04
Use case name :	Modify favorites
Use case description	It is used to modify to the favorites data table
Primary actor(s):	User
Include	None
Extends	None
Trigger	The user open the favorites page in the smartphone application
Pre-condition:	The user is using the handheld device
Post-condition:	Updated favorite table in the database
Basic scenario:	The use case starts when: 1. the user selects drug from the favorites list 2. the user clicks on delete button 3. the system displays message box 'are you sure you want to delete' 4. the user clicks on yes Use case ends
Frequency of use	On demand
Special conditions	None

TABLE 9: Modify favorites use case description

Use case id:	Uc-05
Use case name :	Add reminders
Use case description	It is used to add reminders
Primary actor(s):	User
Include	None
Extends	None
Trigger	The user must open reminder page on the smartphone application
Pre-condition:	The user is using DIMS in the smartphone platform
Post-condition:	Updated reminders page
Basic scenario:	Use-case starts 1. The user selects reminders menu. 2. Clicks on the add. 3. System displays time screen user fills required inputs 4. User click on ok Use-case ends
Frequency of use	On demand
Special conditions	None

TABLE 10: Add reminders use case description

Use case id:	Uc-06
Use case name :	Modify reminders
Use case description	It is used to modify existing reminders
Primary actor(s):	User
Include	None
Extends	None
Trigger	User must open the reminders page on the smartphone application
Pre-condition:	A reminder must exist in the reminder table.
Post-condition:	Updated reminders database
Basic scenario:	Use case state when the user 1. the user selects reminders from the reminders list 2. the user clicks on modify button 3. the system displays message box ‘are you sure you want to modify’ 4. the user clicks on yes use-case ends
Frequency of use	On demand
Special conditions	None

TABLE 11: Modify reminders use case description

Use case id:	Uc-07
Use case name :	Add information
Use case description	It is used to add drug, event ,pharmacy ,news into the system
Primary actor(s):	Administrator
Include	Login
Extends	None
Trigger	The administrator selects the add button in the desired page
Pre-condition:	The user is logged in and administrator page is displayed
Post-condition:	Updated database
Basic scenario:	The use case starts when: 1. The admin selects the desired page from the admin page 2. The admin selects add new link 3. System displays add new forms 4. The admin fills the form and clicks add 5. The system validates input and displays message box 'information successfully added' Use-case ends
Alternative scenario	5.a wrong input goes back to scenario 4
Frequency of use	On demand
Special conditions	User must have an administrator privilege

TABLE 12: Add information use case description

Use case id:	Uc-08
Use case name :	Modify information
Use case description	It is used to modify information like drug, event ,pharmacy ,news in the system
Primary actor(s):	Administrator
Include	Login
Extends	None
Trigger	The administrator selects the edit button in the desired page
Pre-condition:	The user is logged in and admin page is displayed
Post-condition:	Updated database
Basic scenario :	The use case starts when: 1. the admin selects the desired information from the desired page 2. the admin clicks on edit link. 3. system populates information in edit data form 4. the admin edits form and clicks save button 5. the system validates data and displays confirmation message Use case ends
Frequency of use	On demand
Special conditions	User must have an administrator privilege

TABLE 13: Modify information use case description

Use case id:	Uc-09
Use case name :	Login
Use case description	It is used to login to the system to obtain different functionalities of the system
Primary actor(s):	Administrator
Include	None
Extend	Add information , Modify information
Trigger	The user open the administrator home page
Pre-condition:	The administrator must have a username and password.
Post-condition:	Gain access to the system as an administrator
Basic scenario:	The use case starts when: 1. The admin clicks on the login page; 2. The admin enters assigned username and password; 3. Admin clicks on the login button; 4. The system validates input and displays the administrator main page Use case ends
Alternative scenario	4a) If the administrator enters wrong username and password the system displays an error message “wrong username or bad password”. 4a .1 the user is returned to login screen and re-enters user name and password
Special conditions	None

TABLE 14: Login use case description

4.3.2 Class Diagram

Class diagram is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes and the relationship among objects [30]. It shows a collection of static model elements such as classes and their relationships, connected as graphs to each other and their contents including their internal structure and their relationships to other class.

Process, objects represent something in the real world, as an implementation is developed, in proposed drug information management system the define additional implementation objects that are used to provide the required system functionality. So this project focus on the modeling of real-world objects as part of the requirements or early software design processes. When showing the associations between classes, it is convenient to represent these classes in the simplest possible way. To define them in more detail, this project adds information about their attributes (the characteristics of an object) and operations (the things that you can request from an object). As the program runs, these objects interact with each other to implement the system functionality.

The class diagram was developed by taking examples from drug information management system that have been already deployed elsewhere, functional requirements collected, document analysis and drug information facts.

A well-developed class diagram is the bases for a good software design with this in mind the following class diagram was developed for the systems:

4.3.3 Sequence Diagram

Sequence diagram is an interaction diagram that shows how processes operate with one another and in what order. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario [30]. It is used to formalize the behavior of the system and to visualize the communication among objects of the system. The following sequence diagrams portray for the various use cases.

