



**ADDIS ABABA UNIVERSITY
SCHOOL OF INFORMATION SCIENCE
AND
PUBLIC HEALTH
M.Sc in Health Informatics Program**

**Design of TB Patient Adherence to Treatment Follow Up System
For Woreda Nine Health Center in Nifas Silk Lafto Sub-City**

By Azeb Bahre

**A Project Submitted to the School of Graduate Studies of Addis Ababa
University in Partial Fulfillment of the Requirements for the Degree of Master
of Science in Health Informatics**

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DEDICATION

I would like to dedicate this paper to beloved my children Eyob Araya, Aron Araya and Saron Araya who didn't have their mother's follow-up during my study.

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List of Acronyms

AIDS	Acquired Immune Deficiency Syndrome
DOTs	Direct Observed Therapy Short Course
E-TB	Electronic Tuberculosis
FMOH	Federal Ministry of Health
HBCs	High Burden Countries
HEWs	Health Extension Worker
HIV	Human Immune Deficiency Virus
HIS	Health Information System
HSD	Health System Development
HTML	Hyper Text Markup Language
ICT	Information Communication Technology
LTBI	Latent Tuberculosis Infection
MDR-TB	Multi Drug Resistance Tuberculosis
MTB	Mycobacterium Tuberculosis
MySQL	Structured Query Language
NTP	National Tuberculosis Programs
OO	Object Orient
OPD	Out-Patient Department
PHP	Hypertext Processer
RR	Rifampicin Resistance
RNTCP	Revised National TB Control Program
SDLC	System Development Life Cycle
TB	Tuberculosis
UML	Unified Modeling Language
WHO	World Health Organization

Abstract

Background: Globally tuberculosis (TB) is remains a major global health problem and ranks as the second leading cause of death among deaths caused by infectious diseases worldwide.

Electronic based record is computerized medical information systems that collect, store and display patient information. It is a means of create legible and organized records to access clinical information about individual patients and facilitate early identification and successful treatment of all TB cases.

Objective: To design TB patient adherence to treatment follow up system for Woreda Nine Health Center found in Nifas Silk Lafto Sub-city.

Methodology: This project used the object-oriented analysis and design systems development technique and different data collection tools used to collect requirement for the system to be developed. Analysis and design of the proposed system was done by using the Unified Modeling Language, Microsoft Visio 2013, Joomla MySQL data base, PHP, and HTML.

Result: The current system reviewed, the problems in data process, communication, procedures, people, software and hardware. The system was designed by identifying the entire process and system analysis proposed in the use cases. The system design includes sequence diagram, class diagram and user interface has different data such as patient demographic data, diagnosis, and patient treatments follow up, laboratory results, and generate report. The system helps to easily access, update and process those data regarding TB patients follow up system. Which will help to transform the paper based manual system to efficient and effective electronic system.

Conclusion: Generally the designed system could enhance accessibility of data or patient information with the reduction of the unnecessary time wasted to search patient data and compile reports and it makes timely use of information by decision makers, which improves the current service.

Recommendations: The health center collaboration with the Federal Ministry of Health Regional Health Bureau and other stakeholders has to work on the implementation and usability of the system and provide the necessary system support.

The researchers/students continue the project and work on the remaining parts of the system.

CHAPTER ONE

INTRODUCTION

1.1. Background

Tuberculosis is bacterial disease caused by *Mycobacterium tuberculosis* and occasionally *Mycobacterium bovis* and *Mycobacterium africanum*. It typically affects the lungs (pulmonary TB) but can affect other sites as well (extra pulmonary TB). It is transmitted via the respiratory route, with the most important source of infection being the patient with TB of the lung, who is coughing, releasing infectious droplet nuclei, which can also be spread into the air through talking, sneezing, spitting and singing, and can remain in the air for long periods, especially in the absence of direct sunlight (1).

Multidrug-resistant TB (MDR TB) is defined as *Mycobacterium tuberculosis* (*M. tuberculosis*) that is resistance at least to isoniazid and rifampicin (2).

Extensively drug-resistant TB (XDR TB) is defined as *M. tuberculosis* resistant to isoniazid, rifampicin, any fluoroquinolone and at least one of three injectable second-line drugs (2).

Global tuberculosis reports in 2014 the world-wide 9.6 million people are estimated to have fallen ill with TB those 5.4 million men 3.2 million women and 1.0 million children. And 6 million new cases of TB were reported to WHO, fewer than two-thirds (63%) of the 9.6 million people estimated to have fallen sick with the disease. This means that worldwide, 37% of new cases went undiagnosed or were not reported. The quality of care for people in the latter category is unknown (3).

National burden in Ethiopia data WHO estimated that in 2014 there were 200,000 new cases in Ethiopia ranks 10th among the world 22 high burden countries for TB and 4th in Sub-Sahara Africa. While TB kills as estimated 32000 Ethiopians every year it also has a long-term corrosive impact on the health of Ethiopia's population (4).

A major barrier to progressing toward TB elimination in Ethiopia and other high-burden countries is the TB "case-detection rate" of only 60%, meaning that an estimated 80,000 Ethiopians who developed TB in 2014 were never diagnosed or treated, leading to ongoing spread of TB to family members and communities. The gap in case-detection rate is even worse for the more severe multidrug-resistant TB (MDR-TB), where less than a quarter of an estimated 2,200 Ethiopian MDR-TB patients are identified each year. To reduce this burden, detection and treatment gaps must be addressed, funding gaps closed and new tools developed (4).

Drug-resistant TB Globally, in 2013 there were an estimated 480,000 cases, and about 210,000 deaths caused by MDR-TB worldwide. Among the high burden countries (Estonia, Ethiopia and Myanmar)

Extensively drug-resistant TB (XDR-TB) had been reported by 105 countries by 2015. An estimated 9.7% of people with MDR-TB have XDR-TB (5).

Currently in Ethiopia, the Health Sector Transformation Plan (HSTP) is the next five-year national health sector strategic plan, which covers 2008-2012 E.C (July 2015 – June 2020 G.C.). The sector has identified transformation agendas one of the transformation agenda is information revolution. The main objective of information revolution is to enhance the use of timely, accurate and reliable information for decision-making at the local level across the sector. This includes revolutionizing the data management from patient level data to national level reports. The routine systems that are built for collection of data should be supported with appropriate technology to efficiently operate across the line (6).

Health information systems have an advantage of providing quality and accurate data that make, reporting potentially more flexible and efficient. While on the contrary of the paper based system data is collected and compiled manually at the point of care. This manual process has an outcome that hinders from making sound clinical decisions, planning and procurement unpredictable and time consuming in all levels. Additionally it prevents higher level of the hierarchy from viewing the various aggregated data coming from lower levels of the health care systems (7).

Records management is the practice of identifying, classifying, archiving, preserving, health center records as information created, received, and maintained as evidence and information by an organization or person, in fulfilment of legal obligations or in the transaction of business (8).

1.2 Statement of the Problem

Tuberculosis is still among the major communicable diseases with a most important public health significance. Despite of the many efforts that have been put both globally and nationally to combat TB epidemics, it continues to be a major problem. The low detection of poor- adherence cases with a huge concern to the health sector and the failure for cure increases the risk of development of drug resistance TB and further spread in community which in turn increases morbidity and mortality (9).

Multidrug-resistant (MDR) TB has become a major public health problem and presents new barriers to the control of TB. Drug-resistant TB is a man-made problem, largely being the consequence of human error as a result of poor adherence, supply management, quality of anti-TB drugs and inadequate or improper

treatment, which is further exacerbated by human immunodeficiency virus (HIV). Poor infection control practice has also been identified as a major contributing factor for the spread of drug-resistant TB. Nearly half a million cases of MDR-TB emerge every year, but only 3% of them get treatment globally and 110,000 die annually (10).

In Ethiopia studies showed that prevalence of MDR TB as 2.3% in new cases and 17.8% in previously treated patients in 2014. The prevalence of MDR TB cases has increased compared to the first anti-TB drug resistance. Surveillance conducted nationwide in 2005 with a prevalence of 1.6% among newly diagnosed TB cases and 11.8% in previously treated TB cases. The consequences of those increased cases are non-adherence to treatment follow up system, increased rates of treatment failure and relapse. Hence the effect of these reasons increase acquired drug resistance and prolonged infectiousness of patients (10).

Study conducted in Peru that Electronic patient tracing systems to monitor effective treatment and follow-up of patients identified with multidrug-resistant TB. They concluded that committed community health care workers provided with personal digital assistants or smart phones would be able to trace and treat patients who are lost to follow-up or never initiated treatment, to ensure that treatment courses are completed. The tracking and results system in Peru, also now shared with the Philippines and elsewhere, bring clear benefits in reducing delays and errors, and improving service efficiency (11).

Currently in the Health Center the record and patient monitoring follow up system is managed manually in paper based faces many problems, such as patients treatment follow up system, missed scheduled appointments date, time taken for the identification of lost to follow up, incomplete and inaccurate report, problems with data confidentiality and security, especially in HIV positive patients and wastage of time in maintaining paper works. These available data are not sufficient to provide quality health information for health care planners and decision maker about the trends of TB. In our country, the practical challenge for health care providers, planners and policy makers working in primary health care prevention and control activities is lack of timely and reliable health information on the health status.

1.3 Objectives

1.3.1 General Objective

The general objective of this project is design of TB patient adherence to treatment follow up system for Woreda Nine Health Center found in Nifas Silk Lafto Sub city.

1.3.2. Specific Objectives

- ❖ To assess the challenges of existing paper based health information system.
- ❖ To analyze and model the existing system
- ❖ To design new automated system
- ❖ To evaluate the developed prototype

1.3.3. Scope of the Project

The scope of the project is design and development of prototype for TB patient adherence to treatment follow up system for Woreda Nine Health Center found in Nifas Silk Lafto Sub-city. Therefore the project was assessing the existing situation of recording and follow up system of health center information system and identifies user and system requirement, then the identified user and system is also necessary in order to improve the accessibility of the patient information. After the identification of the user requirement, the project was done by the use of object oriented system analysis and design methodology. And the system will be scaled up and applied in other health facilities.

1.3.4. Significance of Study

This newly designed system will provide to different stakeholders various important functionalities and simplifies the provision of the major tasks process makes easy and have the following significances:

- ❖ Enable to the patients get better treatment and follow up, cure, restore quality of life, productivity, prevent death from active TB and MDR-TB or its late effects, patients would have guarantee access to effective personal and public health care service
- ❖ Motivate the community to reduce the risk of development of drug resistance TB and further spread in the community
- ❖ Health care worker it helps to make their work easier, effective and efficient for tracing and controlling lost to follow up /poor- adherence TB patients. Provide quality health care service and it helps to strengthen adherence DOTS program follow up.
- ❖ Health center it helps to improve fast communication of between different stakeholders, it provides patient information at appropriate place and time, improve patient's outcome information and generates report system used for adequate planning and budgeting for strengthening the patient care in the health center
- ❖ Policy makers will contribute knowledge to improve long term planning for health care service, accountability and resource allocation. Overall, the implementation of systems can improve the quality of care

CHAPETER TWO

LITERATURES REVIEW

2.1 Introduction

The literature review enabled the researcher to gain a better understanding of the research topic. In this study a wide range of resources were examined including articles, journals, reports, magazines, books and basic theoretical concepts about ICT, TB and MDR-TB, treatment adherence, recording follow up system and others various aspects of reviews and system related issues discussed.

2.2. Overview of Tuberculosis

Tuberculosis is remains a high-priority communicable disease that causes illness among millions of people responsible for the loss of more years of healthy life than any communicable disease. The epidemiology of TB has an unequal global distribution and the highest numbers of active TB cases are found in less developed countries (12).

World Health Assembly unanimously approved the end TB strategy, a 20-year strategy to “end the global TB epidemic” with the vision of a world with “zero deaths, disease and suffering due to TB”. It identifies three barriers to achieving progress in the fight against TB a) weak health systems, including those with large, unregulated non state sectors b), Underlying determinants of TB such as poverty, under nutrition, migration and aging populations; and risk factors such as diabetes, HIV, smoking and other diseases c) lack of effective tools continuous unmet funding needs (13).

The Ethiopian government have strong commitment to TB control efforts makes it a possible model country for TB control. A major strength of the national TB control program is the government’s commitment to provide health care for the entire population, with carefully crafted five-year plans for improving access to health services. One of this commitment is training and employing a team of health extension workers (HEWs) designed to provide basic health services down to the community level. Ethiopia has also committed to the “End TB Strategy,” with a revised national TB strategic plan that aims for a 50 percent reduction in TB incidence (annual new TB cases) and a 75 percent reduction in TB deaths by 2025 (14).

In addition the first priority of TB control programs is always recommended to be the early identification and successful treatment of all TB cases. This is because treatment rapidly reduces the risk of TB transmission to others. The next priority should be evaluation and follow-up of close contacts of active cases in order to identify secondary cases, source cases in some situations and those with recently acquired

latent tuberculosis infection (LTBI), to offer this group treatment 1% to 2% of close contacts are found to have active disease at the time of contact investigation. In addition, about 5% of newly infected contacts will develop active disease within 2 years of exposure (15).

2.3. Patient Adherence to Treatment Follow Up System

Adherence to treatment means that a patient is following the recommended course of treatment by taking all the prescribed medications for the entire length of time necessary. Adherence is important because TB is nearly always curable if patients adhere to their treatment regimen. Non adherence patient's inability or refusal to take drugs as prescribed. This behavior is one of the biggest problems in TB control and can lead to serious consequences of drug resistance TB (16).

Poor adherence to treatment of chronic disease including TB is a worldwide problem of striking magnitude, however patient with TB are expected to have adherence level greater than 90% in order to facilitate cure. The failure for cure increase the risk of development of drug resistance TB and further spread in community. In sub-Saharan Africa there is high rate of loss to follow up of TB patient that range from 11.1% -29%. Ethiopia is one of the seventh countries that reported lower rate of treatment success and patient who take TB treatment irregularly and unreliable way are at greatly increased risk of treatment failure (17).

Study conducted in Mekelle, Ethiopia reported that on non-adherence to anti-TB drugs and among TB/HIV co-infected patients the reasons for non-adherence to Anti TB treatments are: forget medication, felt sick when take the medication, far away from health facility, change in their daily routine activity, felt depressed/overwhelmed, pill burden ,felt the drug is toxic and want to avoid the side effect (18).

2.4. DOTS-Plus Treatment Follow up System of TB/MDR-TB Patients.

Integration of TB services detection and treatment follow up of all forms of TB, including multidrug-resistant forms, should be integrated into national TB control programmes. Improperly treated patients with resistant strains of TB are a source of ongoing transmission of resistant strains (19).

In Ethiopia Directly Observed Treatment Short Course (DOTs) strategy was launched by WHO in 1994. After further expansion and clarification, the framework has been implemented in 182 countries. Major progress in TB control has been achieved with the expansion of DOTS which has also helped national TB programmes, although the targets for TB control have not yet been met in every corner of the world (20). Ethiopia has adopted the DOTS strategy since 1997 after success of the pilot program with the

development of the first combined tuberculosis and HIV Prevention and Control Program manual. Public Private Mix (PPM) DOTS, Community TB Care and MDR-TB programs have been also piloted and integrated into the TBL and TB/HIV control program (20).

According to WHO study in treating patients with multidrug and extensively drug resistant TB positions a major challenge worldwide given the complicated and long-lasting nature of the regimens involved. Under such circumstances reliable information is central to the quality of patient-centred care and TB programme management. It ensures, that clinicians have all the necessary details on medication, adverse reactions, and results of testing in one place when making decisions on individual patient care. It also helps the efficient management of medicines, laboratory materials and other programme components. Electronic systems are now making this increasingly feasible and providing an important support to different components (21).

Drug-resistant tuberculosis has microbial, clinical, and programmatic causes. From a microbiological perspective, the resistance is caused by a genetic mutation that makes a drug ineffective against the mutant bacilli. An inadequate or poorly administered treatment regimen allows drug-resistant mutants to become the dominant strain in a patient infected with TB. The common causes of inadequate treatment, poor drugs and poor adherence lead to the development of MDR-TB (22). The main cause of multi drug resistance has summarized below.