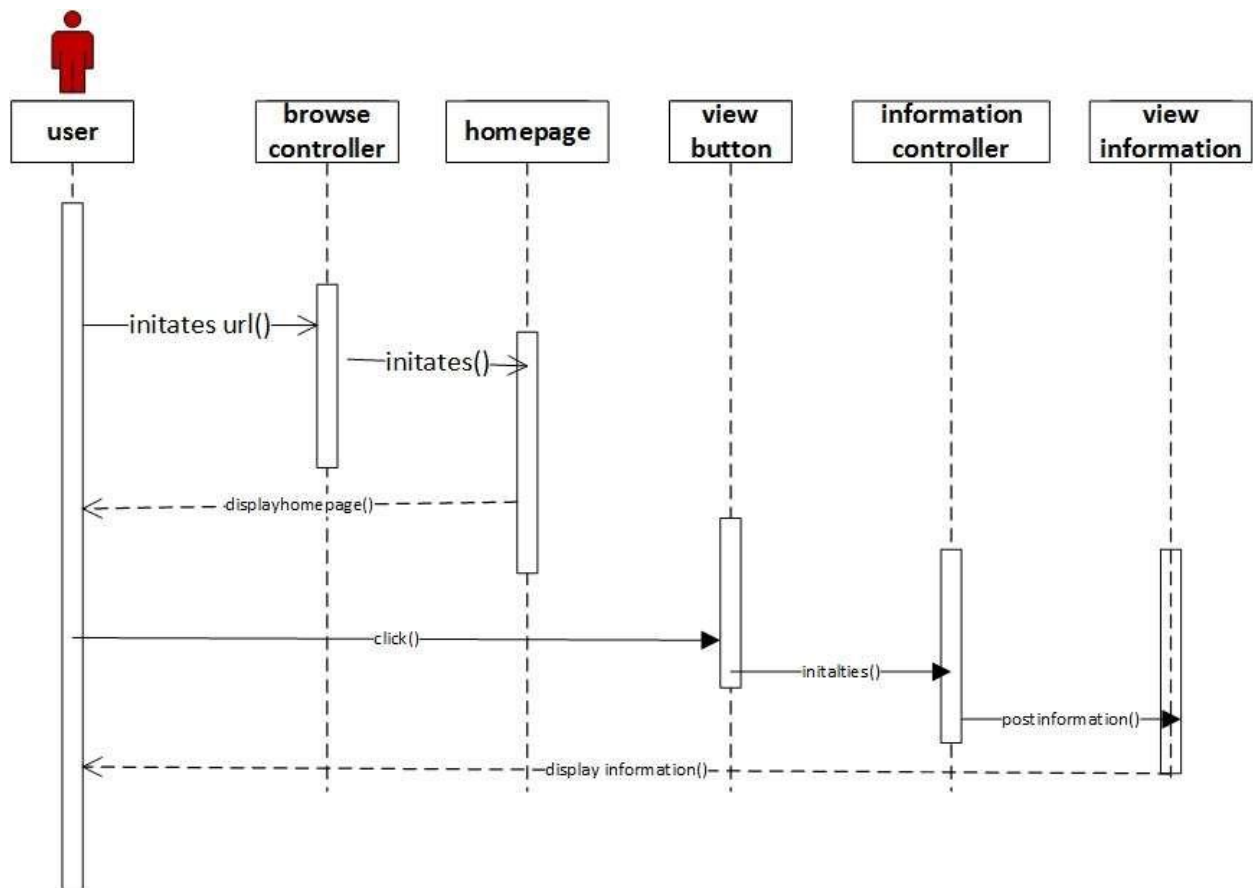


FIGURE 6: View information sequence diagram

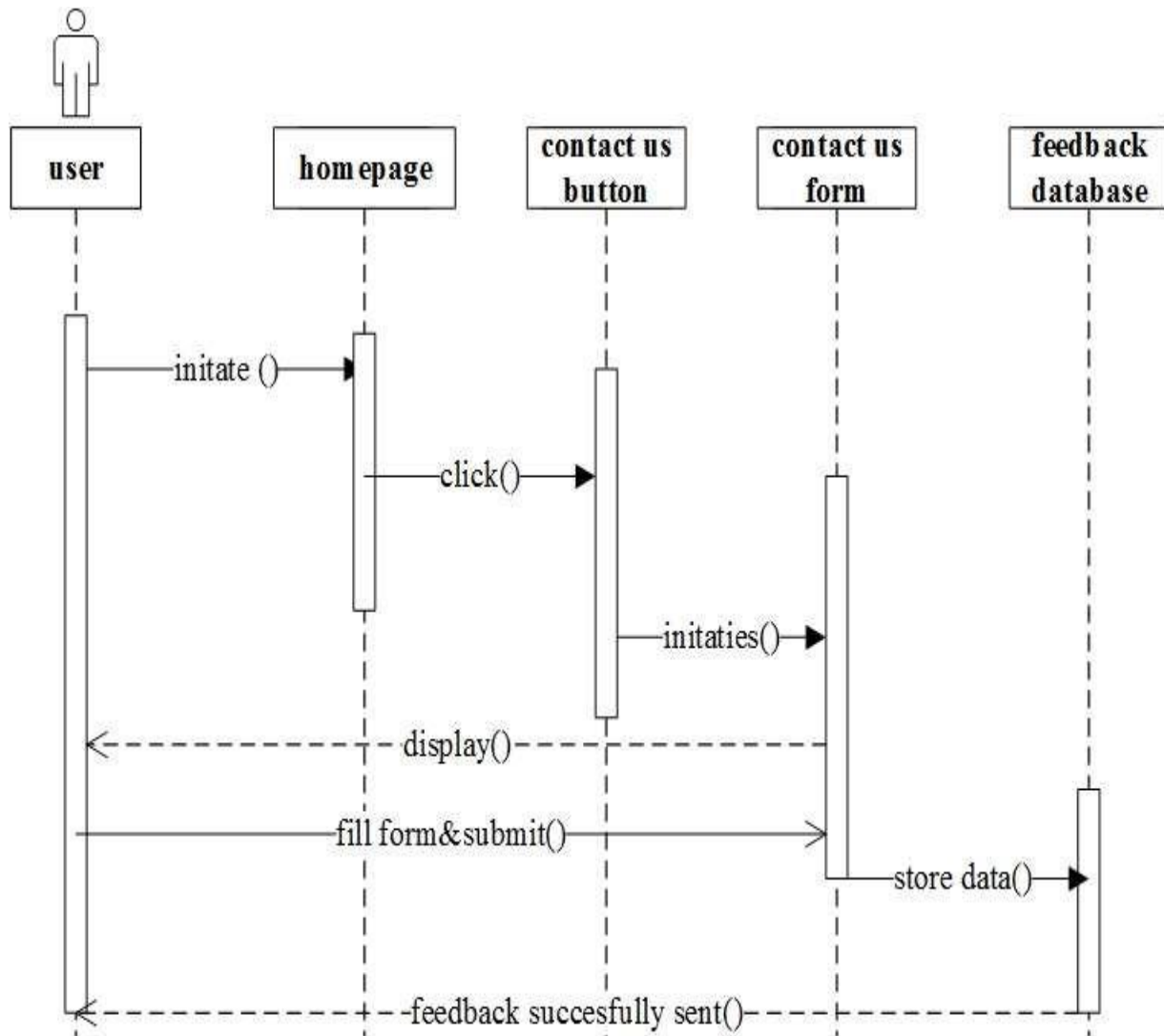


FIGURE 7: Send feedback sequence diagram

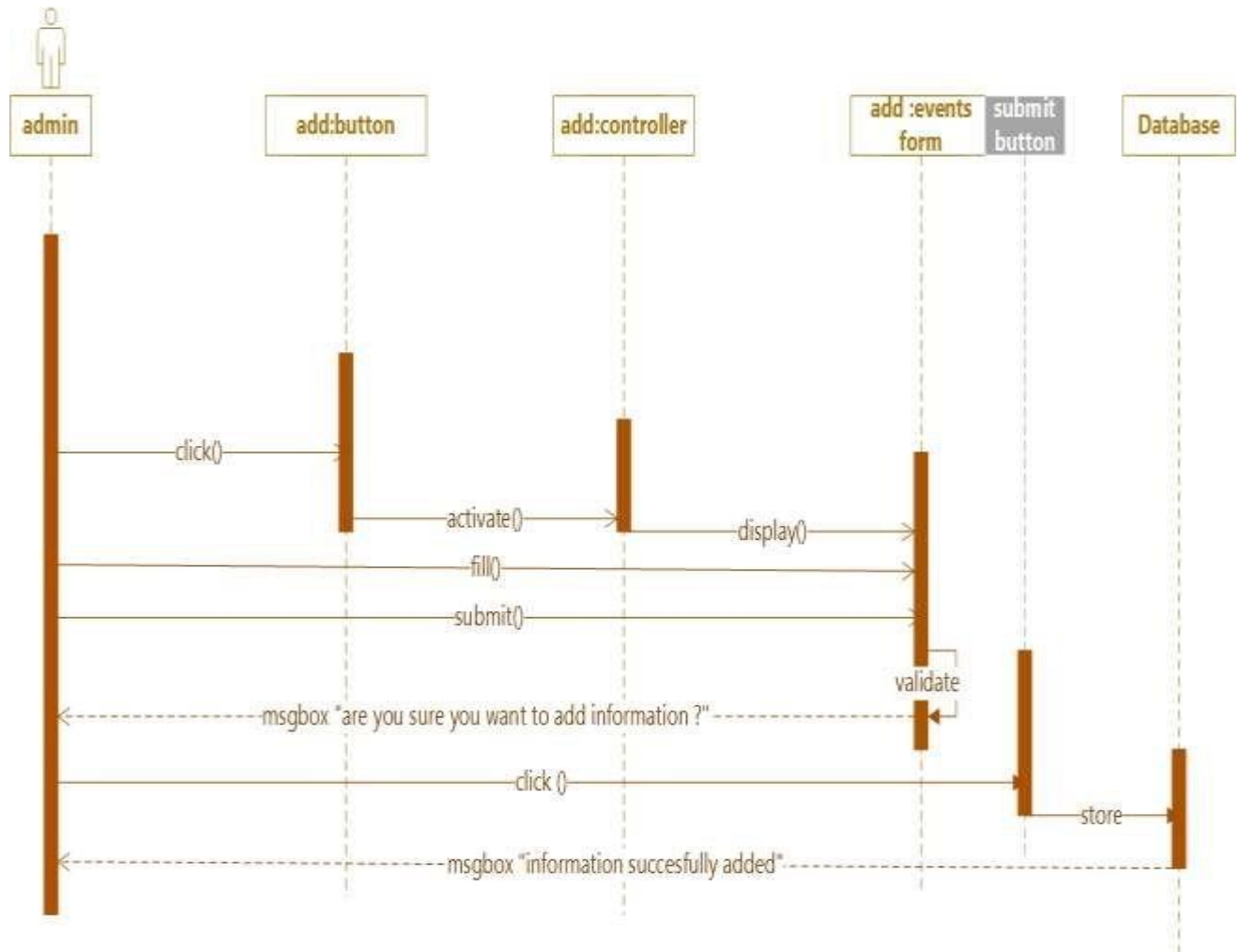


FIGURE 8: Add information sequence diagram

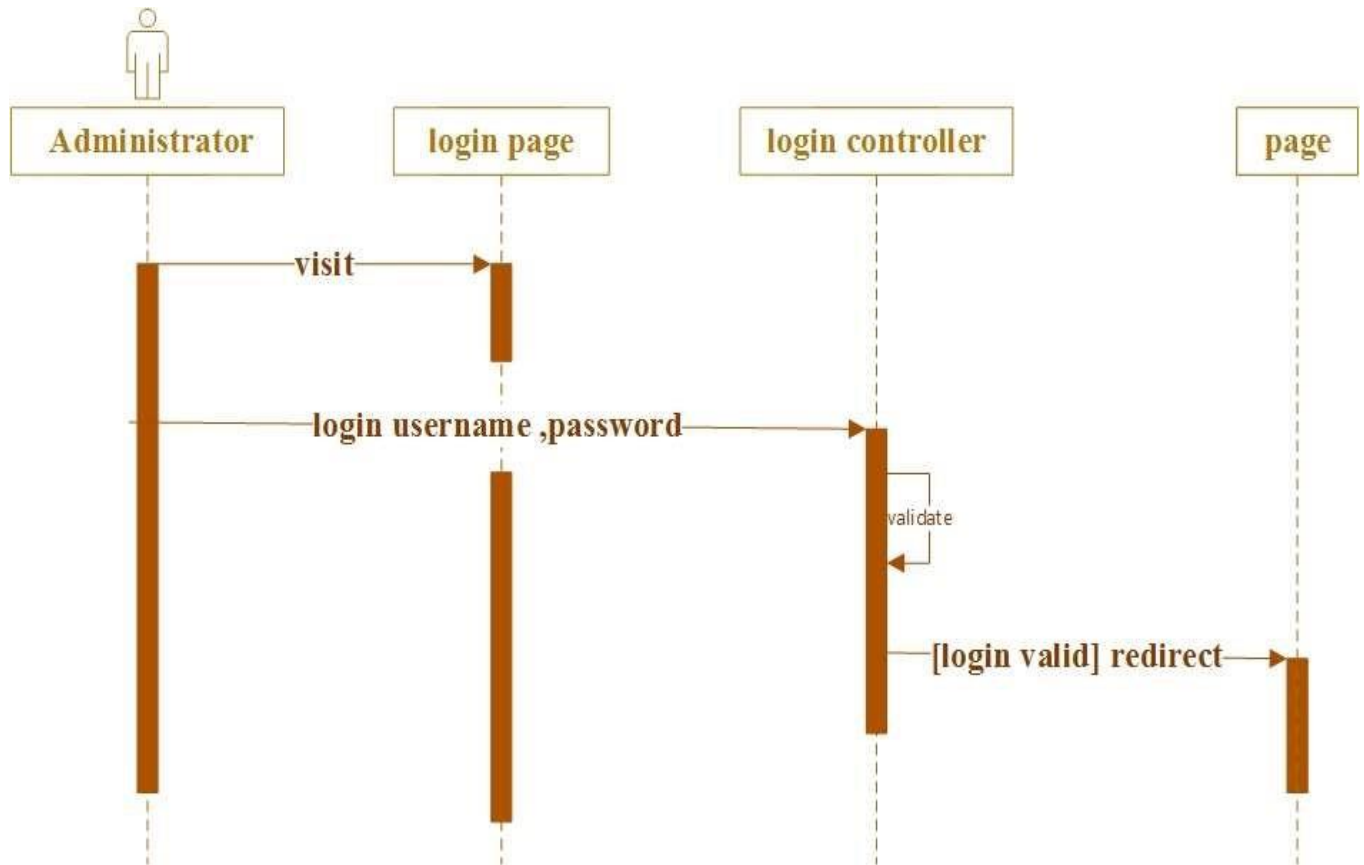


FIGURE 9: Login sequence diagram

In the requirement analysis chapter of the document, the functional and non-functional requirements of the system have been elicited and presented using different UML models like use cases, sequence diagrams and class diagram. This mentioned requirement and modeling have facilitated the system design. This phase of the system development lifecycle is presented in the next chapter.

CHAPTER FIVE

SYSTEM DESIGN

In this section the design phase of the system is presented. System design is all about the design goal of the system and subdividing the system into smaller parts that can be easily realized in order to tackle problems in organized manner [30]. In this section the system architecture, system deployment and user interfaces are shown.

5.1 System Architecture

Modern application design involves partitioning an application into multiple tiers; the user interface, a middle tier of business objects and the data access tier that are helpful to identify the types of processing that we can expect an application to do.

While designing a web based application it is desirable to separate the web server from the dataset and the user interface should be easily located in its working environment. Because of its ability to incorporate afore mentioned concerns three tiered information system architecture is preferable. The health sector has a complex nature which needs different standards and involves various stakeholders. These stakeholders are geographically differing and have different informational needs. They need information from those differing locations with various protocols and data definitions and data structures. The database layer (data tier) (which contain data model, metadata dictionary, and standard drug classifications), applications layer (software applications, user interfaces) and technical or presentation layer (hardware platforms local and wide area networks) are needed to address the stakeholder's requirements in the three tier information system architecture [29].

The proposed system as it involves web based information transaction, retrieval and processing that can be implemented using a web browser on any device that has an access to the internet; thus the system uses a three tier system architecture. These three tiered system architecture will run on a web technology. The proposed web based technology provides a great scalability, portability, increased efficiency, reusability with ease of maintenance during anomalies.

The user interface (presentation tier) interact with user, Interact with external application or services. The developed drug information management systems have multiple forms or user interfaces which interacts with the users of the system [30]. The user interfaces were designed using HTML, CSS and JavaScript for the website and java for the android based system.

On business processing (Business tier) enforcement of business rules, Business related data validations are processed [30]. Here all the main functionalities of the drug information management system core functionalities were designed using PHP and these functionalities will be deployed on web server.

Data processing (Data services tier) handles data manipulation, enforcement of relational data rules is handled on this tier [30]. For the database MySQL was used; all the business transactions are saved into the database and can be accessed through this tier. For the smartphone based application SQLite was used.

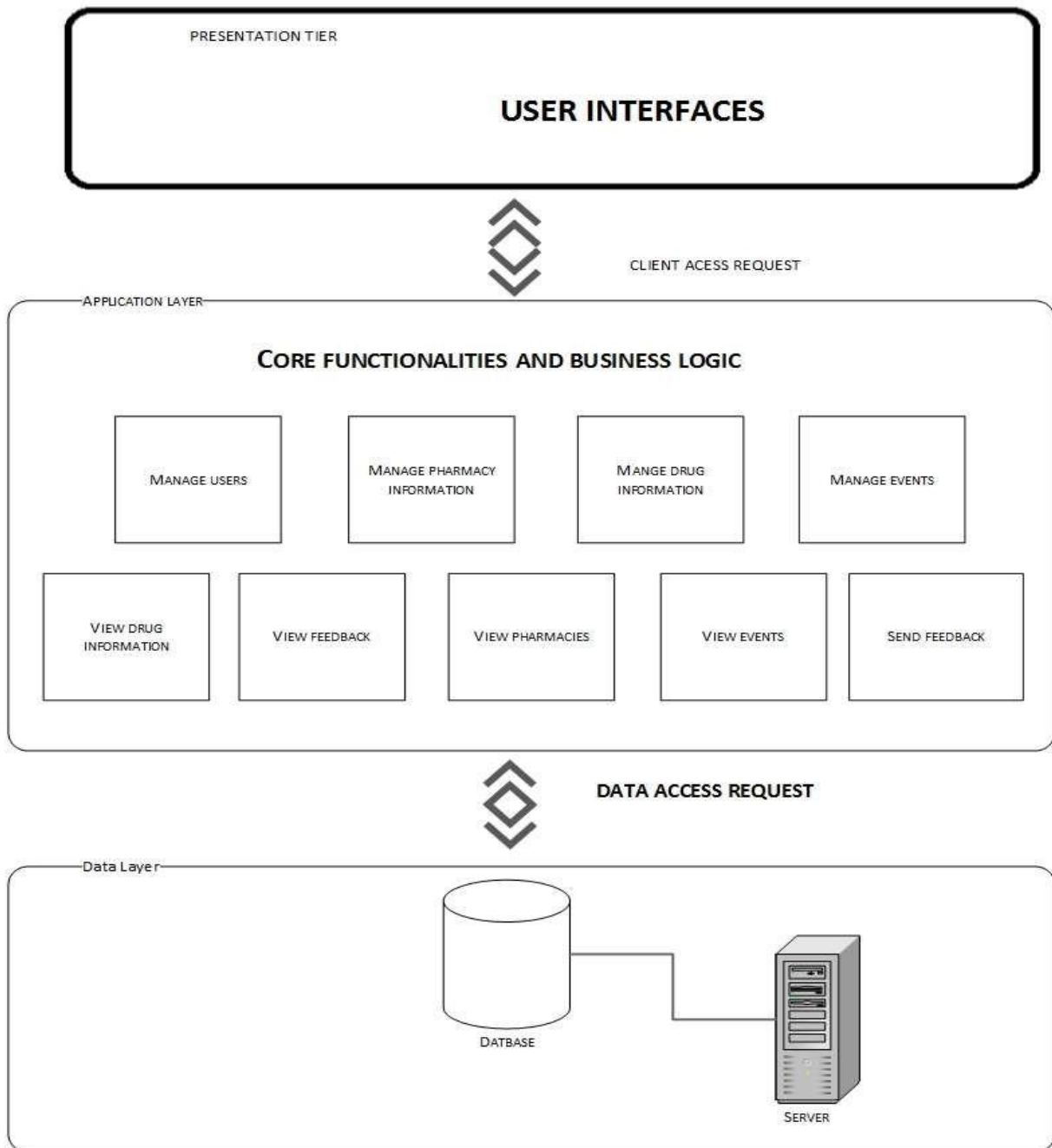


FIGURE 10: DIMS website system architecture

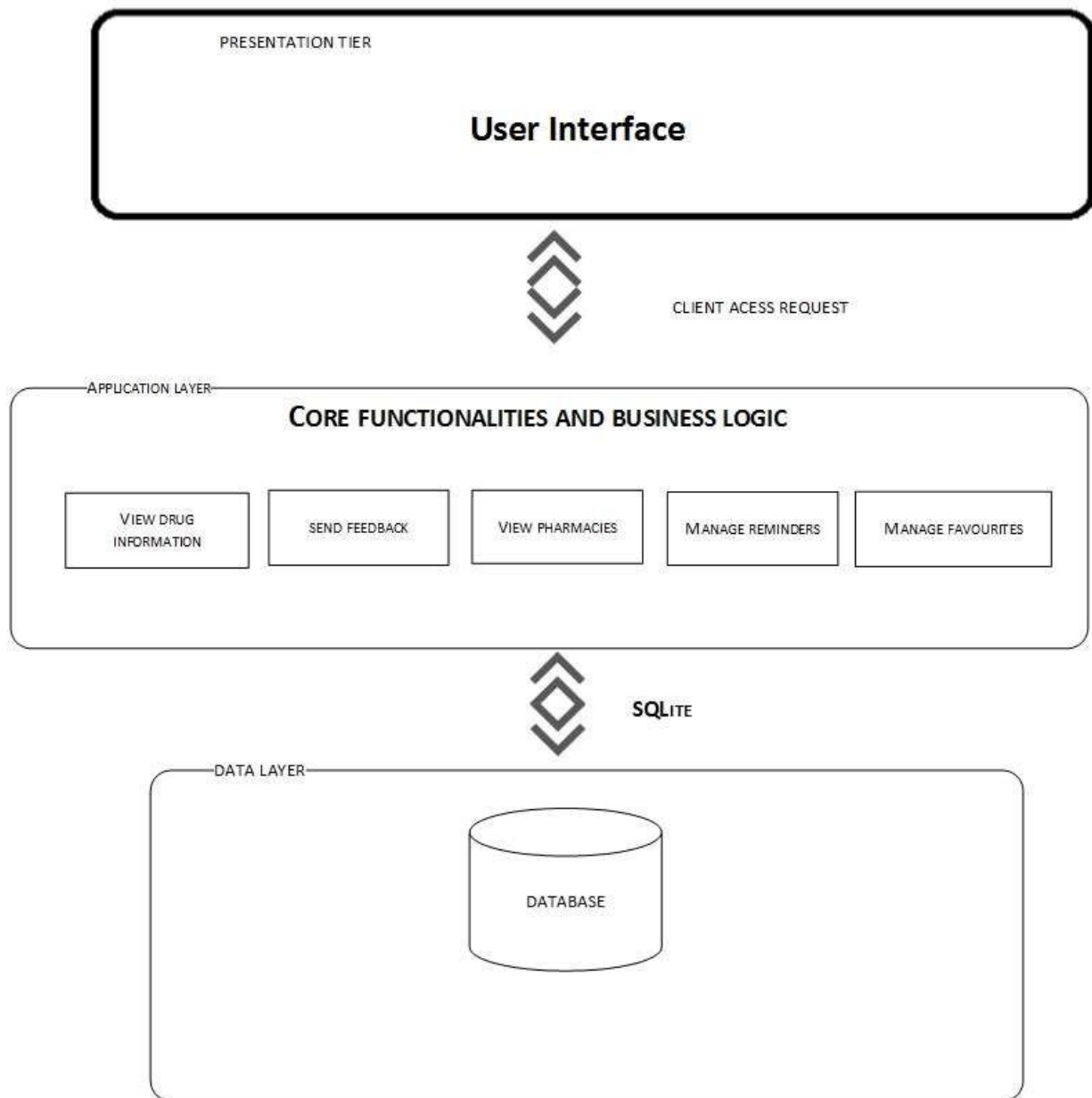


FIGURE 11: DIMS smartphone application system architecture

In the system architecture diagrams figure 10 and 11 the DIMS in both platform uses a three tier architecture. There difference only lies on the user interfaces and database management they use.

5.2. System Decomposition

Since the web-based drug information system architecture is client-server, the system is going to operate at the client side while the output of the system processes directed to the web browser. At client side, a web browser that is capable of interpreting basic HTML, CSS tags must be used. The system and the database as well should reside on the web server with IIS and .NET framework enabled to facilitate the data flow to and from the server. The system has deployed a Relational Database system; Microsoft SQL that is found to be ideal client server architecture and capable of handling concurrent record access have been used.

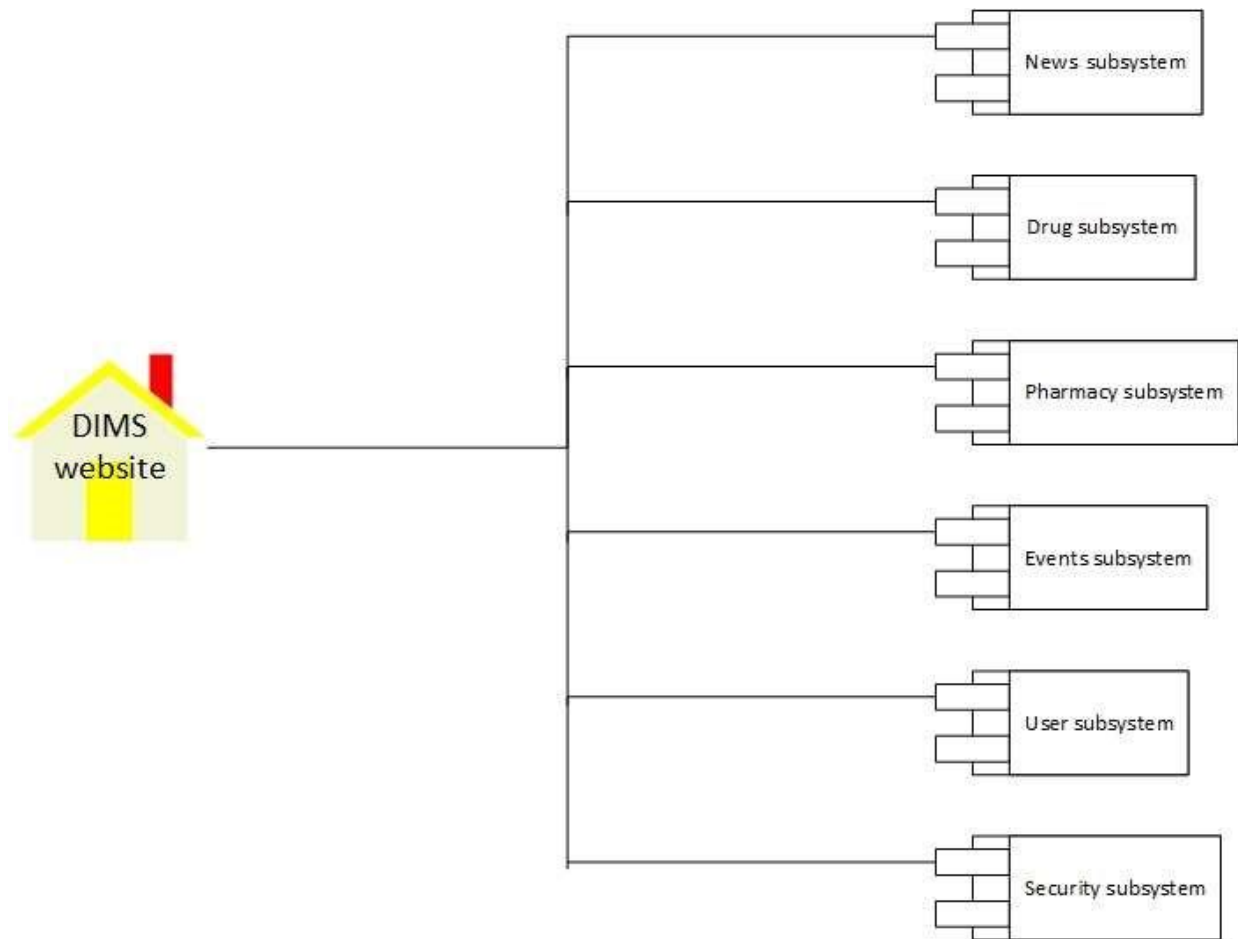


FIGURE 12: DIMS website system decomposition

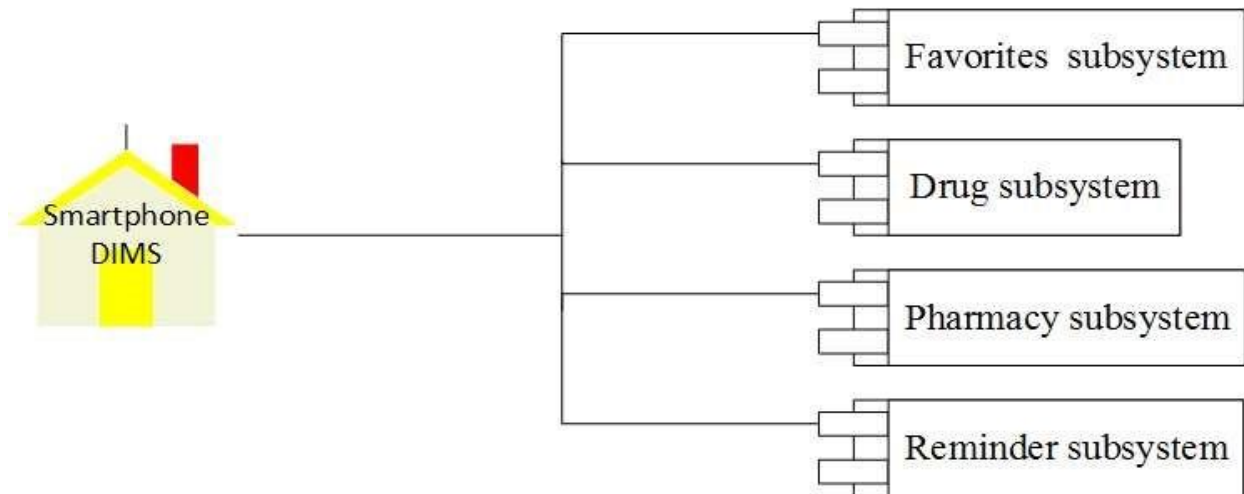


FIGURE 13: DIMS smartphone application system decomposition

5.3 Prototype Implementation

Prototyping is an excellent way for the development team to ensure that requirement and the proposed solutions is consistent with the expectation of the gathered requirements. In the prototype implementation phase, the user interface is developed using HTML and CSS. The MySQL database management is used to develop the database. The PHP code developed using MVC is used to construct the middle layer (application layer) that connects the HTML with the database.