Table 1: Causes of inadequate treatment

Health-care provider/ program related factors	Drug related factors	Patient- related factors
<ul style="list-style-type: none"> • Inappropriate guidelines • Non-compliance with guidelines • Absence of guidelines • Poor training • Poor supervision • No monitoring of treatment provision • Poorly organized or funded TB control program • Inadequate regimens 	<ul style="list-style-type: none"> • Poor quality medicines • Unavailability of certain drugs due to stock-outs of delivery disruptions • Poor storage conditions • Wrong doses or combinations (manufacture related) • Poor regulation of medicine 	<ul style="list-style-type: none"> • Poor adherence/default • Lack of information • Lack of transportation • ADR/drug interaction, • Mal-absorption • HIV • Diabetes mellitus • Malnutrition • Psychiatric condition • Substance/alcohol dependence • Social barriers

2.5. Diagnostics and Laboratory Strengthening TB and MDR-TB

TB high burden countries are using the sputum smear microscopy test method of TB detection. Such method has a number of drawbacks. Low sensitivity in HIV positive individuals and unable to detect rifampicin drug resistance which is a reliable indicator for MDR -TB are major drawbacks. Xpert MTB/RIF is the newly promising fully automated rapid TB diagnostic test. It should be and may be used as the initial diagnostic test in individuals suspected of MDR-TB or TB /HIV in high burden countries (23).

2.6. Information System

Information systems are combinations of hardware, software, databases, telecommunications, people and procedures configured to collect, manipulate, store and process data into information. An information system is a group of interrelated components that work to carry out input, processing, storage, output and control actions in order to convert data into information that can be used to support forecasting, planning, control, coordination, decision making and operational activities in an organization (24).

Information systems play a strategic role in the life of organizations, it provides the management with appropriate information and in the right place and time to help the management to do various functions of planning, organizing, directing and control and decision-making. Every business organization in this era needs information system to keep track of all business activities. Information system transform data to information and summarized the information to meaningful and useful forms as management reports to use it in managerial decision making and support management activities (25).

2.7. Health Information System

Health information systems refer to any system that capture, store, manage or transmit information related to the health of individuals or the activities of organizations that work within the health sector. Overall a well-functioning HIS is an integrated effort to collect, process, report and use health information and knowledge to influence policy and decision-making, program action, individual and public health outcomes, and research. sound decision- making at all levels of a health system requires reliable health statistics that are disaggregated by sex and age (26).

Health information can be the aggregate information about all patients that have attended a health center, outlying clinic or a community awareness or health screening program. Whether we collect data on paper or in a computer, the data should be organized in such a way that we can understand and retrieve them when needed (27).

As most of the health information are personal and confidential, the organizations which produces those information are concerned with the management and use of them. The management of information in health care is critical. Moreover health care customers need as much confidential and accurate information as possible concerning their consultation and treatment options. Thus well managed information can be used to lessen the adverse effect of medical errors and to enhance the quality of medical records, and the protection of patient privacy and confidentiality (28).

Public health with the involvement of government in the use of the generated information to pass administrative and policy decisions use health care data. Effective public health requires timely accurate and confident information from various sources. Health information systems play a major in decision making by minimizing the resource and time needed to generate, analyze and disseminate data along the hierarchy. Whether in the horizontal and vertical structure of a society quality information is needed for effective clinical management and for assessing the extent to which services are meeting the needs and demands of communities (29).

Worldwide good public health data are known for their use as a primary indicator for the growth of a country. Most of the public health data are recorded manually which makes the process of extracting crucial information repulsive and complex. The major data, vital event registration, communicable diseases and epidemic case report data and household surveys designed to measure use of health care services are some. Demographic and health surveys can also be used to generate public health related information (29).

2.8. Electronic Health Record (EHR)

Electronic health record (EHR) systems enable health facilities information to be used by health care providers, embedded clinical decision support and other tools have the potential to help clinicians provide safer, more effective care than is possible by relying on memory and paper-based systems. In addition, EHRs can help health facilities, to monitor, improve, and report data on health care quality and safety, EHR aggregates patient-centric health data from the patient record systems of multiple independent healthcare organisations. An EHR is a long-term record for a patient, detailing his or her involvement with individual healthcare organisations and episodes of care. Many EHRs include detailed clinical data such as individual lab results and prescription refill information. EHRs are commonly used to transfer a patient's healthcare information between organisations, allowing stakeholders in the patient's health to access this information remotely. Additionally, ensuring the interoperability of these systems, delivers increased benefit for the patient, clinician and healthcare provide (30).

2.9. Electronic Medical Record (EMR)

Electronic medical record is a computerized patient tracking and caring system. EMR provides a single shared resource for the collection, storage, and use of patient data by health care providers. EMR possess the following functions: clinical data repository, clinical decision support, controlled medical vocabulary, computerized provider order entry (CPOE), pharmacy and clinical document application. EMR is designed to become a longitudinal patient record that employs comprehensive medical record and availing quality

and timely health information at various levels of decision points throughout the country's health system is very essential for the improvement of Health Care and overall health system (31).

Additionally EMR is a new technology in the health information field where clinical, demographic, and management information is entered in a computerized record. Computers facilitate the speed of communication, accuracy of information, capacity for information storage and data retrieval. Leaders in the health care industry are developing computerized clinical record systems to manage the huge volume of clinical, administrative, and regulatory information in contemporary health care. These systems are also viewed as a way of reducing the rate of medical error, complying with regulatory audits, and improving quality (32).

Study shows that using EMR has demonstrated a number of benefits in the improvement of health care services. Such as decreased storage space requirements and reduced efforts in searching for the records of the patient. The health providers can utilize various templates including demographic information, medical conditions sheets, orders, prescription, image requirements, patient follow-up system, etc. By picking up and using the right template, they can effectively save time, make fewer mistakes and register a patient's details more compressively than when using a hard form paper recording system (33).

2.10. Information Systems for Tuberculosis Care and Control

As the reviews shown that there are various potential benefits to be realized when TB data are captured and stored electronically, compared with paper-based reporting systems. It has many benefits the major immediate benefits include

- ❖ **Data quality.** Transcription of data from one paper-based record to another is prone to error and there is no built-in mechanism for identifying and correcting mistakes. In an electronic system, validation checks can be an integral part of recording and reporting (34).
- ❖ **Data access.** Paper-based systems rely on quarterly reports of aggregated data. Data on individual cases or patients are thus not readily available above the level of a health facility. When electronic records are available, they can be transferred to and shared with anyone, whatever their location (34).
- ❖ **Timeliness of information.** Paper-based records take time to aggregate and transfer to higher levels of the system. Electronic systems can automate the aggregation process and save time and effort as well as reduce the possibility of errors in generating aggregate reports (34).

2.11. TB Patients Follow up Information System

TB patients' follow up information system is a computerized information system that contains information about the patients' follow up status it provides a reliable patient history for every enrolled patient and can also produce accurate follow up patients' records. It may include a range of data, including demographics, medical history, medication and patient treatment follow up status, laboratory test order and results, drug regimen, lost to follow up tracing, check appointment date, reporting, radiology images, personal statistics like age and weight. The system is designed to represent data that accurately captures the state of the patient at all times. It allows for an entire patient history to be viewed without the need to track down the patient's previous medical record volume and assists in ensuring data is accurate, appropriate and legible. It reduces the chances of data replication as there is only one modifiable file, which means the file is constantly up to date when viewed at a later date and eliminates the paperwork (35).

2.12. Related Works

A study done by Mengesha showed that in Ethiopia, the implementation of EMR is through software called Smart Care. (Tulane University's Technical Assistance Program for Ethiopia) is developing the Smart Care software in partnership with CDC and the Federal Ministry of Health Ethiopia (FMOH). Smart Care was first developed, tested and deployed in Zambia by CDC for HIV/AIDS care and treatment. Besides the rich and advanced functionality and features, Smart Care has also been proven to work in limited resources environment of developing countries particularly in Africa. Smart Care possesses numerous advantages and features in comparison to existing EMR applications (36).

A study in Zambia showed that Smart Care Electronic Health Record system (EHR) has been developed and deployed by the Ministry of Health (MOH) Zambia, in collaboration with the Centers for Disease Control and Prevention (CDC) and many other implementing partners. Smart Care is a fully integrated electronic health record system to provide continuity of care and a clinical management information system at the facility and district level. It is a key component in one National M&E system. Currently, Smart Care is deployed in close to 600 facilities in all districts of Zambia. Partners are supporting deployment in government and private facilities but government deployments and enrolment rates are increasing most rapid (37).

A study conducted in Saudi Arabia the NGHGA Experience for a Successful EMR Implementation. NGHGA has four hospitals and 60 primary and secondary healthcare centers in different regions of Saudi Arabia. The NGHGA started to consider EMR implementation as far back as early the 1990s and thus was a leader

of initiative in Saudi Arabia. Provided them with training in Health Informatics in order to manage this linkage. Later, in 2001, the NGHHA purchased an EMR system for all NGHHA sites. Then implemented the system in Riyadh site. In 2004, the system was fully implemented and was operational only in the Riyadh site. In 2010, the system was implemented and operational in all NGHHA sites as well the EMR system at the NGHHA served more than 15,000 users in 2010 (38).

A study conducted in Kenya detention of patient lost to follow-up on TB treatment as one component of the DOTS strategy is direct observation of treatment either by a health care provider or family member. One of the targets of the DOTS strategy is to achieve 85% treatment success, that is, 85% of TB patients complete their treatment and are declared no longer infectious (39).

A study conducted in china showed that Poor treatment adherence is a significant barrier in many settings, TB patients are constrained to self-administer their medication with support from formal health care workers in the course of their long regimen. Under these circumstances, new approaches to adherence monitoring are urgently needed that are affordable, accessible and of proven to helpfulness. Aids to remind patients to take medication regularly have included appliances to monitor the opening of pill boxes, these treatment monitors have also come of age. Electronic medication event monitors can now be equipped with reminding features to provide dosing and refill reminders to patients, and to collect and transmit detailed, patient-specific dosing histories. These details provide insight into discontinuation behaviour, and adherence pattern feedback that is useful to improve adherence (40).

CHAPTER THREE

METHODOLOGY

3.1 Study Area/Setting

The research project was conducted at Woreda Nine Health Center which is one of the ten health centers found in Nifas Silk Lafto Sub-city. It was built in 1987G.C. The size of its population is 51,244 those people get different health service from the health center. The health centre has a total of 145 staff, consisting of 83 health professionals and 62 non health professionals. This project was conducted between December 2016- June 2017 G.C.

3.2 Study Design

An Object Oriented (OO) methodology was employed for the designed system of the patient adherence follow up system this design methodology is chosen because OOD allows large-scale applications to be developed in independent modules. Object-oriented also enables decomposition method of a complex arrangement by the primary objects apparent in the system. Methodologies usually offers a guidance on a number of models that can be used to help design a system and define a set of formal notations in which the recommended models can be written down and documented design for the design of electronic based database system for the health center an object oriented system design methodology was used because of its highly dynamic, flexible and scalable nature. Once the objects are defined and the system functionality is assigned, major components of the software system can be developed independently (41).

3.3. Study Population

The study includes Nifas Silk Lafto Sub-City Woreda Nine Health Center mainly health workers who are working in TB/ MDR/TB clinic, disease prevention department head, medical director, HEW and HMIS staff.

3.4. Data Collection

Semi structured in-depth interview guide questioner was developed to conduct data collection. Primary data was collected by interview and observation. Secondary data were collected through document analysis.

In addition to the interview analysis of different challenges of paper based documents, and assessing the ICT infrastructure for the hardware and software availability of the health center and different forms, reports

and registers, patient tracing mechanism and treatment follow up system were conducted and Different functionalities were assessed the guideline and guiding policies set by the Federal Ministry of Health.

3.4.1 Data Collection Instruments

The interview guide was developed to conduct requirement collection techniques among purposively selected experts who are working in the health center. This project identified business and system requirements and information was collected used interview, observation and document analysis at the Health Center.

Interview

In this project the selected health providers and user of the system were interviewed about the current paper based system and related work in order to identify the core problems that are happening in the existing system. Most of the functional and non-functional requirements of the designed and developed system are identified using interview guide. The interview sessions were conducted in face-to-face interview in working places. The questions asked were precise, relevant and to the point. The responses of the respondents were recorded in taking by a short note which is important input for designing system. The health workers who are working at the health center selected. And the interview questions attached on the appendix.

Document Analysis

Regarding document review it was made from the health center assessed routine data recording, processing and reporting, compiled documents, formats, patient registration book forms, guidelines and other formats were taken as initial requirement for the system design.

Observation

During observation the current business process, daily activities of patient's treatment follow up system, lost to follow up tracing mechanism and, reporting system, registration and documentation were observed in order to identify problems with the current system using observational checklist.

3.4.2 Data Quality Management

Data collection instruments were prepared according to the informational need of the research project before the requirement analysis was held. Requirement data gathering was done by the investigator. Finally the gathered requirements were compiled and checked for completeness.

3.5. System Analysis and Design Technique

The collected data through interview, observation and document reviews were summarized. For designing system with having the Object Oriented software design methodology an iterative and incremental Object Oriented Analysis were used. The design made use of the Unified Modeling Language like:

- ❖ Use case diagram: It is the simplest and most effective technique for modeling system requirements from a user's perspective.
- ❖ Design class diagram: It shows attribute and methods of the each class.
- ❖ Sequence diagram: It used to describe patterns of communication among set of objects which are participated in the use case. Communication between objects is represented by message passing between the objects.
- ❖ System Architecture: The system uses dynamic technology, adding and retrieving data and from the data store whenever requested is possible.

3.6. Design and Development Tools

Frontend (in the Client Side):

HTML is used as a front end for the construction of the interface. It was chosen in the Client Side because its nature of flexibility, supported on all browsers, user-friendly, consistent and efficiency and it is free.

Middle (in the server side):

PHP is used as a middle ware to create the different functionalities, business rules and connections to the database was chosen in the server side because it could be implanted into HTML and it uses as link to connect the HTML with the database. It could be opened with any browser and it could easily be connected to most databases.

Back end

MySQL server is used as a back end server to create the tables and save various data on them. The tools that are selected for the designing and development are majorly chosen on the basis their ease of use, availability, supportability of the system environment and researchers prior experience. Almost all of the tools are open sources which does not require any prior payments

The applications used to design the system were: Joomla was used for the designing of the prototype. Joomla is an open source Content Management System (CMS), which is used to build websites and online applications. It is free and extendable which is separated into front-end and back-end templates

(administrator). Joomla is developed using PHP, Object Oriented Programming, software design patterns and MySQL (used for storing the data) (42). Microsoft Visio 2013: for drawing various modeling diagrams

3.7. Usability Testing Phase.

The investigator used formative usability testing to maximize the usability of the prototype for designed system developed. The prototype is tested against the requirements to make sure that the system developed is actually solving the needs gathered during the requirement phase

Table 2: Summary of methods, techniques, and tools used in each phase of the project

Phases of the software development	Techniques	Tools	Methods
Feasibility, requirement gathering/planning phase	Interview Observation Document review	Questionnaire Observation Checklist	Incremental /Iterative approach
Analysis phase	Use Case Description Contextual Diagram	Microsoft Visio 2013	
Design for the new system	Class diagram Sequence Diagram User interface System architecture	Microsoft Visio 2013	
Construction of the new system	Object Oriented Analysis and Design Programming	HTML, MY SQL, PHP	
Evaluation & Testing	Usability	user test checklist	

3.8. Ethical Consideration

The project was carried out after getting ethical clearance from Addis Ababa University research and ethical committee of college of health Science School of Public Health and permission from Woreda Nine health center Medical Director was obtained before requirement gathering. In addition a consent form was given to all of the respondents prior to giving any information for the requirement collection.

3.9. Dissemination of Results

The result of the project will be disseminated by using formal report to Addis Ababa University school of Information science and school of public health for partial fulfillment of M.Sc and for Woreda Nine Health Center.

3.10. Operational Definition

Health Facilities: are places that provide health care. They include hospital, specialized care centers, health centers, and clinics.

Patient: people who get service from health facilities.

Treatment Completed: a patient who completed treatment, but who does not have a negative sputum smear or culture result in the last month of treatment and on at least one previous occasion.

TB Treatment: cure the TB patient and restore quality of life and productivity, prevent death from active TB, prevent the development and transmission of drug resistance.

Information System: a transformation of data consists of basic fact into an output that is valuable to users.

Efficiency: includes impacts on the level of internal processes which the application of the electronic medical record system has produced or will produce in the future in terms of time and cost savings and quality of information

Effectiveness: includes impacts in terms of improvement of the organisation as a whole measured as process integration, organizational effectiveness, risk management and better care processes;

Quality of service: includes impacts on the overall care process, taking into account its performance, the continuity of care.