5.3.1 User Interface Prototyping

According to Paul Rand - *"To design is much more than simply to assemble, to order, or even to edit; it is to add value and meaning, to illuminate, to simplify, to clarify, to modify, to dignify, to dramatize, to persuade, and perhaps even to amuse."* [31]. Consideration was done for the appearance of the system which included user friendly and easy design. Also, we focused on how to make the system easy on skill for the users.

The design of this system involves different working models (prototype) of the interfaces that the system uses. The user interfaces are designed in way that is easier and can be adoptable with ease to the user. Additionally, starting from the selection of the color to the selection of the various length and width matrix of the web page is done in consultation with the different users of the system.

5.3.1.1 Web based Drug Information Management System User Interface

The homepage is the first page that is displayed when the user opens the DIMS site. It has 5 buttons in the menu bar from which one is a drop down box, which has three lists. It has a search box where the user can search for drugs by generic, by indication or by brand name. The page enables the user to access drug information pages, events pages and address of pharmacies pages. The user can switch between languages using the choose your preferred language tab. The homepage in Amharic and English languages is shown below.

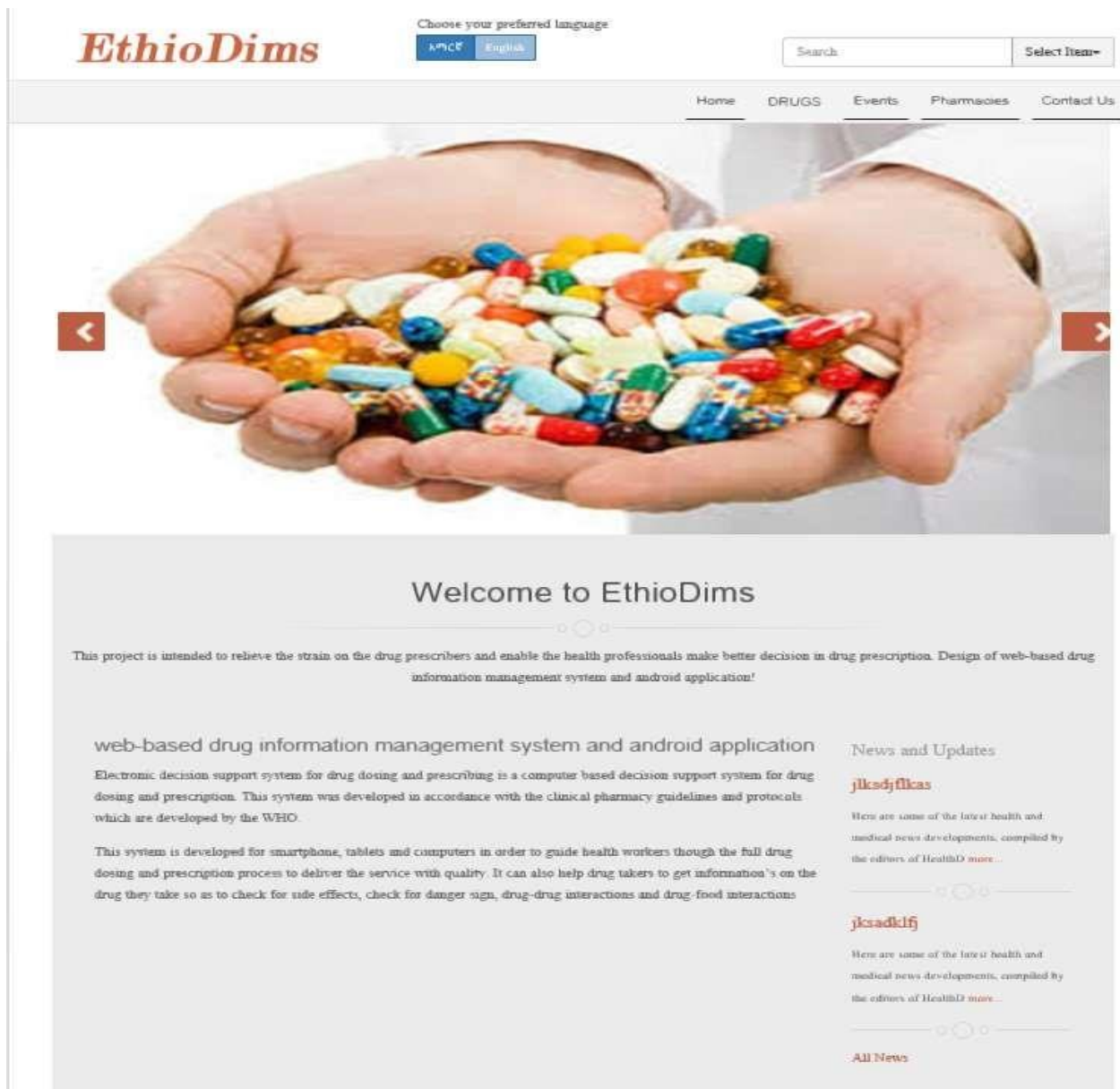


FIGURE 14: DIMS website Homepage English

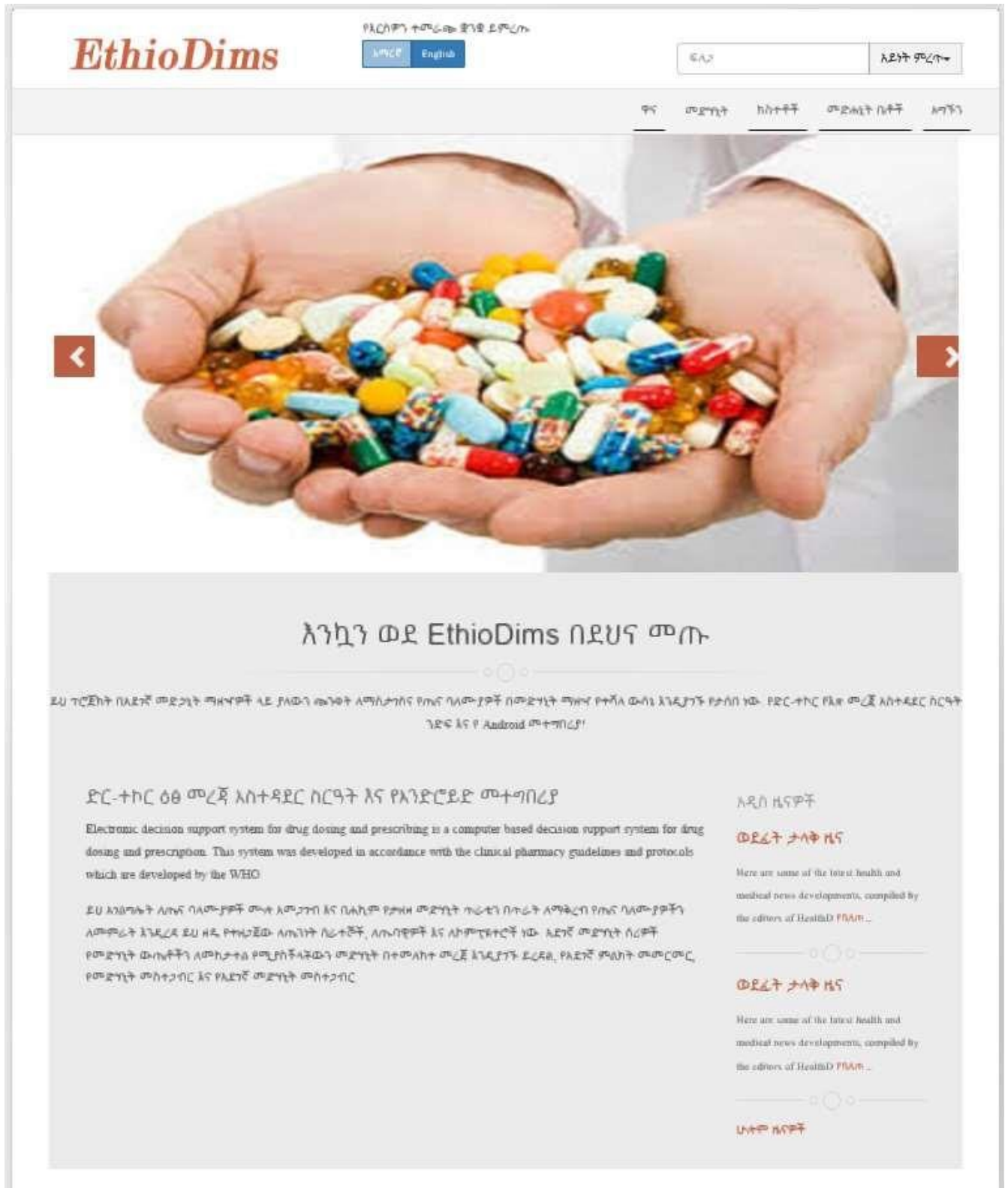


FIGURE 15: DIMS Website homepage Amharic

This page is displayed when the user clicks on the drugs by brands page on the homepage. This page displays all the drugs in the database in alphabetical order, the user can choose how many drugs he want to view on the list by using the drop down box. The user is also able to search drug by brand by providing query in the search box. The search box in this page is a predictive search so there is no need for a search button.

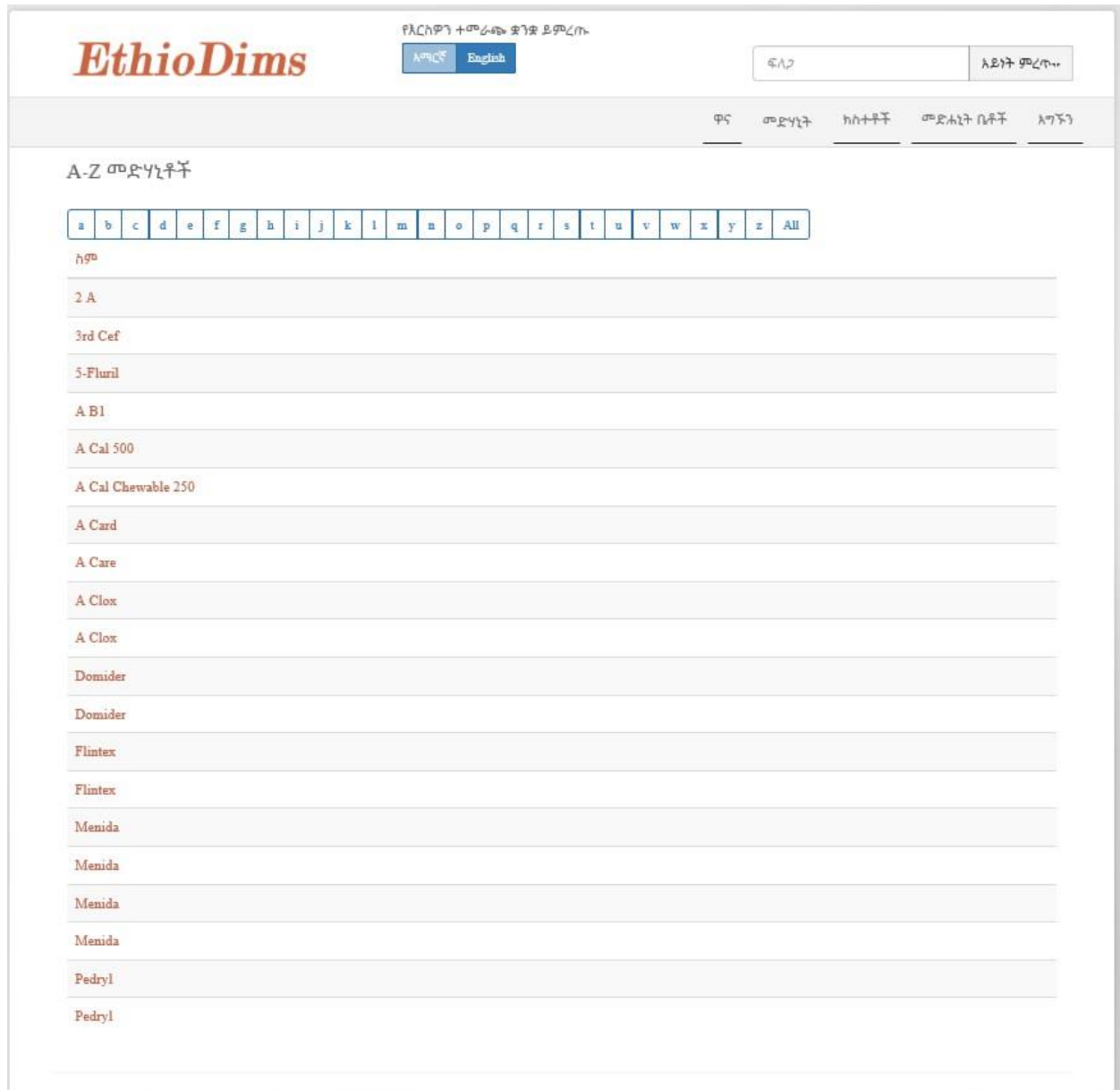


FIGURE 16: All Drugs by brands

This page is displayed when the user clicks on the drugs name from the drug by brands page (figure 15) or any place in the website where the name of the drugs appears. This page displays drug information like the generic name, producing company, name of the brand, form, strength and pack size, the price it is sold in Ethiopia.

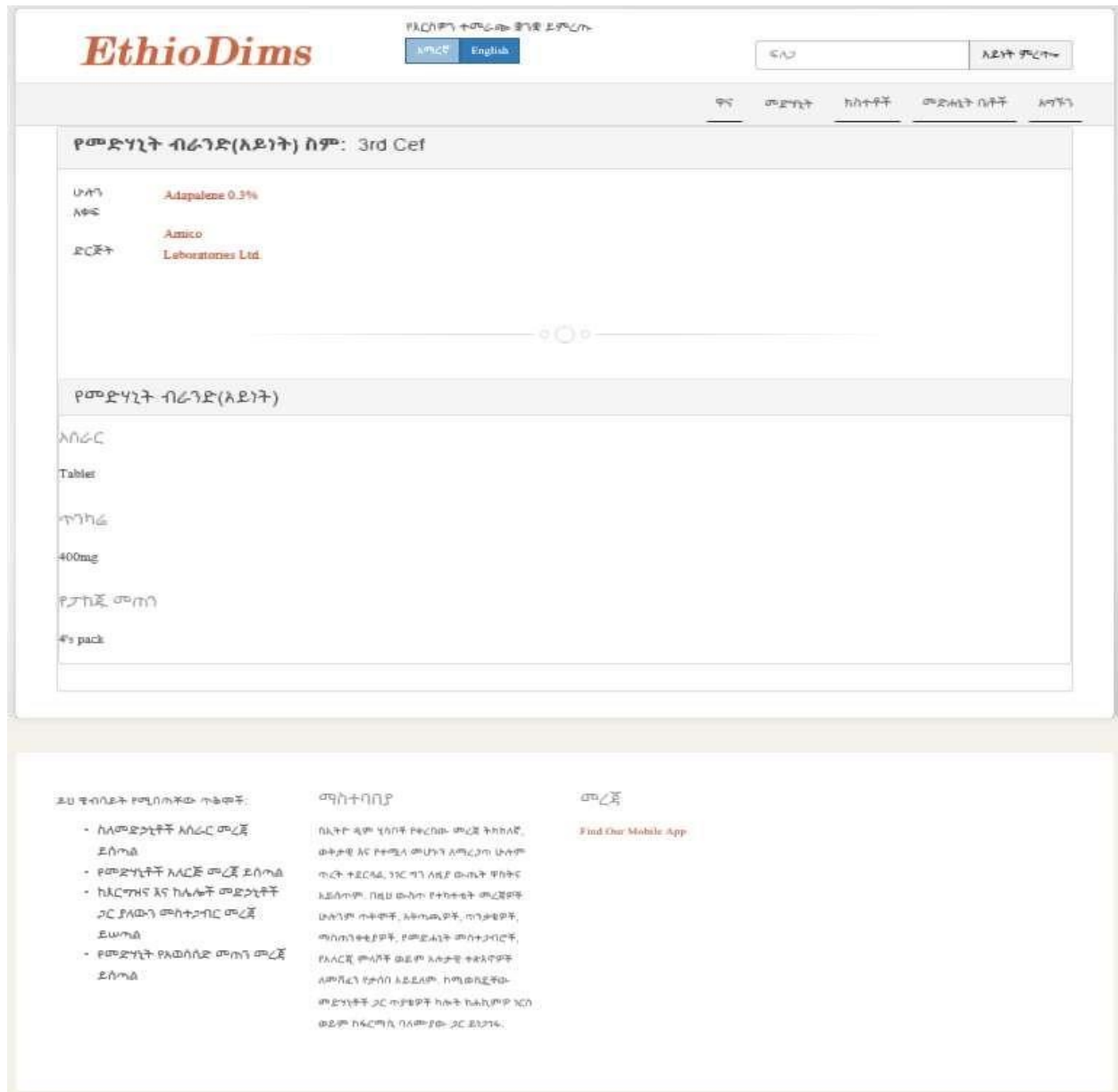


FIGURE 17: Detailed description of the selected drug by brand

This page is displayed when the user clicks on the drugs by generic button on the homepage. This page displays all the generic drugs in the database in alphabetical order, the user can choose how many generic drugs he/she wants to view on the list by using the drop down box. The user is also able to search drug by generic by providing query in the search box. The search box in this page is a predictive search so there is no need for a search button.

EthioDims Choose your preferred language [አማርኛ](#) [English](#) Search [Select Item](#)

[Home](#) [DRUGS](#) [Events](#) [Pharmacies](#) [Contact Us](#)

Generics

[a](#) [b](#) [c](#) [d](#) [e](#) [f](#) [g](#) [h](#) [i](#) [j](#) [k](#) [l](#) [m](#) [n](#) [o](#) [p](#) [q](#) [r](#) [s](#) [t](#) [u](#) [v](#) [w](#) [x](#) [y](#) [z](#) [All](#)

Name

- Abacavir + Lamivudine + Zidovudine
- Acarbose
- Acetazolamide
- Acetylcysteine
- Acitretin
- Acyclovir
- Acyclovir 3%
- Acyclovir 5%
- Adapalene 0.1%
- Adapalene 0.1% + Benzoyl Peroxide 2.5%
- Adapalene 0.5%
- Adefovir Dipivoxil
- Adenonine
- Adenonine 0.2% + Cytochrome C 0.05% + Nicotinamide eye prep
- Adrenaline (Epinephrine)
- Adrenaline + Lidocaine Hydrochloride
- Albendazole
- Alendronic Acid

FIGURE 18: List of drug generics

This page is displayed when the user clicks on the generic name from the drug by generic page or any place in the website where the name of the generic appears. This page displays drug information like the generic name, pregnancy risk categories, precaution, indication, contra indication, dose, side effect, mode of action, interaction links to brands of drugs with the same generic family, related indications and related therapeutics. The user can also see the pregnancy category description guidelines. The page is also displayed in Amharic when the user clicks on the language tab.

The screenshot displays the EthioDIMS website interface. At the top, there is a header with the logo "EthioDIMS" and a language selection bar with "Amharic" and "English" buttons. A search bar and a "Select Item" dropdown are also present. Below the header, a navigation menu includes "Home", "DRUGS", "Events", "Pharmacies", and "Contact Us". The main content area is titled "Generic Name: Adapalene 0.3%". It features a "pregnancy category :C" label. The "About" section lists various drug information fields: Name (Adapalene 0.3%), Precaution (Patients with sunburn, eczema. Pregnancy, lactation. Avoid excessive exposure to sunlight or UV irradiation. Keep away from the eyes, lips, nostrils and mucous membranes. Do not apply to cuts, abrasions, scaly or flaky skin, or patches of sunburned skin. Use with caution with preparations containing sulfur, resorcinol, or salicytic acid.), Indication (Acne), Contra Indication (Hypersensitivity), Dose (Adult: Topical As 0.3% soln/cream/gel: Apply once daily at night.), Side Effect (Mild skin irritation, scaling, erythema, cutaneous dryness, sensations of stinging and burning, pruritus.), Mode Of Action (Adapalene binds to specific retinoic acid nuclear receptors which normalises the differentiation of follicular epithelial cells resulting in decreased microcomedone formation.), and Interaction (Increased irritation may occur with medicated or abrasive soaps, products with a pronounced drying effect and those containing alcohol or astringents.). At the bottom, there is a "Related Brands" section with a plus icon.

FIGURE 19: Detailed description of the selected drug generic

The public website has a total of 12 major user interfaces for each language excluding message boxes some of this interfaces are shown in figure 13 up to 19 the rest can be found in the annex 3.

5.3.1.2 Smartphone Based Drug Information Management Application

The android application has 12 user interfaces. This user interfaces accept on tap, on keyboard and gesture movement on the screen of the phone. The smartphone application user interfaces were all designed using just in mind prototype which is a software that allows the user create a mid-level prototype. Some of these user interfaces are shown below:

Home screen – it is the first page that is display for the user when the application is opened. It has 8 buttons the user can interact with the application using tap gestures.



FIGURE 20: DIMS smartphone application homepage

Set reminders page – this page allows the user to create a reminder for drug intake schedule. The clock is displayed when the user taps on the add button located on the bottom right side of the screen (see figure 20).



FIGURE 21: DIMS smartphone application fill reminder

Drugs by brand page – this page is displayed when the user tap the all drugs button on the home screen. This page displays all the drugs in the database in alphabetical order. The user is also able to search drug by brand in the search box made available to him/her. To access the information, the user is expected to tap on the desired drug name. On figure – in the search box the letter ‘a’ was written as a search parameter. The search function is a predictive search meaning the result are displayed the moment the user types a letter in the search box (see figure 21).



FIGURE 22: DIMS smartphone application all drugs with search

Favorites page – this page is displayed when the user taps on the favorite drugs button on the home screen. This page displays all the drugs in the database that have been selected as favorites by the user. The user can remove drugs from the favorite drugs list by clicking on the cancel button (see figure 22)

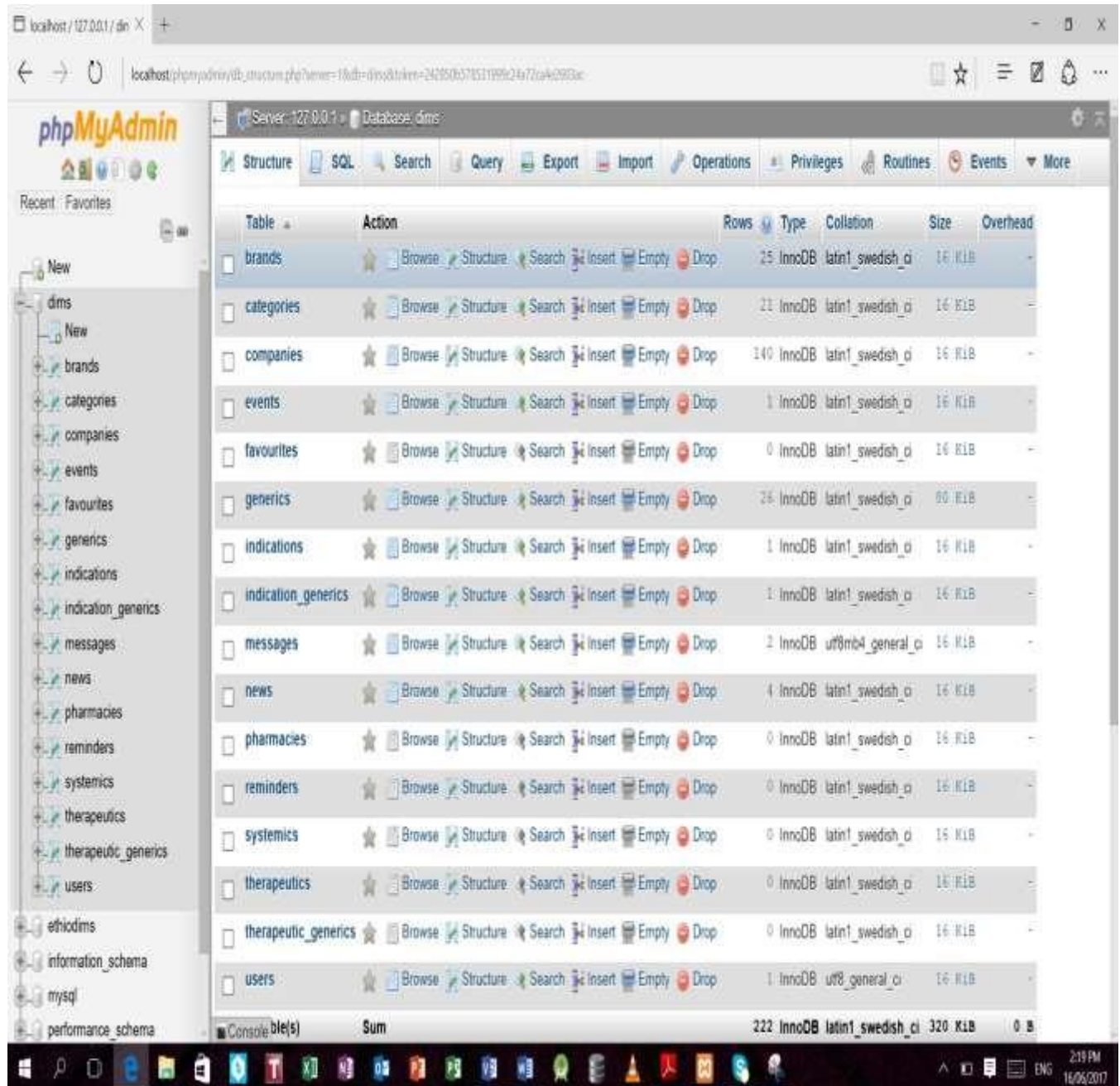


FIGURE 23: DIMS smartphone application favorites

The smartphone applications user interface has been designed with the idea of constancy and uniformity in mind. All the pages are easy to understand and closely related to that of the website hence making the switch between the platforms smooth and understandable.