CHAPTER FOUR

BUSINESS AREA AND REQUIREMENT ANALYSIS

4.1. Introduction

Gathering and analysis of the requirement is one of the basic and essential steps in the software development life cycle. Investigations of the existing system in use by various means provide the basic and necessary inputs for the system to be designed. The collected inputs should be organized in a meaningful manner to provide the proper functionalities of the system in a way that shows the flow of information, data generated and the users of the system. In this chapter the current system in use, the business process, system model and the design of the new system are presented.

4.2. Findings of the Current Organizational System

The findings of the existing system according to the respondents by the use of the semi structured questionnaire developed for interview and observation by the investigator are identified and presented in accordance with the different information system components. These identified issues are presented in main subtitles: the data and process, people, procedure, report (communication), hardware, and software.

4.2.1. The Current System of the Origination

As mentioned by the Medical director of the health centers and observed by the investigator, the main services delivered by the health centers included Out Patient Department (OPD) where patients can get service without being admitted, In Patient Department (IPD) where patients can get service with being admitted, Maternal and Child Health Care (MCH) which includes: Anti Natal Care (ANC) where pregnant women get pregnancy related follow up, Family Planning (FP) in which contraceptive can be provided for clients, Expanded Program of Immunization (EPI); in this case both mother and child can get immunization service, and Delivery service which provide delivery management. The other services delivered at the health centers includes: Tuberculosis (TB) clinic where patients screened and treated for TB, under five service provided for children of age less than five year, Voluntary Counseling and Testing (VCT) service, Anti-Retroviral Treatment (ART) service for those living with HIV virus and. From these services data produced from OPD, under five, TB and MCH are sources of the HMIS data.

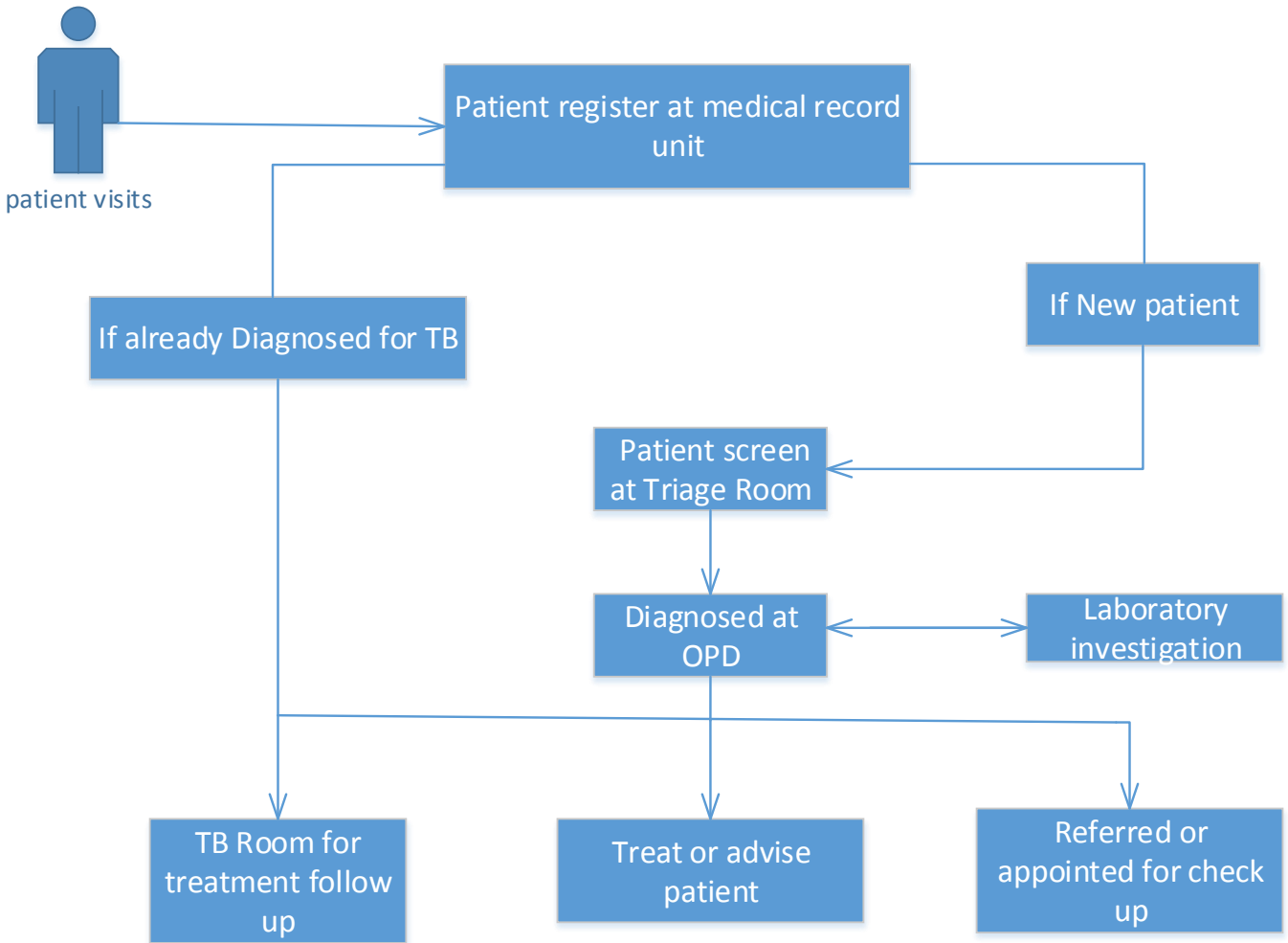


Figure 1: Business process model of existing system

4.2.2. Data and Process in the Current System of TB Clinic

The existing system in TB clinic data and information processing are addressed in the following points: during requirements gathering for identifying each type of information processing in the current system uses manually or paper-based record system. This system maintains data about individual patient's registration, record diagnosis, drug regimen, lab result, and treatment follow up intensive phases and continuation phases, the intensive phase starts from day one for two months and followed by the continuation phase for four/ten months of treatment, this help to prevent drug resistance and regulates the outcome of the patient and also MDR-TB treatment follow up system has intensive phase eight months and twelve months for continuation phases according to culture result, searching lost to follow up, HIV counselling and test result, and previous treatment history; household contact screening and treatment outcomes (e.g. cured, treatment completed, died, failure, lost to follow up, not evaluated and move to

MDR), bacteriological data (sputum smear follow up at 2nd, 5rd and 6th months, culture and Genxpert), and generate report. Using forms in TB clinic are; TB treatment cards, registration book, referrals, requests for investigations drug prescriptions. All patient data are recorded based on national standard of TB prevention and control program. In the facility individual patients file stored in TB room.

The following problems were identified during requirements gathering:

- ❖ Poor adherence patient treatment follow up system.
- ❖ Difficulty to generate timely and accurate outcome reports.
- ❖ Incomplete sputum follow up occur very frequently
- ❖ Time taken for searching lost to follow up patients
- ❖ Problem on security and confidentiality

The identified problems of existing system described using PIECES frame work. Since the health center used paper based system different problems are existed, some of the problems identified are presented by using performance, information, economy, control, efficiency and service (PIECES) frame work.

a) Performance related problem

- ❖ In the current manual system, the time taking to searching non adherences to treatment follow up patients reason for unwanted outcome like increase failure rate, relapse rate, lost to follow up rate, and move to MDR.
- ❖ Incomplete laboratory investigation during treatment follow up occur very commonly. This results increase treatment complete rate instead of cure rate.

b) Information related problem

- ❖ To get timely and accurate reporting have some problems because time taking to count the cases from registration forms.
- ❖ During counting outcome report always discrepancy case compared with previously starting treatment in the same cohort.
- ❖ Prone to human error, During counting of cases, there is also a probability of miss counting and recounting of cases
- ❖ Poor decision making due to unreliable data.

C) Economy

- ❖ During search patient data the health center wastes manpower, resources and time is high

D) Control (Security)

- ❖ Patient information is not secured it can be access by anyone especially HIV positive patients exposed to irresponsible body.

E) Efficiency

- ❖ Health providers waste much time to searching for any patient information
- ❖ Manually generating report does not timely ready for use

F) Data may be lost some of lab results and other investigations are usually lost due to the large volume of papers handled every day

G) Service

- ❖ Paper based recording system is due to some problems reduce quality of service that sometimes observed on time taking medication and investigations

4.2.3. Health Providers in the Current System of TB Clinic

Currently in the health center there are two TB focal persons who are working on the existing system and can access and modify any information system concerning tuberculosis patient data. During patient data recording, TB focal person is accountable and responsible for any errors and missing values, patient registration, treatment follow up procedures and generate quarterly reports as acquired by stakeholders. The health center has IT professional who enter data to HMIS format.

4.2.4. Management (Procedure) in the Current System

In the existing system the organization follows a national guideline for patient treatment follow-up procedures. TB focal person staffs in the health center are familiar with the existing health information policies and guidelines. The existing systems of treatment procedure contains the followings:

- ❖ TB patient must take the medication daily for intensive phase and weekly for continuation phase (DOTs) at Health center
- ❖ Drug regimen must be according to WHO/FMoH guidelines.
- ❖ TB treatment regimen and sputum follow up must be free in health facilities
- ❖ TB patient treatment follow up should be monitored by trained health providers (TB focal person)

- ❖ HIV testing and counselling for TB patients should be recommended
- ❖ Confirmed MDR-TB patient should be referred to treatment initiating center

4.2.5. Reporting (Communication) of the Current System

In the health center, there is no system to support for data analysis in the existing system. The TB focal persons undertakes data analysis using health center clinic service quarterly delivery report form. The reporting of TB/HIV collaborative activities were integrated into HMIS and all forms and registrations are standardized. These reports mainly include number of Tuberculosis case detection rate (all forms and relapse), TB retreatment rate, TB treatment outcome, TB case detection through community TB care, proportion of TB case (all forms) provided treatment observation (DOT) by community among all TB cases, proportion of TB case (all form) contributing by private sector, number of MDR TB case detection and etc. Reports are prepared quarterly in printed format on patient information submitted to facility HMIS focal person, and quarterly submitted to sub city and regional health bureau disease prevention and control department for TB coordinators. Communication is made only using paper based recorded documents.

4.2.6. Software

According to the response given by the HMIS focal and TB focal person, there is smart care applicable software in ART clinic for HIV patients follow up information system and eHMIS for reporting system. But currently there is no any applicable software to improve TB patients follow up information system and no computer network for sharing information.

4.2.7. Hardware

The health center currently has 25 desktop computers which are located in reception room, facility head office, department heads, ART pharmacy, pharmacy, laboratory, finance, personal room, TB clinic, HMIS and secretary. TB Clinic uses this computer for the purpose of preparing report, data records and writing letter.

4.3. Forms Used in the Current System

- ❖ Patient registration form: this longitudinal registration form is used to store basic demographic and clinical health information this refers to patient-related information which includes patient diagnosis, drug prescription, and follow up attendance or encounter information, lab result, and appointment date and contact screening.
- ❖ Laboratory request form and TB diagnostic service request and report form like microscope examination, Gene Xpert, TB culture result, drug susceptibility testing (DST) those forms includes: Patient identification, TB disease type and treatment history, request for testing at reference laboratory (diagnosis, follow up, specimen sputum and other).
- ❖ National tuberculosis and leprosy control programme tuberculosis referral and transfer form includes health unit, category of patient, basic demographic information, type of TB, drug regimen, date of starting treatment, sputum result and other lab results, X ray findings, symptoms and physical findings.
- ❖ Health center quarterly service delivery report form these formats include attributes: disease, age and gender and disease name for disease attribute, for age and male and female for gender, tuberculosis case detection rate (all forms), TB treatment outcome, number of MDR-TB cases detected (RR/MDR-TB cases), HIV screening for TB patients and Co-trimoxazole preventive therapy during TB treatment. Those different forms attached on the appendix

4.4. Requirements Analysis of the Existing System

Requirement phase of system development life cycle identify requirement of the existing system and used that as an input for the succeeding system development phases. Requirement analysis is done based on the requirements gathered with potential users and finally organized under requirement description for recording and treatment follow up system.

4.4.1. Functional Requirements

Functional requirements defines functions of a system or its components and specify particular results of the system and what the basic functions of the system are. It also describes the interaction between the system and the users independent of its implementation while identifying basic business processes and functionalities. Functional requirements were identified based on the concept of what a system is supposed to do the following functional requirements (43)

Table 3: Functional requirements

Req ID	Use Case ID	Description of the Requirement
RQ-1	UC-3	The system shall enable register individual patient's information
RQ-2	UC-3	The system shall enable to the users (health providers) to track patients' information.
RQ-3	UC-6	The system shall able to easy patient treatment follow up system (intensive and continuation phase)
RQ-4	UC-6	The system should enable to the users (health providers) to show previously ordered laboratory result request (sputum follow up)
RQ-5	UC-5	The system should enable to the health providers to show current and previously ordered patients drug regimen order.
RQ-6	UC-8	The system should enable to search lost to follow up patients
RQ-7	UC-4	The system should records patient diagnosis and treatment follow up data.
RQ-8	UC-7	The system should record the patient laboratory order and result.
RQ-9	UC-8	The system should generate quarterly standard reports

4.4.2. Non-functional Requirements

Non-functional requirement describes user behavioral properties that the system must have, such as **Performance:** performance is an important issue for the system because one of the drawbacks of the paper based system is performance issue. So this system makes fast the activities by making the server and the software should be fast enough to respond in real time (44).

Security: Since the system is going to handle personal information which is confidential, it should be protected from unauthorized users and intruders. No one can log into the system. Without a registered user name and corresponding password. The system has two groups of users the data base administrator and limited user. The data base administrator user has full privilege to perform on the system. Whereas the limited user can only perform limited operations, for example TB focal person allows only to access the information of TB treatment follow up system and can change their own username and password (44).

Virus Control Requirements: systems require that all information systems permitting the import or up load of user files check those files for viruses before they are stored in the system.

Availability: The system should be available all the time 24 hours/ 7 days a week, and there should be 24 hours/day of electricity and back up source such as generator to work the system without interruption.

Maintainability: The system will be easily maintained by the developer as well as other authorized trained person. The system will also be modifiable at any time to enhance features based on the office needs. As needs change from time to time the original system will be made available to fill the gap between the system and the newly emerging needs. The system could be enhanced by adding new functionalities without necessarily changing the basics

Error handling: The system is expected to handle errors encountered during run time. Error should arise from users and from the system. Errors that occurred from the wrong doing of users will be handled by appropriate exception handling mechanism

User interfaces: This is basically concerned on what kind of Graphical User Interface (GUI) the system should provide or what is the level of expertise of the user. Since the system is going to be used by different user categories, it should have a very simple and user friendly interfaces for ever one to understand the functionalities easily (44).

Usability: The system should be easily understood, learned, and used by its intended users(44).

4.4.3. Essential Use Case

Essential use case is used to explore usage-based requirements in the existing system. It is technology independent. It describes the fundamental business task of the existing system without bringing technological issues into account. Use-case can be shown using use case description which is the textual scenario and use case diagram, clear representation of use case stories. And this modeling technique gives us the opportunity to reflect the behavioral requirements of the new system which are going to develop. In addition to this it is important to remember that use cases are used for both as-is and to-be behavioral models. As-is use cases focus on the current system, while to-be use cases focus on the desired new system (45).

a. Actor Identification

Actors are roles played not only by people, but by organizations, software and machines.

Table 4: Identified actors

Health providers	Refers to a health Professionals who register the patient, give and record treatment monitoring and generate report
HEW	Refers to a health professional who working in the community health (provided treatment observation (DOT) by community among all TB cases)
HMIS officer	Refers to a person who generate a report from the system

b. Essential Use Case Identification

Identified use cases according to major functions in the system. These use cases are major processes (backbone of the system).So this is the reason why choose the following use cases.