5.3.2 The Database Layer

The database layer of the system contains the database table and is used to store the data of the system. All fields in the table are identified and the corresponding primary keys, which are used to identify each instance in the table uniquely are assigned. Figure 23 shows all the tables in the database created from MySQL database management system.



The screenshot displays the phpMyAdmin interface for a MySQL database named 'dms'. The left sidebar shows the database structure tree with 'dms' selected. The main panel shows the 'Structure' tab for the 'dms' database, listing 22 tables. Each table entry includes a checkbox, the table name, an 'Action' menu, and columns for Rows, Type, Collation, Size, and Overhead. The tables listed are: brands, categories, companies, events, favourites, generics, indications, indication_generics, messages, news, pharmacies, reminders, systemics, therapeutic_generics, users, ethiodims, information_schema, mysql, and performance_schema. The 'Sum' row at the bottom indicates a total of 222 rows across all tables.

Table	Action	Rows	Type	Collation	Size	Overhead
brands	Browse Structure Search Insert Empty Drop	25	InnoDB	latin1_swedish_ci	16 KIB	-
categories	Browse Structure Search Insert Empty Drop	21	InnoDB	latin1_swedish_ci	16 KIB	-
companies	Browse Structure Search Insert Empty Drop	140	InnoDB	latin1_swedish_ci	16 KIB	-
events	Browse Structure Search Insert Empty Drop	1	InnoDB	latin1_swedish_ci	16 KIB	-
favourites	Browse Structure Search Insert Empty Drop	0	InnoDB	latin1_swedish_ci	16 KIB	-
generics	Browse Structure Search Insert Empty Drop	26	InnoDB	latin1_swedish_ci	60 KIB	-
indications	Browse Structure Search Insert Empty Drop	1	InnoDB	latin1_swedish_ci	16 KIB	-
indication_generics	Browse Structure Search Insert Empty Drop	1	InnoDB	latin1_swedish_ci	16 KIB	-
messages	Browse Structure Search Insert Empty Drop	2	InnoDB	utf8mb4_general_ci	16 KIB	-
news	Browse Structure Search Insert Empty Drop	4	InnoDB	latin1_swedish_ci	16 KIB	-
pharmacies	Browse Structure Search Insert Empty Drop	0	InnoDB	latin1_swedish_ci	16 KIB	-
reminders	Browse Structure Search Insert Empty Drop	0	InnoDB	latin1_swedish_ci	16 KIB	-
systemics	Browse Structure Search Insert Empty Drop	0	InnoDB	latin1_swedish_ci	16 KIB	-
therapeutics	Browse Structure Search Insert Empty Drop	0	InnoDB	latin1_swedish_ci	16 KIB	-
therapeutic_generics	Browse Structure Search Insert Empty Drop	0	InnoDB	latin1_swedish_ci	16 KIB	-
users	Browse Structure Search Insert Empty Drop	1	InnoDB	utf8_general_ci	16 KIB	-
Sum		222	InnoDB	latin1_swedish_ci	320 KIB	0 B

FIGURE 24: All tables in the database

5.4 System Evaluation

Usability testing is a technique used in user-centered interaction design to evaluate a product by testing it on users. This can be seen as an irreplaceable usability practice, since it gives direct input on how real users use the system (29). This is in contrast inspection methods where experts use different methods to evaluate a user interface without involving users.

Usability testing usually involves systematic observation under controlled conditions to determine how well people can use the product. Basic feature of usability tests of the software is how easy to use, to learn and how convenient is the software to end user.

5.4.1 System Performance Measures

System performance testing is the process of determining whether the prototype system is correct, that is whether it meets the level of accuracy as required. It confirms whether the right prototype system has been built.

The performance testing of the system used information which were available in the database and information which were made available on paper. For the testing of the system six tasks were selected (the details of the task including name, description, requirement and instructions described in annex 5). The participants were asked to perform the listed tasks and the findings are described as follows.

5.4.1.1 Average Time on Tasks

The average time on the task is the average time taken to perform the tasks by participants. the average time taken to perform the tasks by participants is shown in the table below.

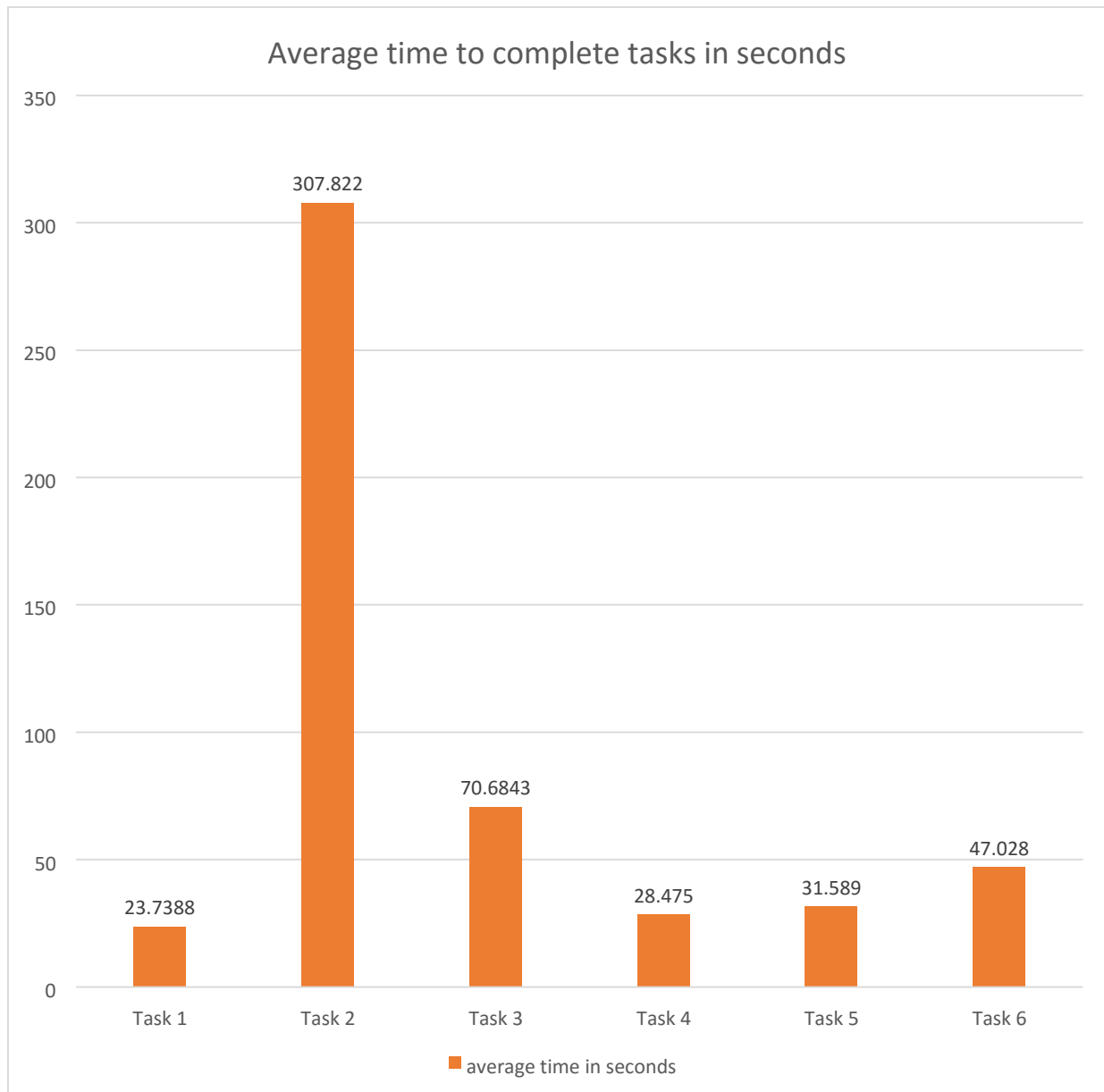


FIGURE 25: Average time on task by task

These six tasks are described illustrated in appendix 5 that includes task name, description, instructions, and expected time to complete. The average time needed to complete Task 2 that is registering new drug generic is more than other tasks. The reason for Task 2 taking more time than other tasks is, it has more fields to fill rather than others.

5.4.1.2 Tasks Success Distribution by Participants

The determining criteria of task success distribution are complete with ease, complete with difficulty and failed to complete the task. The result of task success distribution was obtained from

the recorded data about the condition of the user performance to complete the task that has been observed by the testing session observer and the average time taken to perform the tasks.

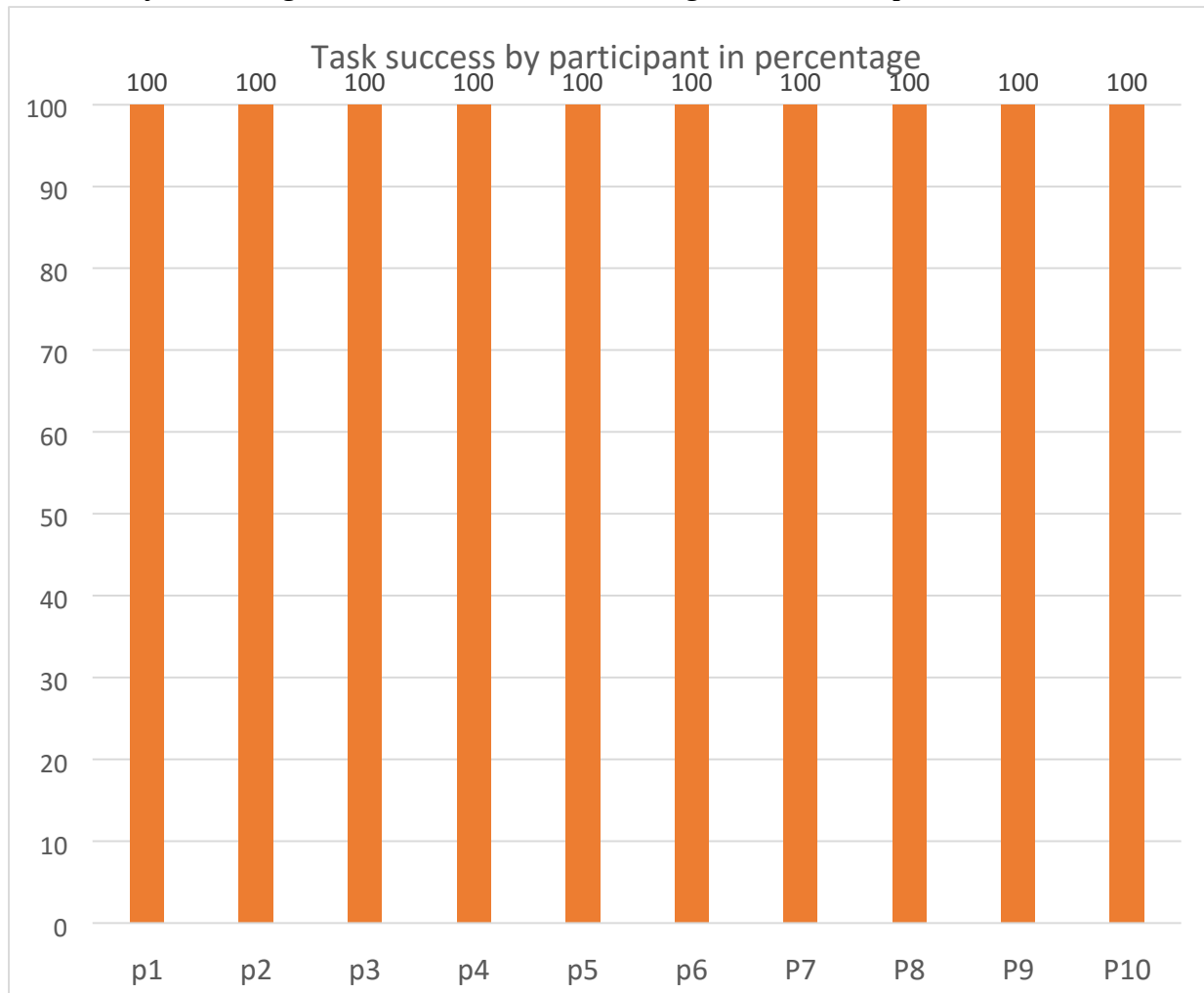


FIGURE 26: DIMS website success rate by participant

In the figure above it is clear to see that all the participant has completed the tasks.

5.4.1.3 Average Time on Task by Participants

The participants were asked to perform the tasks which are described in appendix 5. During the test session the time to complete the given tasks by participant were recorded. The average time to complete all the given tasks by each participant is illustrated in the figure

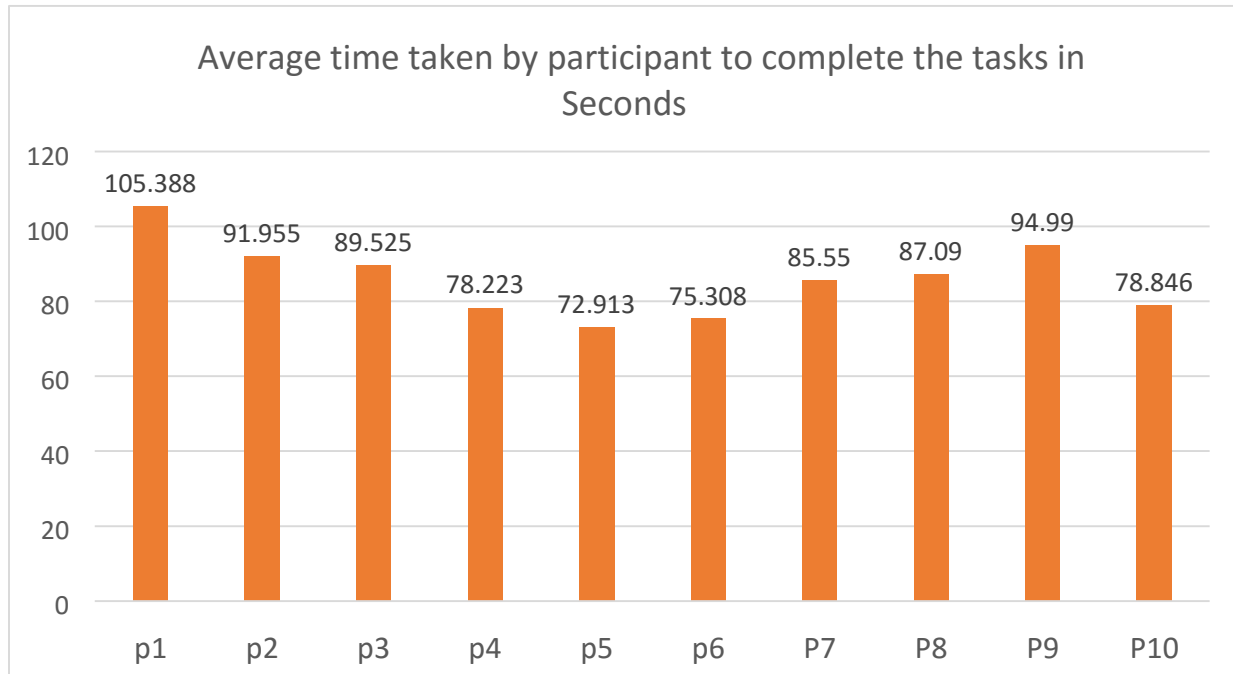


FIGURE 27: DIMS website average time taken by participants to complete the tasks

Participant 1 and participant 9 took a long time to complete registering new drugs by generic information and new drugs by brand. Hence increasing the average time taken to complete their tasks.

5.4.1.4 Average Time vs Expected Time

The summary of task performance showed that the task of using DIMS website took the average time to complete the task versus the expected time. The expected time is the average time of the observers to complete the task (task list and description is shown in appendix 5). Figure shows, the average time taken and expected time to complete the six tasks.

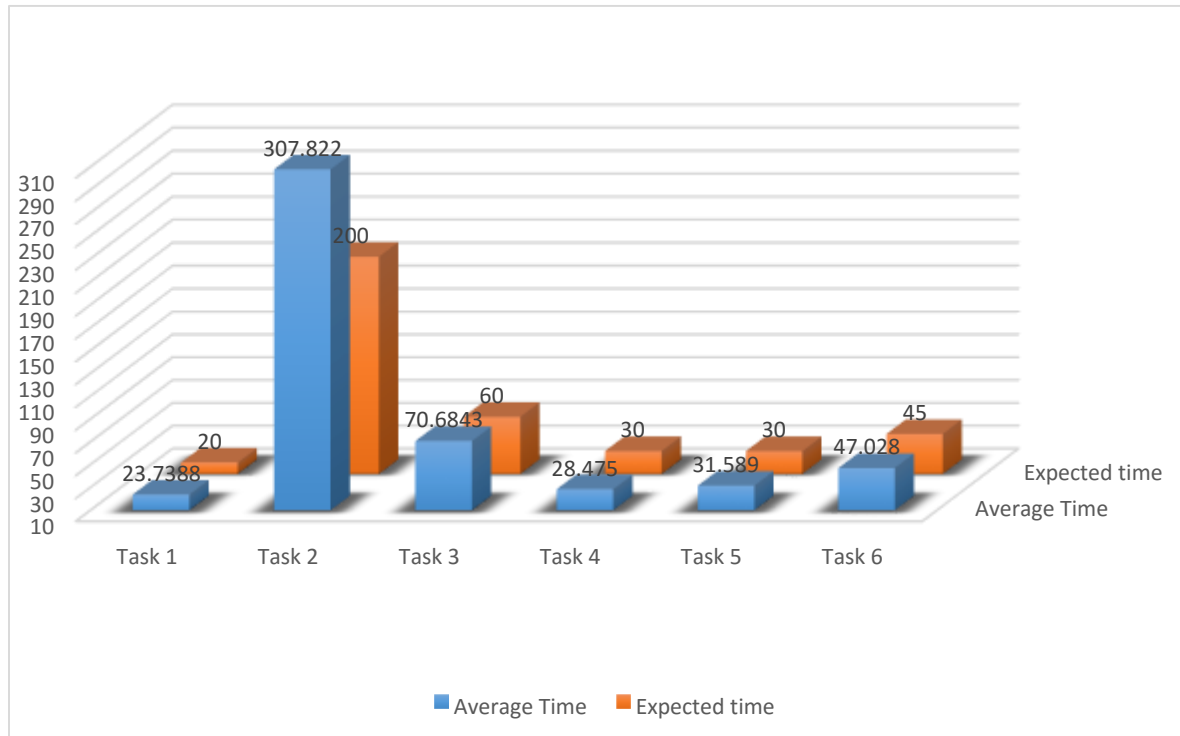


FIGURE 28 : DIMS website average time vs expected time

The difference between the average time and expected time to complete the task has a significant difference on some tasks.

5.4.2 System Usability Test

Under system usability testing, the process of ensuring that whether the system satisfies the requirements of its end-users is performed. This permits end-users to test the system by actually using it and evaluating the benefits received from its use. Morae Tech Smith software was used to conduct the usability test of the system by using its user satisfaction survey question.

Cognitive walk through evaluation method was applied to test the usability of the system. Through this method the evaluator first determines the exact sequence of correct task performance, and then estimates, on a screen by screen basis, the likely success or failure of the user in performing such a sequence. Concentrates more on the difficulties users may experience in learning to operate an application to perform a given task. The importance of this evaluation form is to evaluate to what extent the system is usable with regard to the end-users in the domain area.

The result of usability testing is demonstrated as follows. The values for all attributes in table 15 are fixed as: Strongly agree = 5, Agree = 4, undecided = 3, Disagree = 2 and Disagree = 1.ain area

Usability Testing							
No	Criteria for evaluation	Strongly disagree	Disagree	Undecided	Agree	Strongly agree	Average
1	I think that I would like to use this system frequently				2	8	4.80
2	I found the system not complex					10	5
3	I thought that the system was easy to use				1	9	4.90
4	I think that I would not need the support of a technical person to be able to use this system					10	5
5	I found the various functions in this system were well integrated				2	8	4.8
6	I thought the system has constancy			1	1	8	4.7
7	I would imagine that most people would learn to use this system very quick				2	8	4.8
8	I found the system not cumbersome to use				1	9	4.90
9	I felt very confident using the system					10	5
10	I didn't needed to learn a lot of things before I could get going with this system				1	9	4.90
Average						4.88	

TABLE 15: Result from Likert scale for website

From a score of 5 the evaluators scored 4.80 to use the system frequently. The 2nd evaluation criteria the system is not complex scored 5. The evaluators scored 4.90 on the criteria of system's ease to use. For the criteria of technical person not need to be able to use the system scored 5. For the 5th criteria that is whether the various functions in this system were well integrated scored

4.80. The evaluators were scored 4.70 for the criterion of the system doesn't have inconsistency. For the criteria their imagination about most people would learn to use this system very quickly scored 4.80. The evaluators were scored 4.90 for the question the system is not a cumbersome to use. The evaluators felt confident to use the system scored 5 for the last criteria the evaluators scored 4.90.

Finally, the average usability of the prototype system according to the evaluation results filled by the participants is 4.88 out of 5 or 97.6%.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATION

The earlier chapters have brought to light some significance issues in the development of the electronic versions of the drug information management systems for the improvement of drug prescription and drug usage .in this part of the document, conclusion of the study and recommendations for future works will be stated.

6.1 Conclusion

This paper shows my initial step for the creation of a localized drug information management system website and smartphone application that empowers better drug prescription and drug usage. In the development of these systems, qualitative study was carried out. Information was acquired using interviews from domain experts and document analysis was carried out to find solutions to the problem that were stated.

Unified modelling language method was used to analyses the collected requirements and create the design of the system. Design of the systems was done by using NetBeans 7.4.1 with PHP scripting language for the web based system while Justin mind prototype tool was used for the smartphone application. The database was created using MySQL database management system. The methodology used for the evaluation of the system is usability lab testing method and the testing was done using a Likert scale questionnaire for the smartphone application and for the website Morea Tech Smith usability testing software was used. From the test that was carried out, the developed system scored 4.88 out of 5 hence passing the usability test.

Generally, the prototype system serves as a reference system for drug information and helps the health professionals get access to information about event such as seminars and knowledge sharing meetings available. The smartphone application was designed to give drug information as well as to set reminders on drug intake schedules. The initial feedback from health professional and non-health professionals has been extremely positive.

6.2 Recommendations

Drug information management system are attracting interests for all aspects of the community both from health professional and non-health professionals. with the expansion of EthioTelcom internet infrastructure more people in Ethiopia have access to internet. on the other hand, android phone is becoming the must have gadgets in Ethiopia

From the findings of the study the following recommendations for future works are forwarded:

- To deploy the smartphone application based on the design carried out
- To make the website and smartphone application more effective; It must be designed by incorporating multiple languages predominant in Ethiopia.
- There is a need to integrate blogs, forums and other facilities into the website system so as to create a knowledge sharing platform for the population.
- The database must include drug images.