- 1, Register patient information
- 2, Register patient diagnosis
- 3, Register drug regimen
- 4, Monitor treatment follow up
- 5, Register lab result
- 6, Search appointment date
- 7, Generate report

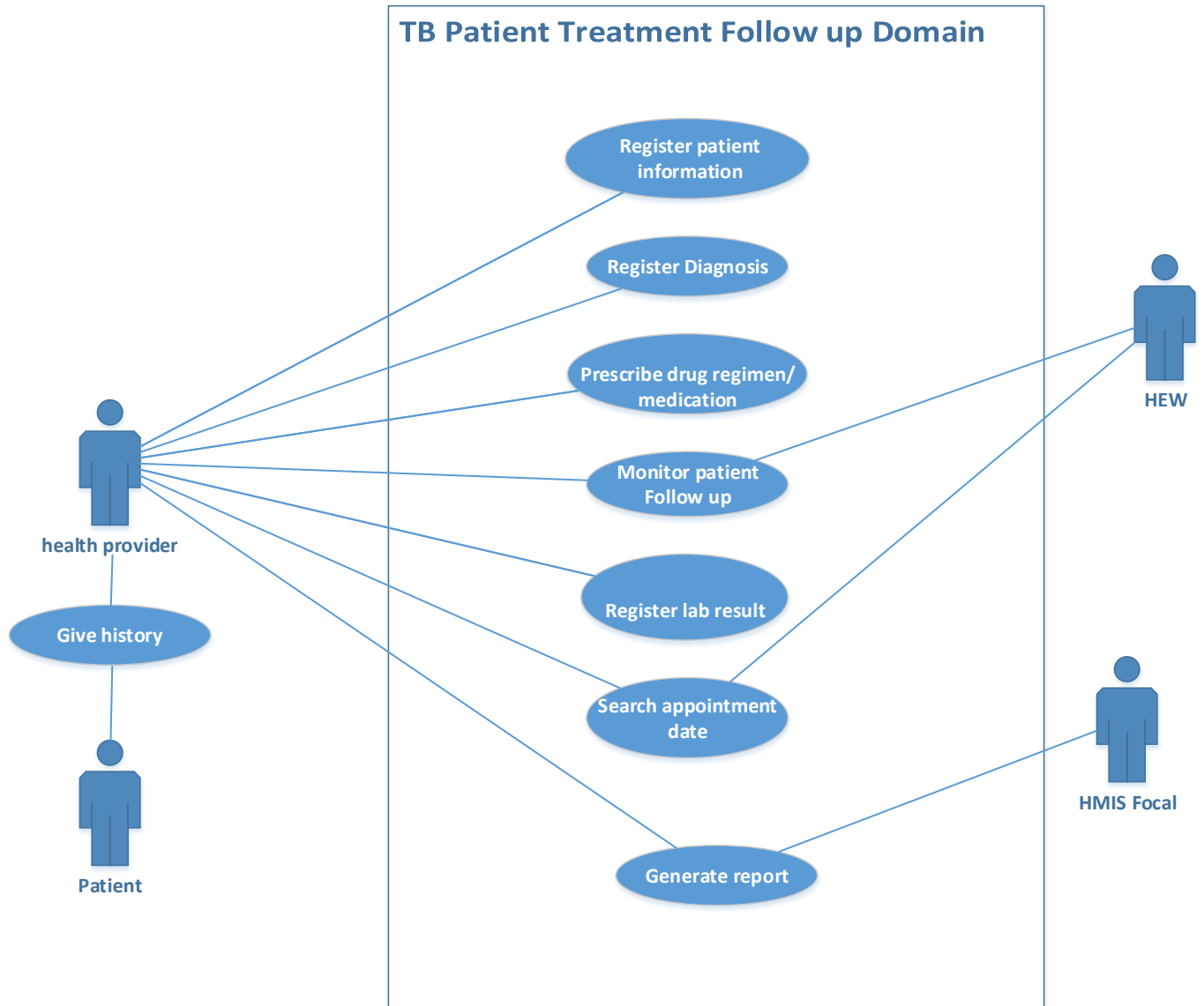


Figure 2: Essential use case diagram

4.4.4 Essential Use Case Scenarios

Use case scenario is a textual representation of the course of events encountered when an actor is interacting with the system. A use case's scenarios make up a sequence that describes the dialog between the system and with one or several actors. The scenario of each essential use case is listed below.

Table 5: Registration essential use case.

Use case ID	UC-3
Use Case Name	Register patient
Usecase Description	This use case describes how a patient personal information is registered
Primary Actor	Users (health providers)
Pre-Conditions	The patient should be register in the registration book in TB room
Post-Conditions	The patient registered in to the registration book
main scenario	<ol style="list-style-type: none"> 1.TB patients comes to TB clinic for treatment follow up 2.Health providers request information 3.If patient comes for the first time gives detail information 4.If the patient need conformation test for any TB diagnosis, give lab order or Genxpert for further investigation 5. After conformation of the TB diagnosis if the patient eligible for treatment. register patient with full information 6.If not eligible refer 7.Use case ends
Alternative courses	-

Table 6: Prescribe drug regimen essential use case

Use Case ID	UC_5
Use case Name	Record treatment use case
Primary actor	Users (health providers)
description of use case	The use case describes the process used to prescribe and record treatment
Precondition	The patient should be diagnosed for TB
Post condition	Medication prescribe and recorded
Main success scenario	<ol style="list-style-type: none"> 1. Before start treatment the health providers assess patient condition and measure clinical data 2. If the patient eligible to start TB treatment should be prescribe according to national guidelines for six /12months 3. If not eligible refer 4. Use case end.
Alternative path	-

Table 7: Treatment follow up essential use case

Use case ID	UC-6
Use Case Title	Treatment follow up
UseCase Description	This use case describes the processes of the assessment and monitoring of patient adherence to treatment follow up system.
Primary Actor	Users (health providers)
Pre-Conditions	The health providers should be order the treatment.
Post-Conditions	Treatment follow up started
Main scenario	<ol style="list-style-type: none"> 1. After patient had been registered start treatment follow up for six / twelve months and have two phases intensive and continuation phases 2. In intensive phase the patient expected to come to the health facility daily for taking medication for two months and the health providers follow daily attendance 3. Before intensive phase finished 2nd months sputum follow up ordered 4. The health providers receive and record lab result of 2nd months sputum follow up 5. Patient start continuation phase after two months and come to health facility weekly for four/ ten months 6. The health provider follow weekly attendance and request lab order at 5th and 6th months for sputum follow up 7. After 6th months of treatment follow up the patient complete TB treatment 8. Use case end
Alternative path	<ol style="list-style-type: none"> 4a. If the patient smear positive at 2nd month follow up continue the treatment and repeat sputum at 3rd months 6a. If the patient smear positive at 5th and 6th month follow up send for Gen Xpert and start retreatment follow up. Might be the Gen Xpert result is RR refer patient

Table 8: Record appointment essential use case

Use Case ID	UC_ 8
Use case Name	Appointment
Primary actor	Users (health providers)
description	The use case describes the process used for register the appointment information of the patient.
Precondition	The patient should be start treatment
Post condition	The patient appointment information should be registered and appointment paper given to the patient.
Main scenario	<ol style="list-style-type: none"> 1.The health providers give treatment appointment schedule date for patients on intensive phase daily and weekly for continuation phase of treatment follow up 2.Health provider checks manually daily and weekly schedule dates of follow up 3.If the patients miss the schedule date 4.Remind patients' schedule date by telephone or HEW 5. Use case ends
Alternative path	-

4.5. The Proposed System

The proposed system is applicable for Woreda Nine Health Center. The current system which is paper-based has significant problems with patient treatment adherence to follow up system. And the new system would have great importance and will be used a patients data recording and to facilitate early detection and successful treatment of all TB and MDR-TB cases on TB control programs.

Depending on the gathered requirements of the current system the investigator proposed a new system that will enable to: Monitor the patient treatment adherence follow up, on time searching of lost to follow up patients, security and confidentiality documentation and generate accurate, complete and reliability reports and acquire backup data. In addition the proposed system shall be facilitate to improve patient's treatment outcomes cure rate and treatment success rate. And should reduce treatment failure, relapse, lost to follow up and move to MDR-TB.

4.6. Process Modeling

A process model is the conceptual representation of the business process in the TB departments. Process modeling shows the overall model of the data, decision logic in business processes and activity flow in the department. With the power of visualization, process modeling is used to communicate information regarding a process and the interaction it includes within the departments. Process model can also be used to show the newly proposed system. The proposed system will integrate those different functionalities that need to be interoperable for the full functioning as a system (46).

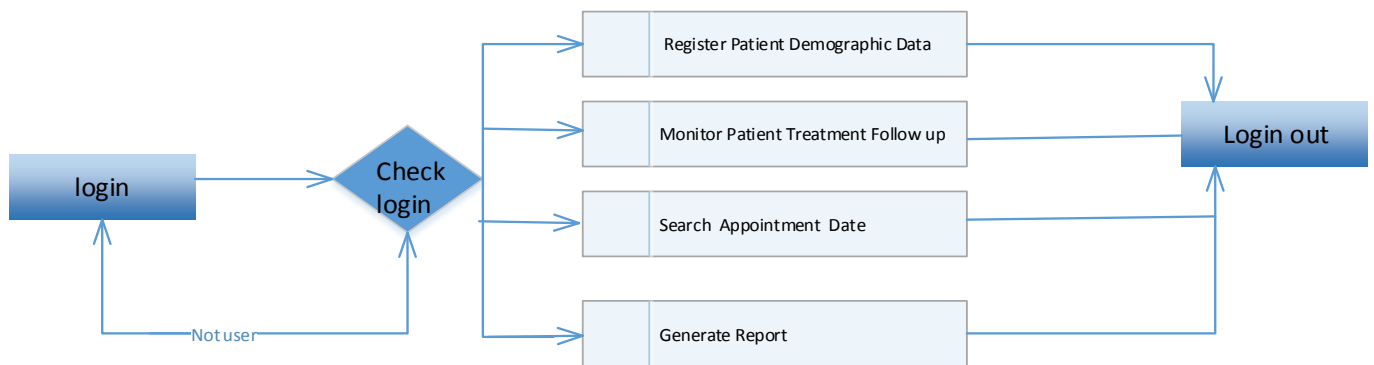


Figure 3: Business process modeling of the proposed system

4.7. Contextual Modeling

Contextual modeling is one way of expressing the business process modeling which shows the context into which the business process fits into with all the external entities that receive from and contribute to the information system. Additionally they help to decide system boundaries and what functionality should be included in the system and what is provided by the system's environment. They also provides a view of the overall business process as one process. Context models normally show the environment and the several other automated systems (47).

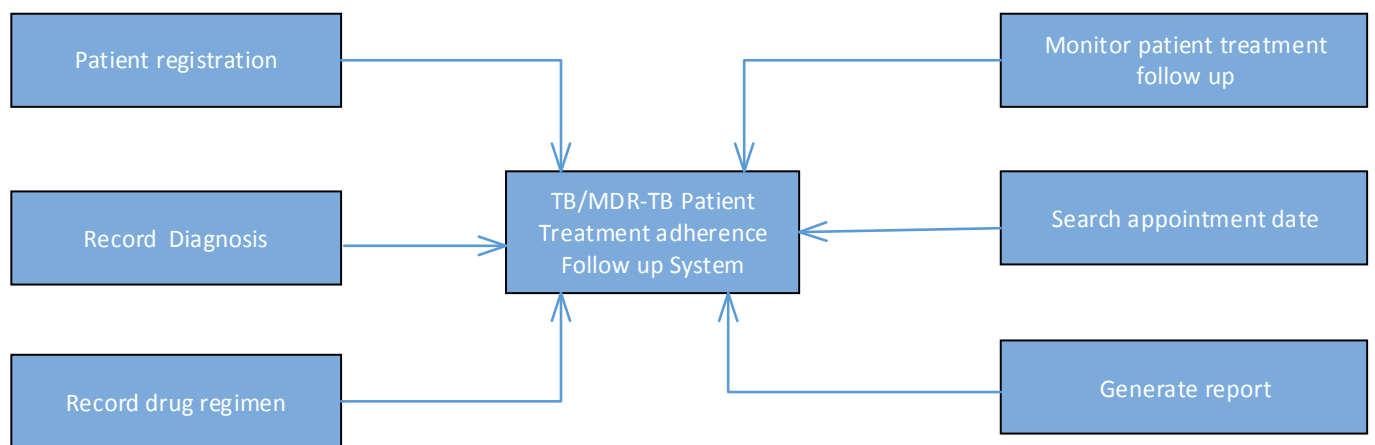


Figure 4: Contextual modeling for new system

4.8. System Modeling

System modeling is the process of developing abstract models of a system. There is exist in different modeling approaches which allow us present a model. These models reveal different view or perspective of a system. These various models are used during the requirements engineering process to help and provide a road map to derive the requirements for a system. Most importantly system modeling is used to provide interaction, structural and behavioral perspective of a system. They have priceless value during the design process to describe the system to engineers implementing of the system and after implementation to document the system's structure and operation (48).

4.9. Object-Oriented Modeling

There are different modeling languages for modeling in object oriented design and analysis, though unified modeling language UML, which has become a standard modeling language for object-oriented modeling

is used for modeling of this system . The Unified Modeling Language is a set of different diagram types that can be used to model software systems and so supports the creation of many different types of system model. Object-oriented modeling emerged, where similar object-oriented notations were integrated to create the UML. The UML is universally accepted as the standard approach for developing models of software systems (49),(50).

4.10. Use Case Analysis Model

A use case diagram illustrates in a very simple way the main functions of the system and different kinds of users that will interact with it. Use cases are used to describe the functionality of the system and as a model of the dialog between the actors and the system. Those use cases are used for to-be use cases focus on the desired new system. A use case describes a function provided by the system that yields a visible result to the actors (51).

Table 9: List of Actors and their responsibility

Health provider (TB focal person)	Is a person who works in the service provider setting, performs diagnosis, treat patient with TB and other diseases
System administrator	Is a person who is administer the system and maintain user account
HMIS officer	Is a person who is aggregating HMIS report from the system and send to responsible body

The new proposed system should be identified the following use cases.

1. Manage user account
2. Login
3. Register patient
4. Record patient diagnosis
5. Prescribe drug regimen
- 6 .Monitor follow up
7. Record lab result
6. Search appointment date
9. Generate report

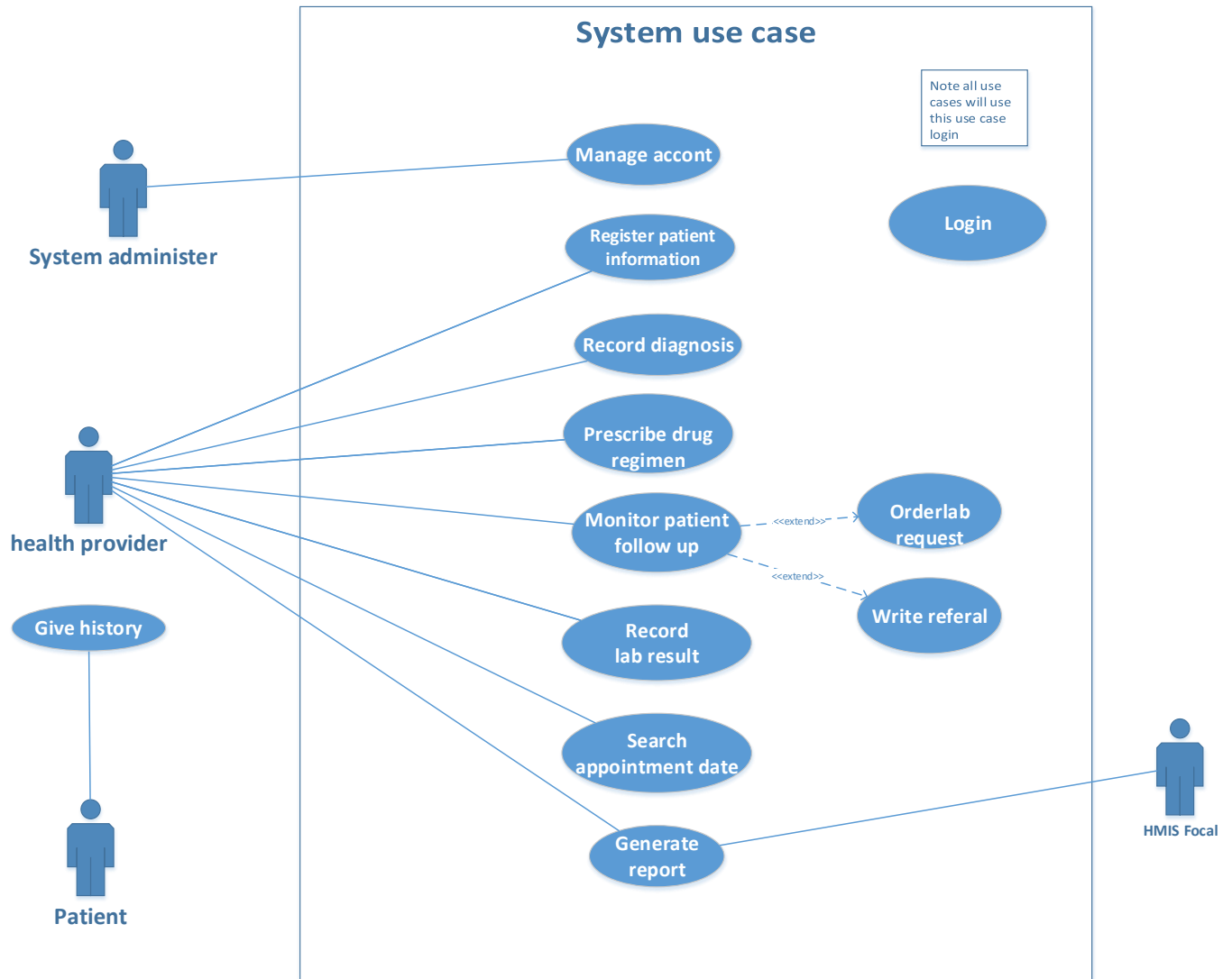


Figure 5: System use case diagram

4.10.1. Use Case Narrations

The use cases narrations are used to describe each process identified in a use case diagram. It is a significance to make the end user to understand the process of the system.

Table 10: Manage user account use case

Use case ID	UC-1
Use Case Title	Manage user account
Use case Description	The use case describes how the system administrator Activates, inactivates and provides privilege to the users of the system
Primary Actor	System Administrator
Pre-Conditions	The account of user must exist and authorized.
Post-Conditions	The system manage the user account
Main scenario	<ol style="list-style-type: none"> 1. The system displays main menu screen 2. The administrator open user account option 3. The system displays user account list 4. The administrator select the list user account information 5. The system confirms the inserted /updated/removed records 6. Ends use case
Alternative courses	<ol style="list-style-type: none"> 4a. If the user wants to create account for user records. <ol style="list-style-type: none"> a. The user click on create account button. b. The system displays a form to create the user account. c. The user fills the required information and click on submit button. d. The system confirms the inserted data. e. The system saves new account. 4a.1. If the user wants to remove the user account. <ol style="list-style-type: none"> a. Select and click the user account. b. The system displays confirm account remove c. The user clicks confirm remove button. d. The system removes the selected user account from the database

Table 11: Login use case

Use case ID	UC-2
Use Case Title	Login
Use-case Description	This use case describes the user enable to enter into the system
Primary Actor	Users (system administrator, health providers, HMIS focal persons)
Pre-Conditions	The user has known user name and password which is existed within the system.
Post-Conditions	The system displays system main menu interface
Main scenario	<ol style="list-style-type: none"> 1. The system display main menu login window 2. The users click login button. 3. The system displays login interface 4. The users enters the username and password 5. The system verifies the username and password 6. The user logged in to the system then system will display the main menu interface. 7. Use case ends
Alternative courses	<ol style="list-style-type: none"> 4a. If the username or password is not valid, an error message is displayed. 4a1. The user clicks an ok button. 4a2. The user is returned to login screen and reenter user name and password for five times if the user does not use the correct password the system will lock shown after five trial.

Table 12: Register use case

Use case ID	UC-3
Use Case Title	Register Patient
Use case Description	This use case describes the process of TB patient registration information system
Primary Actor	Users (health providers)
Pre-Conditions	The user is logged into the system.
Post-Conditions	The system registered patient information in to the database
Main scenario	<ol style="list-style-type: none"> 1. The system displays user interface or main menu screen 2. The user click registration from the main menu 3. the system displays registration form 4. The user fills patient information on the patient registration form and save the records 5. The system verifies the information 6. Use case ends
Alternative courses	<ol style="list-style-type: none"> 4a.If the patient is already registered on the system <ol style="list-style-type: none"> 4a.1.The system shows messages to enter patient name or ID and retrieved previous patient records. 4b. If the patient is a new <ol style="list-style-type: none"> 4b.1.The user add the registration form 5a. If the user clicks on cancel button <ol style="list-style-type: none"> 5a.1 The system return to the main menu

Table 13: Register diagnosis use case

Use case ID	UC-4
Use Case Title	Register Diagnosis
Use case Description	This use case describes the processes of relevant investigation patient information recording system
Primary Actor Users	Users (Health providers)
Pre-Conditions	The user is logged into the system.
Post- Conditions	Register diagnosis information is available in the database system
Main scenario	<ol style="list-style-type: none"> 1. The system displays users main menu or user home page 2. The user selects diagnosis from the user main menu option 3. The system displays diagnosis recording form 4. The user fills and marks in diagnosis form with complete information and click save button. 5 The system save or stored the diagnosis information on the database 6. Use case ends
Alternative courses	<ol style="list-style-type: none"> 4a. If the patient is new admitted , <ol style="list-style-type: none"> 4a.1 The user adds new diagnosis form. 4a.2 if the patient already exist on the database, <ol style="list-style-type: none"> 4a.2.1 the user enter diagnosis no 4a.2.2 The system retrieves previous patient records on the database. 5a. If the user clicks on cancel button <ol style="list-style-type: none"> 5a.1 The system return to the main menu 5a.2. If the user clicks on save button <ol style="list-style-type: none"> 5a.2.1. The system clear the input box

Table 14: Prescribe drug regimen use case

Use case ID	UC-5
Use Case Title	Drug regimen
Use-case Description	This use case describes the health providers prescribed drug to the patients
Primary Actor	Users (health providers)
Pre-Conditions	The user is logged into the system.
Post-Conditions	The patient detail information is available in the database system and retrieves prescription
Main scenario	<ol style="list-style-type: none"> 1. The system displays drug prescription user main menu screen 2. The user selects drug prescription from the main menu option 3. The system displays the drug prescription form for TB and MDR-TB 4. The user click on Add button 5. System displays the drug prescription detail form 6. The user fills and marks drug prescription records and click save button 7. The system saves or stored the drug prescription records on the database.
Alternative courses	<ol style="list-style-type: none"> 4a.If the patient is already provided the drug prescription records <ol style="list-style-type: none"> 4a.1 The user search previous drug prescription records from the system 6a. If the user clicks on cancel button <ol style="list-style-type: none"> 6a.1 The system return to the main menu 6a.2. If the user clicks on save button <ol style="list-style-type: none"> 6a.2.1. The system clear the input box

Table 15: Monitor patients treatment follow up use case

Use case ID	UC-6
Use Case Title	Monitor patient follow up
Use case Description	This use case describes the processes of the assessment and monitoring of patient follow up information system
Primary Actor	Users (health providers)
Pre-Conditions	<ol style="list-style-type: none"> 1. The user is logged into the system. 2. The system display treatment intervention information.
Post-Conditions	The patients treatment follow up information is available in the database system
Main scenario	<ol style="list-style-type: none"> 1. The system displays users main menu or main menu screen 2. The user selects treatment follow up link in the user main menu option 3. The system displays intensive and continues treatment follow up phase form for TB and MDR-TB 4. The user fills in treatment follow up form with complete records and click on the save button 5. The system save or stored the treatment follow up records on the database 6. Use case ends
Alternative courses	<ol style="list-style-type: none"> 4a. if the patient already exist on the database <ol style="list-style-type: none"> 4a.1 the system retrieve records from database 4b. if the user new admitted <ol style="list-style-type: none"> 4b.1 the system adds and updates the existing information on the patient Database. 5a. If the user clicks on cancel button <ol style="list-style-type: none"> 5a.1 The system return to the main menu

Table 16: Register lab result use case

Use case ID	UC-7
Use Case Title	Record laboratory result
UseCase Description	This use case describes the processes of relevant investigation patient information recording system
Primary Actor	Users (health providers)
Pre-Conditions	The user is logged into the system.
Post- Conditions	The order and result request information is available in the database system
Main scenario	<ol style="list-style-type: none"> 1. The system displays users main menu or main menu screen 2. The user selects lab result form from the user main menu option 3. The system displays result recording form 4. The user fills and marks in result form with complete information and click save button. 5 The system save or stored the result form information on the database 6. Use case ends
Alternative courses	<ol style="list-style-type: none"> 4a. If the patient is new admitted , <ol style="list-style-type: none"> 4a.1 The user adds new result form. 4a.2 if the patient already exist on the database, <ol style="list-style-type: none"> 4a.2.1 the user enter lab result no 4a.2.2 The system retrieves previous patient records on the database. 5a. If the user clicks on cancel button <ol style="list-style-type: none"> 5a.1 The system return to the main menu 5a.2. If the user clicks on save button <ol style="list-style-type: none"> 5a.2.1. The system clear the input box

Table 17: Search appointment dates use case

Use case ID	UC-8
Use Case Title	Search appointment dates
Use-case Description	This use case describes the process of search patients schedule dates
Primary Actor	Users (Health providers)
Pre-Conditions	The system should have registered patient schedule records in data base
Post-Conditions	The system search remind schedule date for registered patients
Main scenario	<ol style="list-style-type: none"> 1. The system displays users main menu or main menu screen 2. The user selects schedule appointment date from the main menu option 3. The system displays schedule appointment date form. 4. The users fill patient schedule appointment date. 5. The user click on search button into the system. 6. The system automatically list lost to follow up patients 7. ends use case
Alternative courses	<ol style="list-style-type: none"> 4a. If the user makes error while enters the data, the system Displays error message. 4a1. The user clicks an ok button. 4a2. The system informs the user to re-enter patient information. 8. Use case ends.

Table 18: Generate report use case

Use case ID	UC-9
Use Case Title	Generate Standard report
Use case Description	This use case describes the process of producing standard report
Primary Actor	Users (health providers)
Pre-Conditions	1. The user is logged in to the system. 2. All data registered in data base system to generate report
Post-Conditions	The system generate standard reports
Main scenario	1. The system displays main menu user interface 2. The users selects the report from menu option 3. The system displays all data records 4. The users selects and marks the data records to be generated and click on generate button 5. The system generates the report from the database system and displays documented report 6. The user click save button. 7. The system saved the data on data base 8. End use case

4.11. Sequence Diagram

Sequence Diagram is one of the unified modeling language, system designing tool. The sequence diagram majorly shows the interactions between actors and the system and between system components. The UML has a rich syntax for sequence diagrams, which allows many different kinds of interaction to be modeled. Besides its use of showing the interaction, Sequence diagram also shows the sequence of interactions that take place during a particular use case or use case instance. Sequence diagram employs different representation for the objects and the sequence or time interaction. The objects and actors involved in a particular use case or scenario are along the top of the diagram, with a dot-ted line drawn vertically from these. Interactions between objects are indicated by annotated arrows. The rectangle on the dotted lines indicates the lifeline of the object concerned (i.e., the time that object instance is involved in the computation) (52).