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ANNEXES

A.01 Interview questionnaire

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES SCHOOL OF INFORMATION SCIENCE AND SCHOOL OF PUBLIC HEALTH Informed Consent Form for participants

This informed consent form is for health professional and consumer in Addis Ababa and who we are inviting to participate in this study project designing a web based drug information-n management system and android application.

Information Sheet

I am Micheal Tesfaye, a master's student in Addis Ababa University. I am doing a projects study regarding drug information management system as per requirement of fulfillment for master program in health informatics. I am going to give you information and invite you to be part of this study project. You do not have to decide today whether or not you will participate in the study. Before you decide, you can talk to me if you feel comfortable about the project. This consent form may contain words that you do not understand. Please ask me to stop as we go through the information and I will take time to explain. If you have questions later, you can ask me.

Purpose of the study project:

We want to find ways improve drug information management to improve the drug dosing and prescription. We believe that you can help us by telling us what you know about current drug dosing and prescription and health information. We want to get insight on normal practice of drug prescription by health professionals and drug information uses by consumers.

Type of study:

This project study will involve your participation in an interview that will take about twenty minutes.

Participant selection:

You are being invited to take part in this project because we feel that your experience as a health worker can contribute much to our understanding and knowledge of drug information management and health information management system.

Voluntary participation:

Your participation in this project is entirely voluntary. It is your choice whether to participate or not. If you choose not to participate nothing will change.

Procedures:

During the interview, I will sit down with you in a comfortable place at the Hospital or cafe. If you do not wish to answer any of the questions during the interview, you may say so and we will move on to the next question. The information recorded is confidential, and no one else except project team will access to the information documented during your interview. The entire interview will be recorded, but no-one will be identified by name on the tape.

Benefits:

There will be no direct benefit to you, but your participation is likely to help us find out more about how to improve the drug reference method currently deployed and enable us to develop a drug information management system.

Reimbursements:

You will not be provided any incentive to take part in the study.

Confidentiality:

We will not be sharing information about you to anyone outside of the project team. The information that we collect from this study project will be kept private. Any information about you will have a number on it instead of your name. It will not be shared with or given to anyone except project team.

Sharing the results:

The knowledge that we get from this project study will be shared with you.

Right to refuse or withdraw:

You do not have to take part in this study if you do not wish to do so, and choosing to participate will not affect your job or job-related evaluations in any way. You may stop participating in the interview at any time that you wish without your job being affected. I will give you an opportunity at the end of the interview to review your remarks, and you can ask to modify or remove portions of those, if you do not agree with my notes or if I did not understand you correctly.

Who to contact:

If you have any questions, you can ask me now or later. This proposal has been reviewed and approved by Addis Ababa University Research Ethics Committee, which is a committee whose task it is to make sure that project study participants are protected from harm.

Certificate of Consent

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Signature of Participant _____

Date _____

Questionnaire

Starting time and date _____

1. Which group do you belong in?

☐ Health professional ☐ Client

2. What type of information technology device do you use?

☐ Personal computer ☐ smartphones or tablets ☐ both ☐ none

3. Do you have access to internet connection?

☐ Yes ☐ no

3. 1.If yes, how often? _____

4. Have you used drug information references?

☐ Yes ☐ no

If yes answer question 4.1 else skip to question 7.

4.1. How often do you it?

☐ Every hours ☐ daily ☐ sometimes ☐ seldom

4.2. Reason for use?

☐ Work ☐ personal use

4.3. If yes, what type of drug references do you use?

☐ Manual ☐ automated ☐ both

If manual answer question number 5 else answer question number 6 if use have chosen both answer both sections, please give short and precise answer for the following questions.

5. For manual

5.1. Where do you get the manual drug references from?

5.2. What are the benefits you got from using a manual drug reference?

5.3. What are the drawbacks of using manual drug reference?

6. For automated

6.1. Where do you get the automated drug references from?

6.2. What are the benefits you got from using an automated drug reference?

6.3. What are the drawbacks of using automated drug reference?

7. What functionalities do you want from the proposed system?

7.1. In the case of the web-based system?

7.2. In the case of android application?

The interview was finished at _____

We would to thank you on for the successful completion of the questionnaire for any question and further involvement in this project you can email us on michealtesfayeam@gmail.com

A.02 Sample Source Code

Some source code for the website dims are listed as follows

Add to generic

```
public function add()

    {$generic = $this->Generics->new Entity ();

    if ($this->request->is('post')) {

        $generic = $this->Generics->patchEntity ($generic, $this->request->data);

        if ($this->Generics->save($generic)) {

            $this->Flash->success (__ ('The generic has been saved.'));

            return $this->redirect (['action' => 'index']);}

        else {$this->Flash->error (__ ('The generic could not be saved. Please, try again.'));}

        $categories = $this->Generics->Categories->find ('list', ['limit' => 200]);

        $this->set (compact ('generic', 'categories'));

        $this->set ('_serialize', ['generic']);}
```

Edit generic

```
public function edit ($id = null)

    {$generic = $this->Generics->get ($id, [

        'contain' => []]);

    if ($this->request->is (['patch', 'post', 'put'])) {

        $generic = $this->Generics->patch Entity ($generic, $this->request->data);

        if ($this->Generics->save($generic)) {

            $this->Flash->success (__ ('The generic has been saved.'));

            return $this->redirect (['action' => 'index']);}

        else {$this->Flash->error (__ ('The generic could not be saved. Please, try again.'));}

        }

        $categories = $this->Generics->Categories->find ('list', ['limit' => 200]);

        $this->set (compact ('generic', 'categories'));

        $this->set ('_serialize', ['generic']);}
```

Drugs by brand index page

```
<div class="brands index large-12 medium-12 columns content panel">

  <div class="panel-heading"><div class="panel-title"><h3><? = __ ('A-Z Drugs')?></h3>

</div>

</div>

<div class="panel-body">

<table cellpadding="0" cellspacing="0" class="display " id="data-table" class="ui-resizable-w">

  <thead>

    <tr>

      <th><?= $this->Paginator->sort('name') ?></th>

      <!--<th class="actions"><?= __ ('Actions') ?></th>-->

    </tr>

  </thead>

  <tbody>

    <?php foreach ($brands as $brand): ?>

      <tr>

        <td><?= $this->Html->link($brand->name, ['action' => 'view', $brand->id]) ?></td>

      </tr>

    <?php endforeach; ?>

  </tbody>

</table>

</div>

</div>
```

A.03 User Interfaces

As mentioned on the system analysis the website as to users the administrator and the user the administrator can add information to the database modify the database and even delete from the database here are some user interface that allow the administrator complete these tasks: Add drugs by brand

The screenshot shows a web browser window with the URL `localhost:8080/brands/add`. The page is titled "Add Brand" and features a sidebar with links: "List Brands", "New Generic", and "New Company". The main content area contains a form with the following fields:

- Generic:** A dropdown menu with "5-Aminosalicylic Acid (Mesalamine)" selected.
- Company:** A dropdown menu with "Astellin Pharmaceuticals Ltd." selected.
- Name:** A large text input field.
- Form:** A large text input field.
- Strength:** A large text input field.
- Price:** A large text input field.
- Packsize:** A large text input field.

At the bottom of the form is an "Add" button. The browser's taskbar at the bottom shows various application icons and the system clock indicating 12:24 PM on 29/05/2017.

Add drugs by generic

This page enables the administrator to add a new drug generic into the system this page has dropdown box and text boxes to fill. After the form is filled the administrator clicks on the add button.

List Generics

List Categories

New Category

List Brands

New Brand

List Formulations

New Formulation

List Indications

New Indication

List Therapeutics

New Therapeutic

Add Generic

Name

Precision

Indication

Contra Indication

Dose

Side Effect

Category

A

Mech Of Action

Interaction

Indications

Tuberculosis
Control disease
Infectious cause
Inflammation, lower disease

Therapeutics

Acetaminophen
Pain relief, reduce
Anti-inflammatory
Anti-inflammatory

edit

Edit indication

In this page there are only to box this is because the administrator can edit the relation between a drug generic and the indication. The administrator can delete the indication from this page as well.



The screenshot shows a web application interface for editing an indication. On the left is a sidebar with four links: 'Delete', 'List Indications', 'List Generics', and 'New Generic'. The main area is titled 'Edit Indication'. It contains a 'Name' section with a text input field containing 'Crohn's disease'. Below this is a 'Generics' section with a list box containing four items: '5-Aminosalicylic Acid (Mesalamine)', 'Abacavir + Lamivudine + Zidovudine', 'Acarbose', and 'Acetolololol'. The first item is selected and highlighted in blue. At the bottom of the main area is a 'Save' button.

Delete

List Indications

List Generics

New Generic

Edit Indication

Name

Crohn's disease

Generics

- 5-Aminosalicylic Acid (Mesalamine)
- Abacavir + Lamivudine + Zidovudine
- Acarbose
- Acetolololol

Save

A .04 Interview Questions for Usability Test Participants

1. Age
2. Sex ☐ Male ☐ Female
3. Education
☐ Higher education
☐ First degree
☐ Second degree
☐ Others
4. Field of study
☐ Health related
☐ Non-health related
5. Computer skills
☐ Beginner
☐ Good
☐ very good
☐ Excellent
6. Typing speed
☐ Beginner
☐ Average
☐ Advanced

Computer skills: Beginner: typing, mouse use, basic computing and application, Good: intermediate computing and applications, Very Good: proficient computing, application, Excellent: proficient computing, applications and programming.

Typing speed: Beginner: less than 80 characters per minute, Average: 80- 190 characters per minute, Advanced: more than 190 characters per minute

A .05 Task Description

Task No	Task Name	Task Description	Test requirement	Test Instruction
1.	Log in Actor system administrator	Log in to the system so as to use the feature of the website with administrator privilege. Measurement attributes: ☐ Time to complete the task	➤ This test requires: ➤ Open the administrator page ➤ Must have a valid user name and password ➤ It should be completed within 30 seconds.	Log in to the system by using provided user name and password
2.	Add new drug generic Actor system administrator	Add new drug generic information. Measurement attributes: ☐ Time to complete the task	➤ This test requires: ➤ Log in to the system ➤ It should be completed within 3 minutes.	• Open the generic page from the homepage • Click on the add generic link • Fill the form • Click ok
3.	Add new drug by brand Actor System Administrator	Add a new brand of drug into the system. ☐ Time to complete the task	➤ This test requires: ➤ Logged into the system ➤ Should be completed 1 minute.	• Open the add drug form • Fill the form correctly • Click ok
4.	search drug by brand information Actor user	Search available information Measurement attributes: ☐ Time to complete the task	➤ This test requires: ➤ The user must input valid search index. ➤ It should be completed within 30 seconds.	• Open the A-Z page • Click on the search box • Input the search index in the search box • Select the desired result
5.	View drugs by generic for a specific brand of drug	View generic drug information for selected brand of drug that exists in the database.	➤ This test requires: ➤ DIMS public website must be opened	☐ Click on the A-Z drugs tab on the homepage under drugs

	Actor user	Measurement attributes: ☐ Time to complete the task	➤ It should be completed within 30 seconds.	☐ Select drugs by brand ☐ Click on the generic name
6.	Send feedback Actor User	Send feedback to the administrator via their email. Measurement attributes: ☐ Time to complete the task	This test requires: ➤ The sender must have a valid email account ➤ It should be completed within 45 seconds.	☐ Click on the contact us link on the DIMS public website homepage ☐ Fill the form ☐ Click the send button

A.06 Use-case Description

Use case id:	Uc-10
Use case name :	Notify Updates
Use case description	It is used to notify the smartphone user that an up-to-date database is available
Primary actor(s):	System
Include	None
Extend	None
Trigger	The user is connected to the internet
Pre-condition:	The application is connected to the internet and updated database is available .
Post-condition:	Updated database.
Basic scenario:	The use case starts when: 1. The application is connected to the database; 2. The system finds updated database; 3. The system displays notification of available database; 4. The user chooses to update database; 5. The application gets updated database. Use case ends
Alternative scenario	4a) the user click not to update database;
Special conditions	None

DECLARATION

I declare that this project is my original work and has not been presented for degree in any other university, and that all sources of materials used for the project have been acknowledged.

MICHEAL TESFAYE

This project has been submitted for examination with our approval as university advisors.

Dr. Million Meshesha

Dr. Nigussie Deyessa

Place and Date of submission: Addis Ababa, June 2017