login page

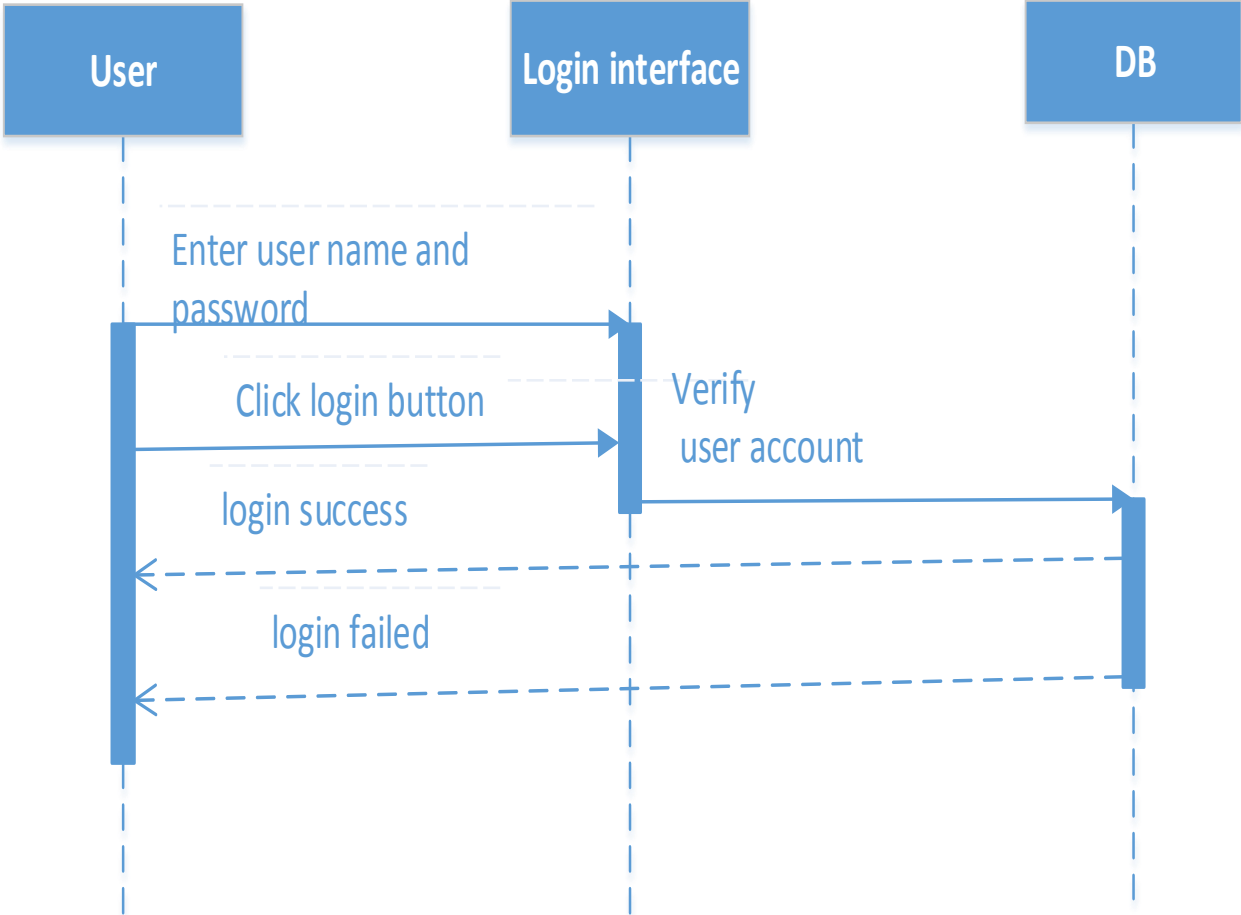


Figure 6: Login sequence diagram

Registration Page

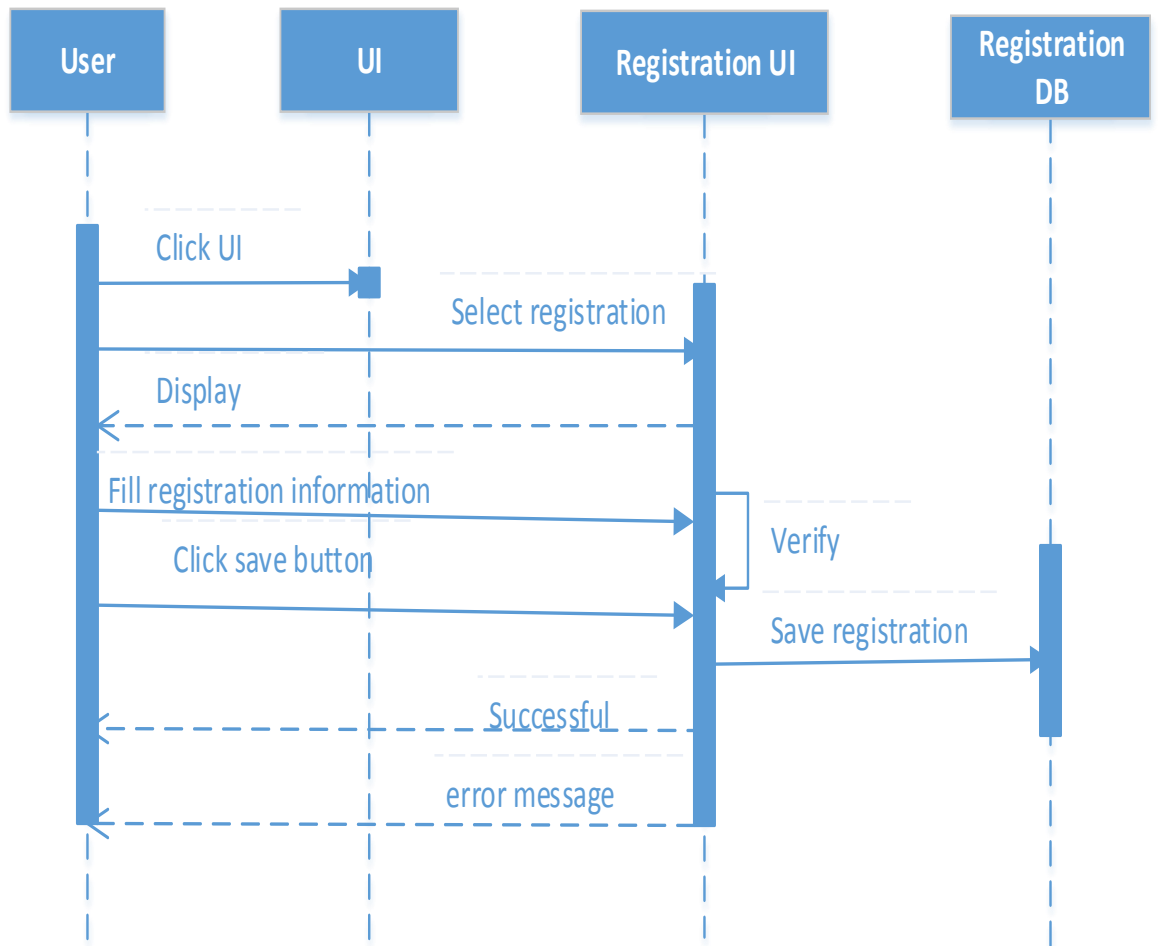


Figure 7: Registration sequence diagram

Diagnosis page

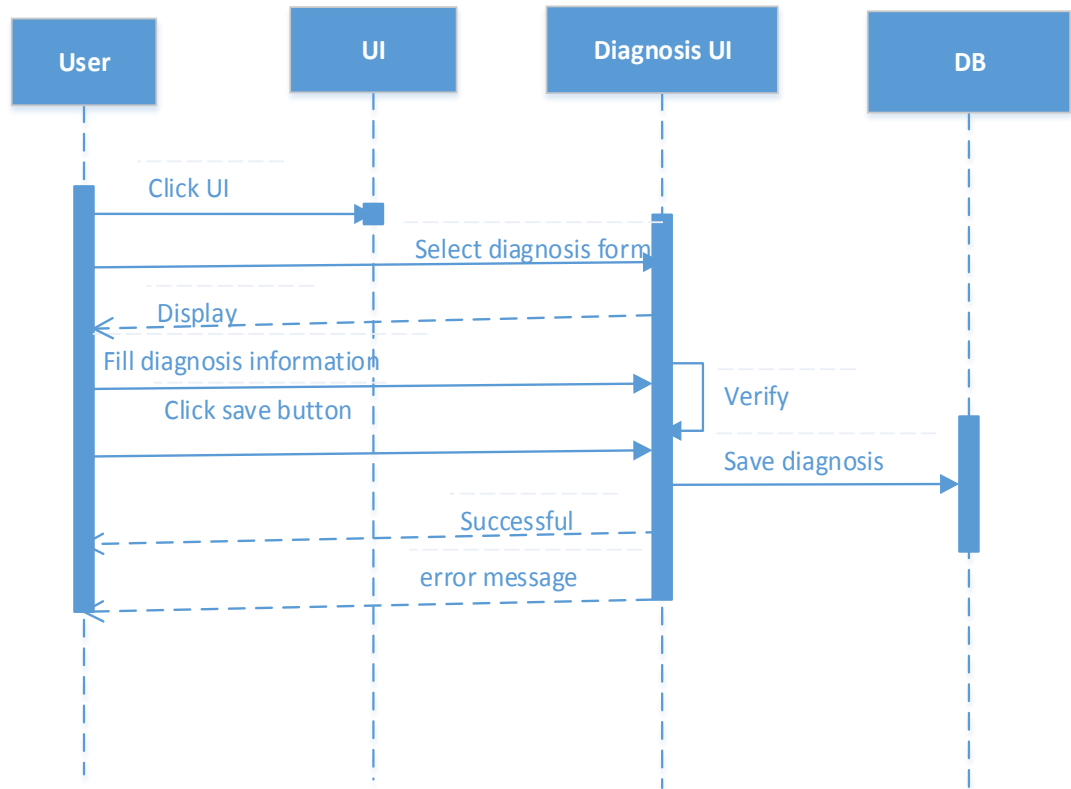


Figure 8: Diagnosis sequence diagram

Drug regimen Page

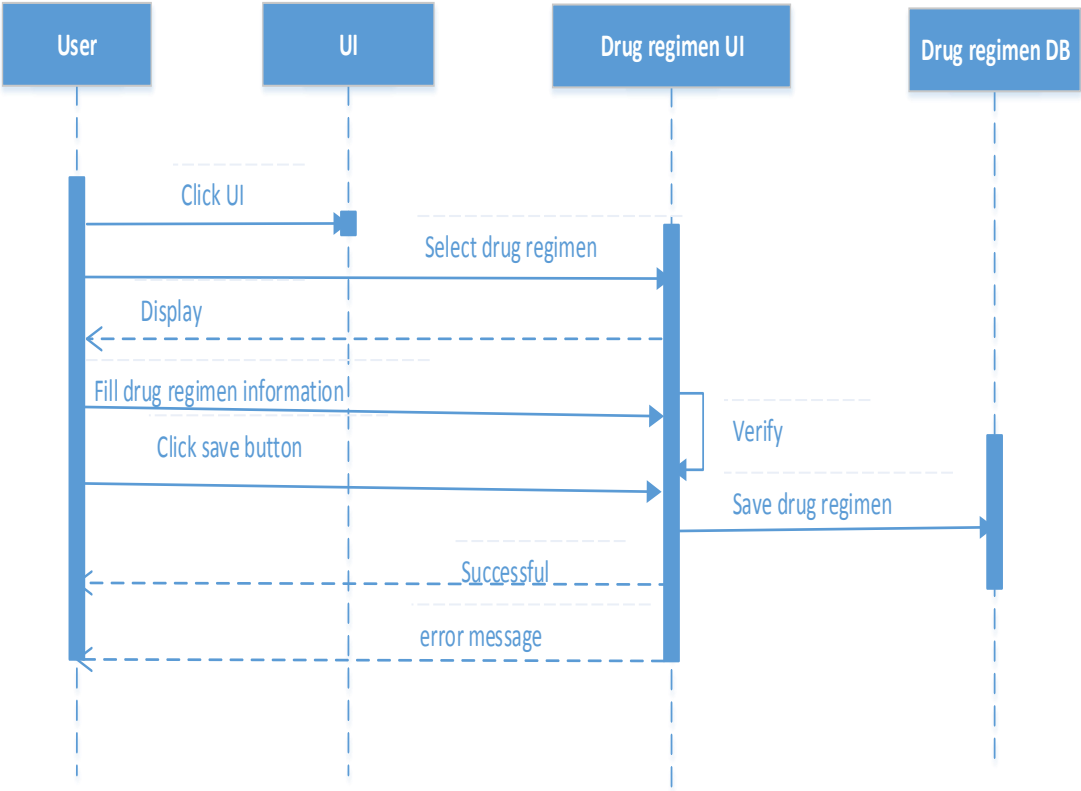


Figure 9: Drug regimen sequence diagram

Follow Up Page

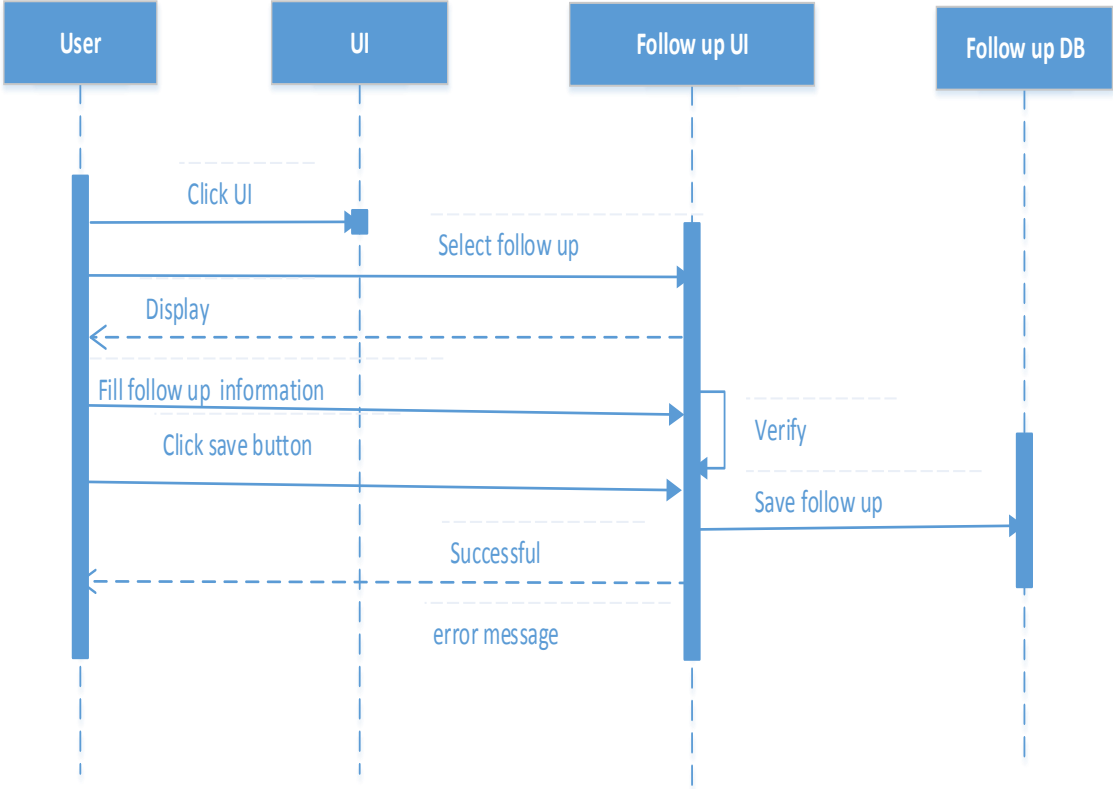


Figure 10: Follow up sequence diagram

4.12. Class Diagram

Classes are represented in a rectangular box. The top box has the name, the middle one has the attributes/properties/data members and the lower one has the behavior/ member functions/ methods.

The class diagram is used to present the system classes (object), their attributes, association between classes, attribute type, class methods (what a class can do), navigability of class, and dependency between classes. All the classes are identified by taking noun words from the narrated use cases defined previously and differentiate the words that should not be a class. After identifying all possible classes, the second step was looking for the association between each class. The classes identified were, user class, user account and administrator class, health provider, patient, contact person, diagnosis, drug regimen (TB drug and MDR-TB drug), treatment follow up, Lab result, and appointment date classes. Depending on the existing system document and document reviewed, the attributes of each class were identified by their type. The attributes are used as an identity for a class (53).

4.13. The Proposed System Architecture

The architecture is composed of three layers: the user interface layer, the application logic layer and the database layer (54). The three-tier architecture aims to solve a number of recurring design and development problems, hence to make the application development work more easily and efficiently. The interface layer, in the three-tier architecture offers the user a friendly and convenient entry to communicate with the system while the application logic layer performs the controlling functionalities and manipulating the underlying logic connection of information flows finally, the data modeling job is conducted by the database layer, which can store, manage and model information needed for this application (54).

User Interface layer

The first tier is the user interface layer. This tier manages the input/output data and their display. With the intention of offering greater convenience to the user, the system is prototyped on the data base the users are allowed to access the system by using any existing software. The user interface tier contains HTML components needed to collect incoming information and to display information received from the application logic tiers (55), (56).

Application Logic Layer

The application logic layer is the middle tier which bridges the gap between the user interface and the underlying database, hiding technical details from the user. It communicates with the user interface, performs the statistical modeling and simulation, and interacts with the database layer such as retrieving hurricane data from the database and storing the statistical model and simulation results into the database

Database layer

The database layer is responsible for modeling and storing information needed for the system and for optimizing the data access. Data needed by the application logic layer are retrieved from the database, then the computation results produced by the application logic layer are stored back in the database. Since data are one of the most complex aspects of many existing information systems, it is essential in structuring the system. Both the facts and rules captured during data modeling and processing are important to ensure the data integrity (56). The system architecture is summarized in Figure 12:

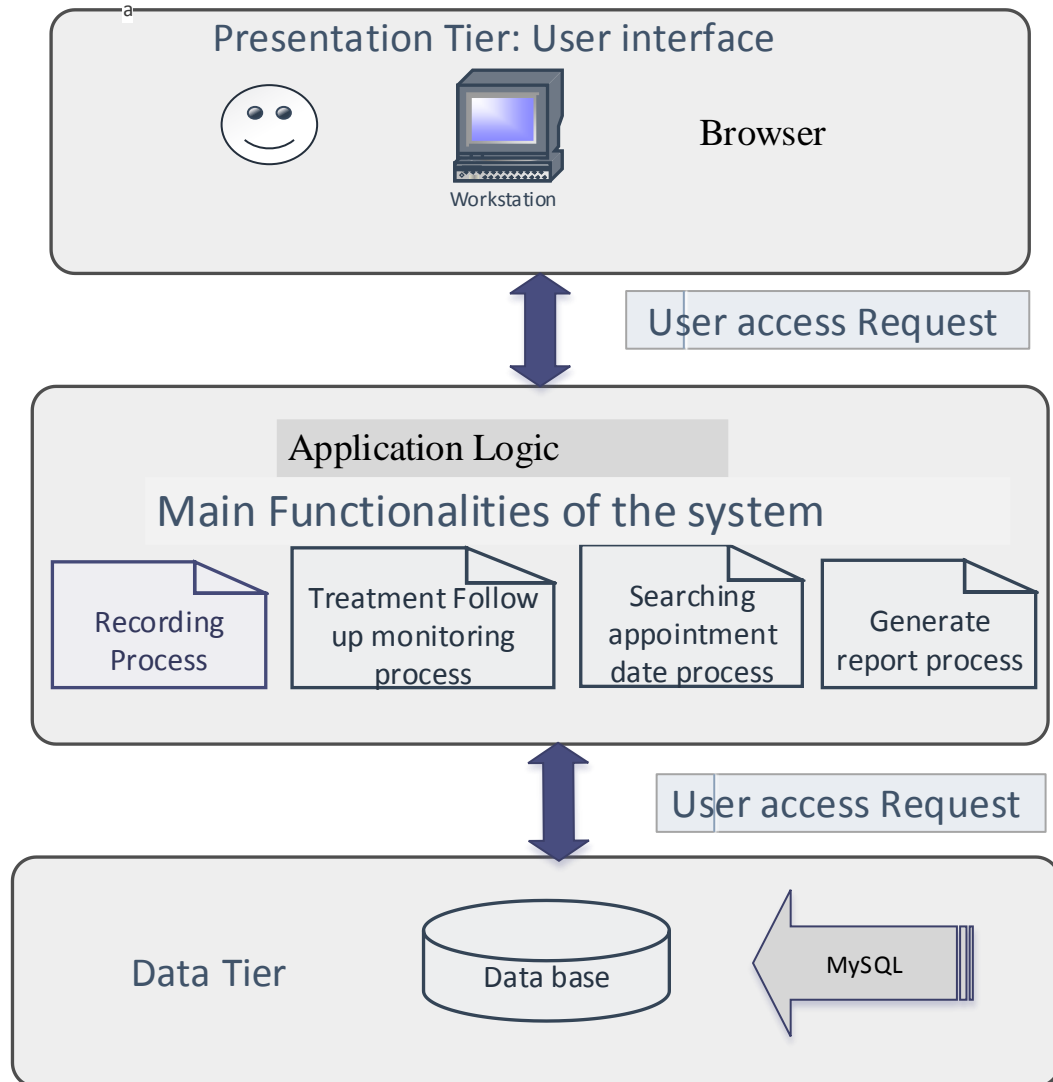


Figure 12: System architecture diagram

4.14. User Interface Flow Diagrams

Interface-flow diagrams show the relationships between the user interface components, displays and reports that make up the investigator application. Interface-flow diagrams enable the investigator to validate the design of patient monitoring follow up system user interface (57).

The Home Page

After you complete the login page, the system will welcome and redirect you to the home page. On the home page, you'll find the system's main menu.

User Interface As you browse the system, you'll notice that the pages follow a standard layout. For example, at the top of each page you find links to the main modules of the system under the following user interface.

User interface offer a high-level view of the interface of a system you can quickly gain an understanding of how the system is expected to work. It puts you into a position where you can validate the overall flow of our application's user interface (57).

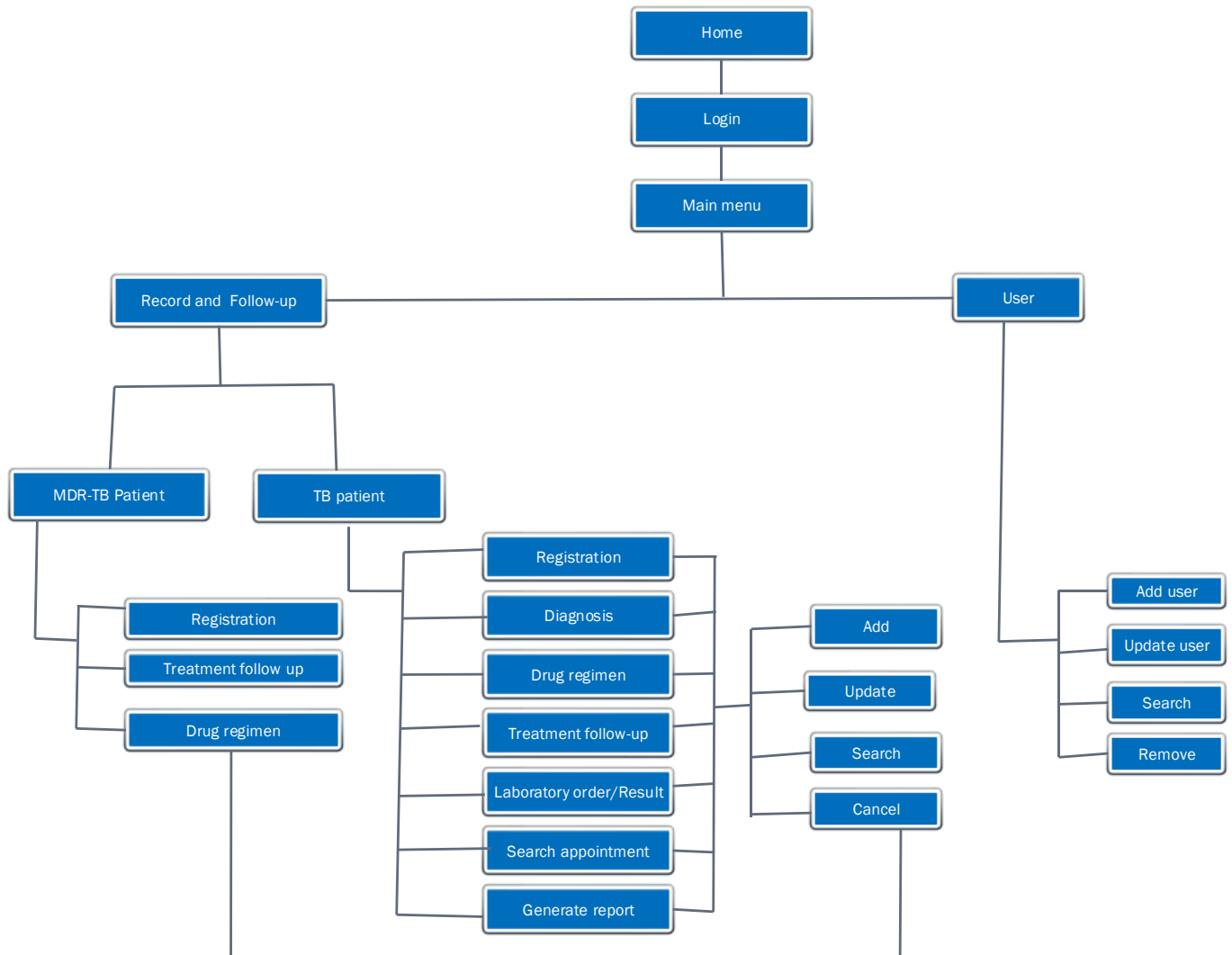


Figure 13: User interface follow diagram

4.15. User Interface Prototyping

A prototype is a working model that does not normally have all the required features or provide all the functionality of the final system. The main purpose of developing a prototype database system is to allow users to use the prototype to identify the features of the system that work well, or are inadequate, and if possible to suggest improvements or even new features to the database system. In this way, we can greatly

clarify the users and developers of the system and evaluate the feasibility of a particular system design. The design of this system involves different working models (prototype) of the interfaces that the system uses. (58).

4.15.1. Accessing the System

A user starts the process by logging into the system by means of a valid username / password combination. A new user has to first be registered in order to obtain access to the system. Users with administrative privileges have authorization to register new system users. A new users can be registered with either limited (normal user) or unlimited (administrative) privileges. During the process of user registration, all users are issued with a unique user name and password combination. This combination is used by the registered user to access the system resources that fall under their privilege level. A user gains access to the system resources after a username password combination has been verified as accurate after which they are redirected to the homepage.

The system homepage serves as the gateway to the entire recording and follow up system. Therefore, once a user is logged into the system they can access all system resources available to them based on their privilege level.

The login page is used to confirm the user in the system and the user will enter a user name and password. The system will check for the user account and password. If you have not entered a valid user name or password, an error message will be displayed in this case, repeat the operation

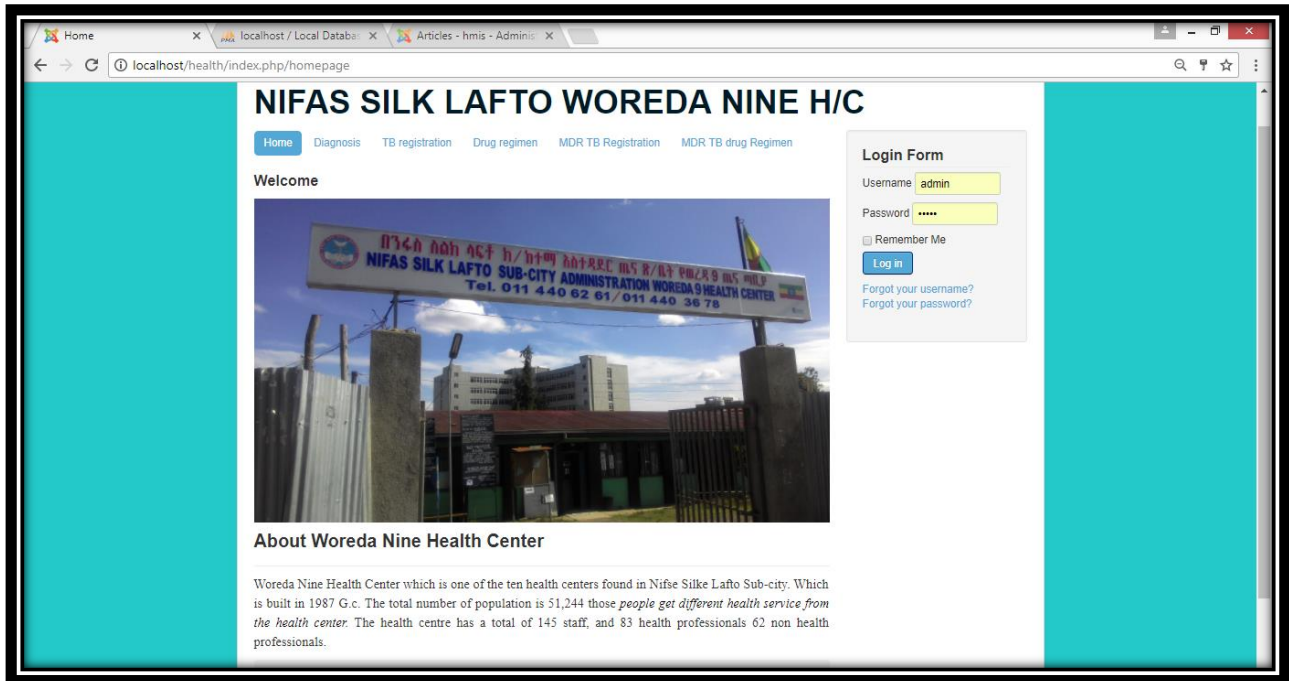


Figure 14: Login user inter face screen

TB patient registration window, user in the main menu page click registration button, the system will display sub menu patient registration the user click the sub menu form .To add new patient information in the registration sub menu form, click on submit the existing information.

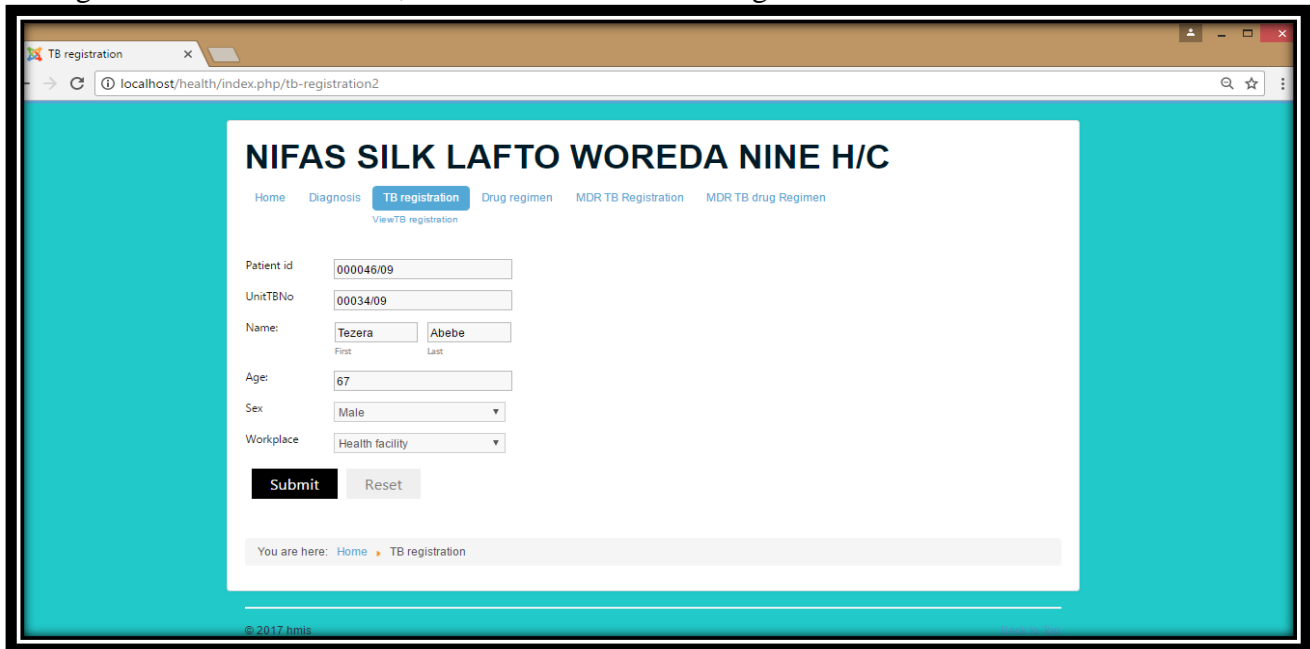


Figure 15: TB patient registration user interface screen

View TB patient registration window, user in the registration window click registration view button, the system will display sub menu patient registration view. To search lost to follow up, generate report and other functions.

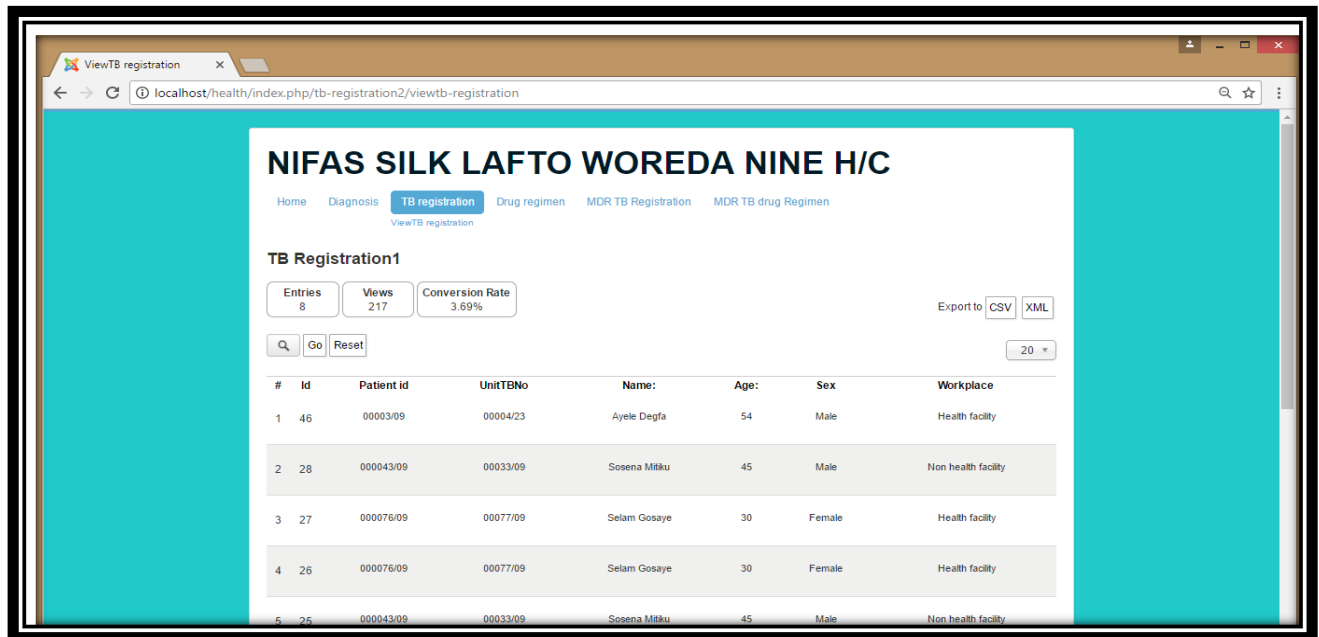


Figure 16: View TB patient registration user interface screen

MDR-TB patient registration window, user in the main menu page click registration button, the system will display sub menu patient registration. To add new patient information in the registration sub menu form, click on submit the existing information.

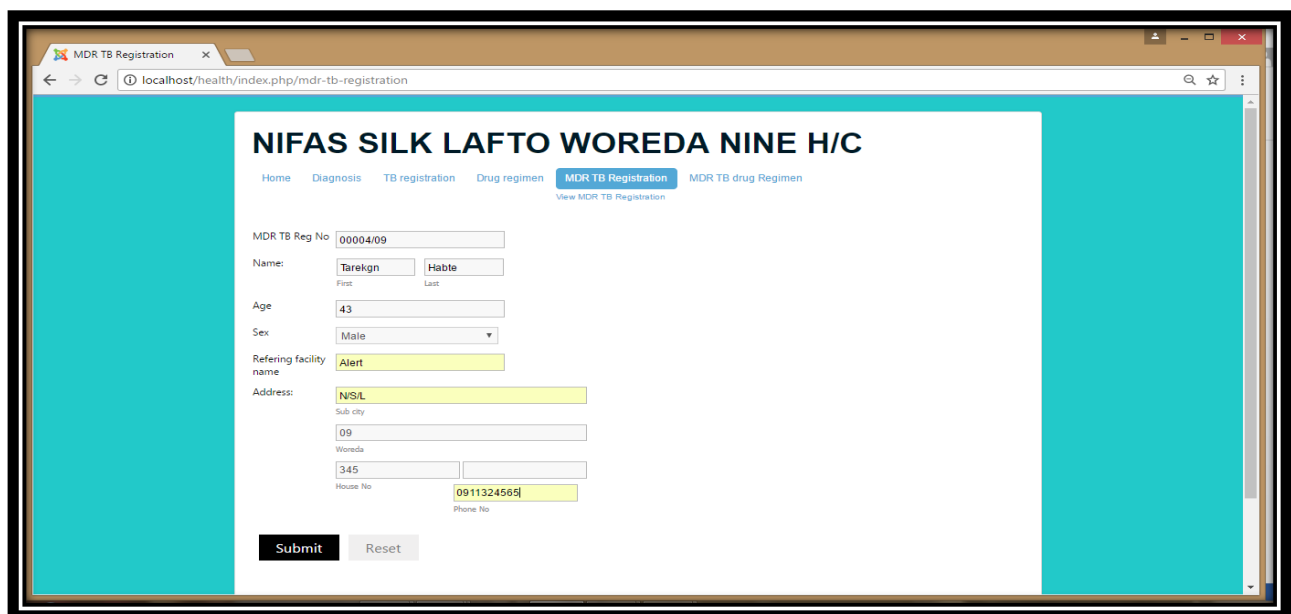


Figure 17: MDR-TB registration user interface screen

View TB registration window, user in the registration window click registration view button, the system will display sub menu patient registration view. To search lost to follow up, generate report and various information needed.

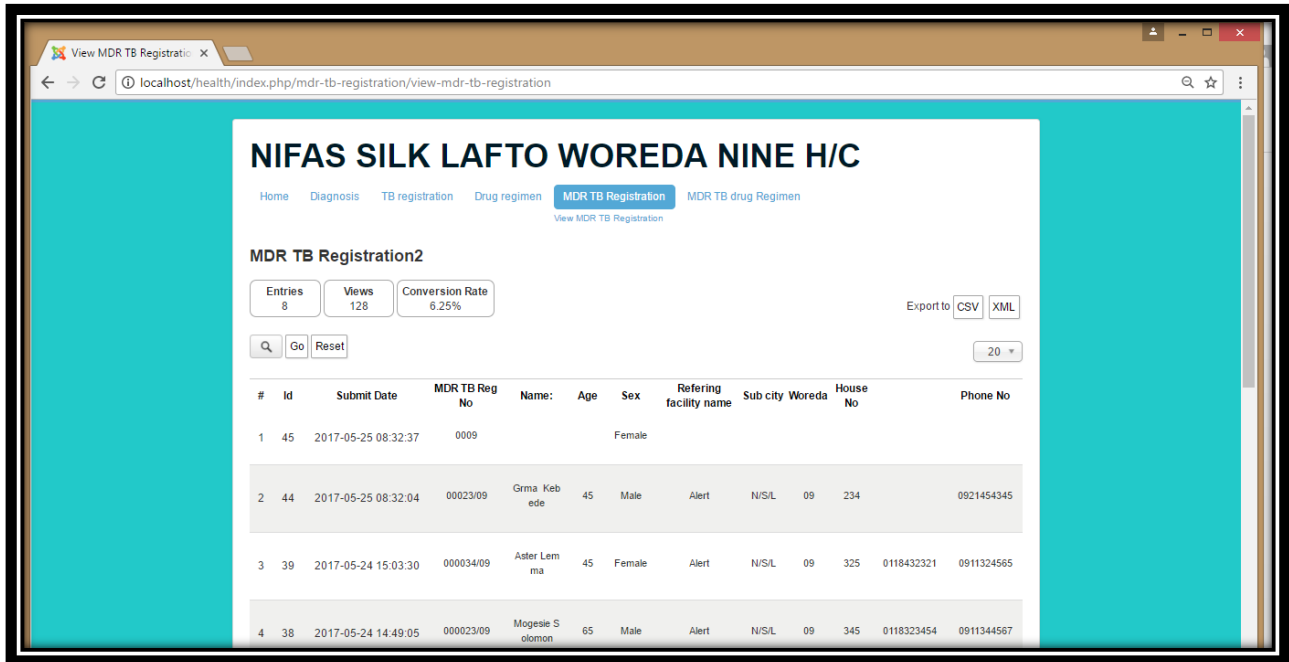


Figure 18: View MDR-TB registration user interface screen

TB diagnosis window, user in the main menu page click diagnosis button the system will display diagnosis. To add new patient diagnosis in the diagnosis form click on submit the existing information by patient id.

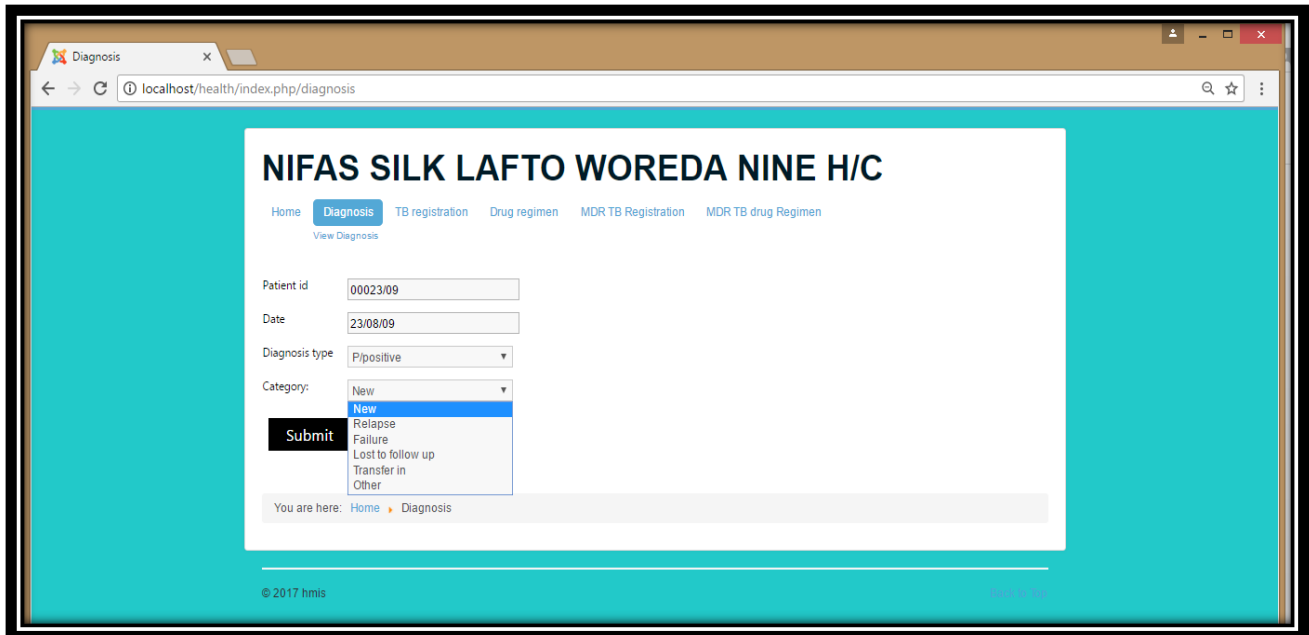


Figure 19: Diagnosis user interface screen

TB diagnosis view window, user in the main menu page click view diagnosis button the system will display view diagnosis form to see various information needed.

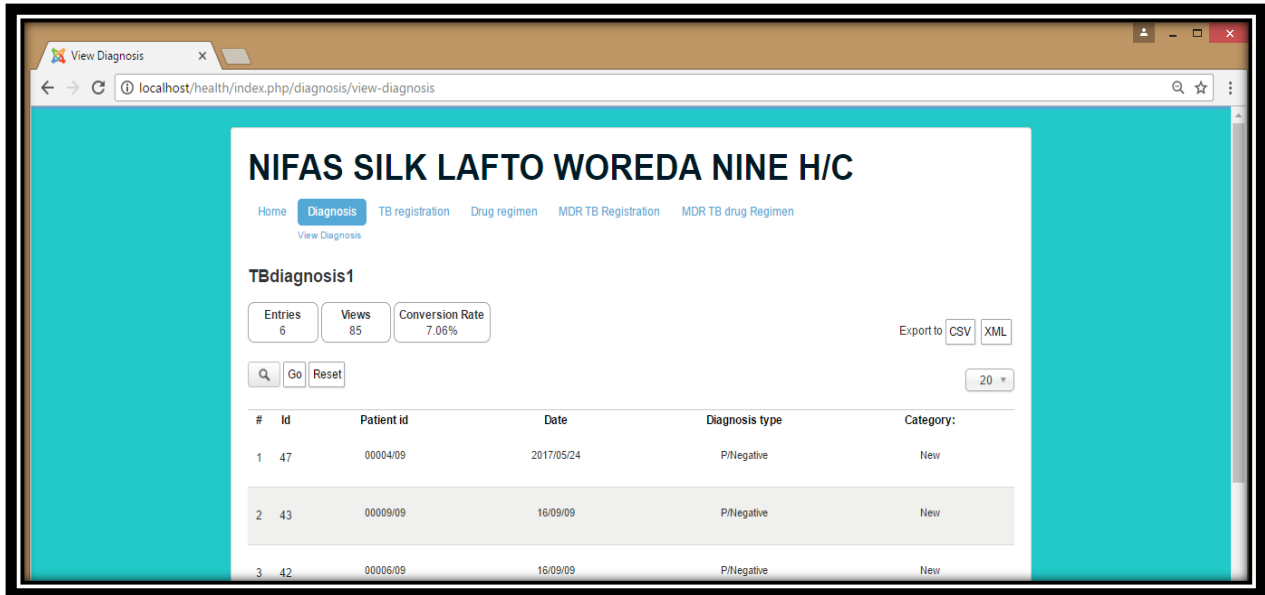


Figure 20: View diagnosis user interface screen

TB drug regimen window, user in the main menu page click drug regimen button, the system will display sub menu TB drug regimen form .To add new patient drug in the drug regimen form, click on submit button the existing information by patient id.

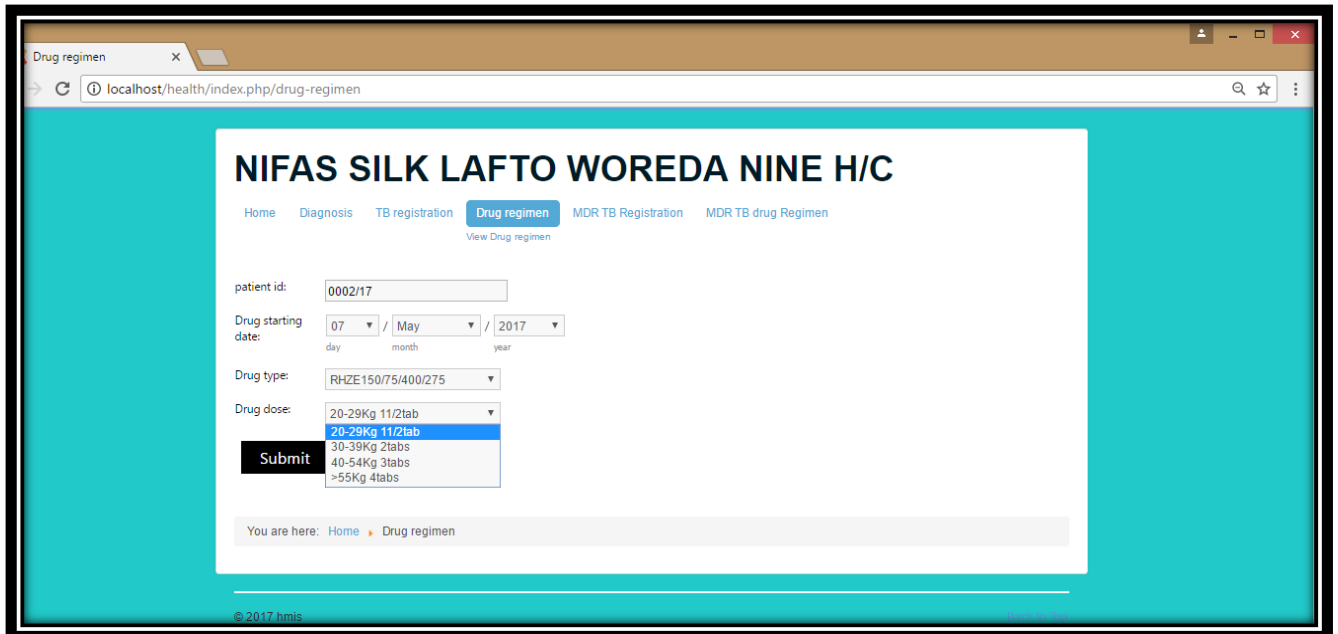


Figure 21: TB drug regimen user interface screen

TB drug regimen view window, user in the main menu page click drug regimen view button, the system will display sub menu TB drug regimen view form to see various information needed.

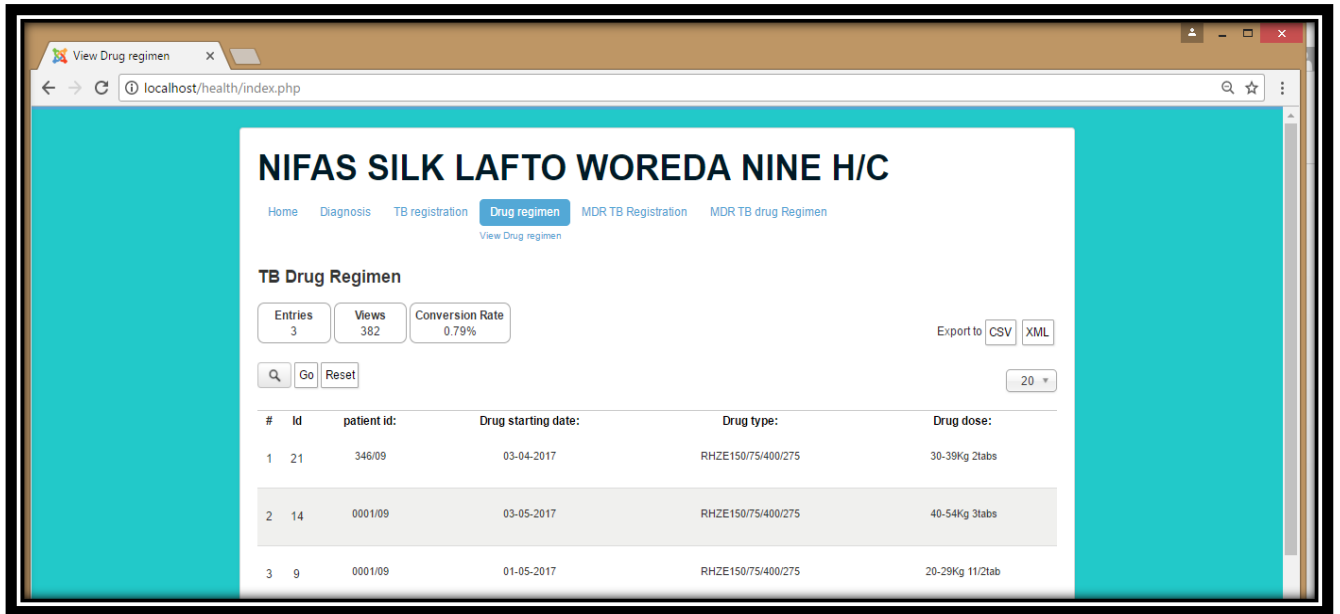


Figure 22: View TB drug regimen user interface screen

MDR-TB drug regimen window, user in the main menu page click drug regimen button, the system will display sub menu drug regimen form. To add new patient drug in the drug regimen form, click on submit button the existing information by patient id.

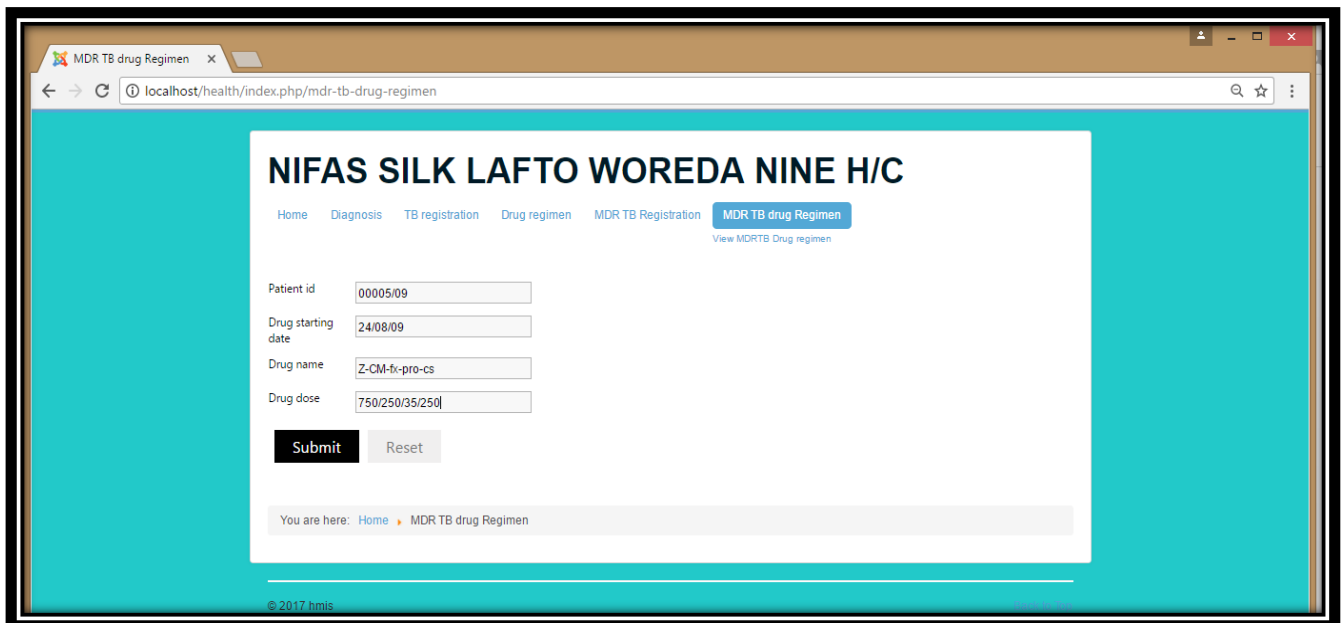


Figure 23: MDR-TB drug regimen user interface screen

MDR-TB drug regimen view window, user in the main menu page click drug regimen view button, the system will display sub menu drug regimen view form. To see various information needed.

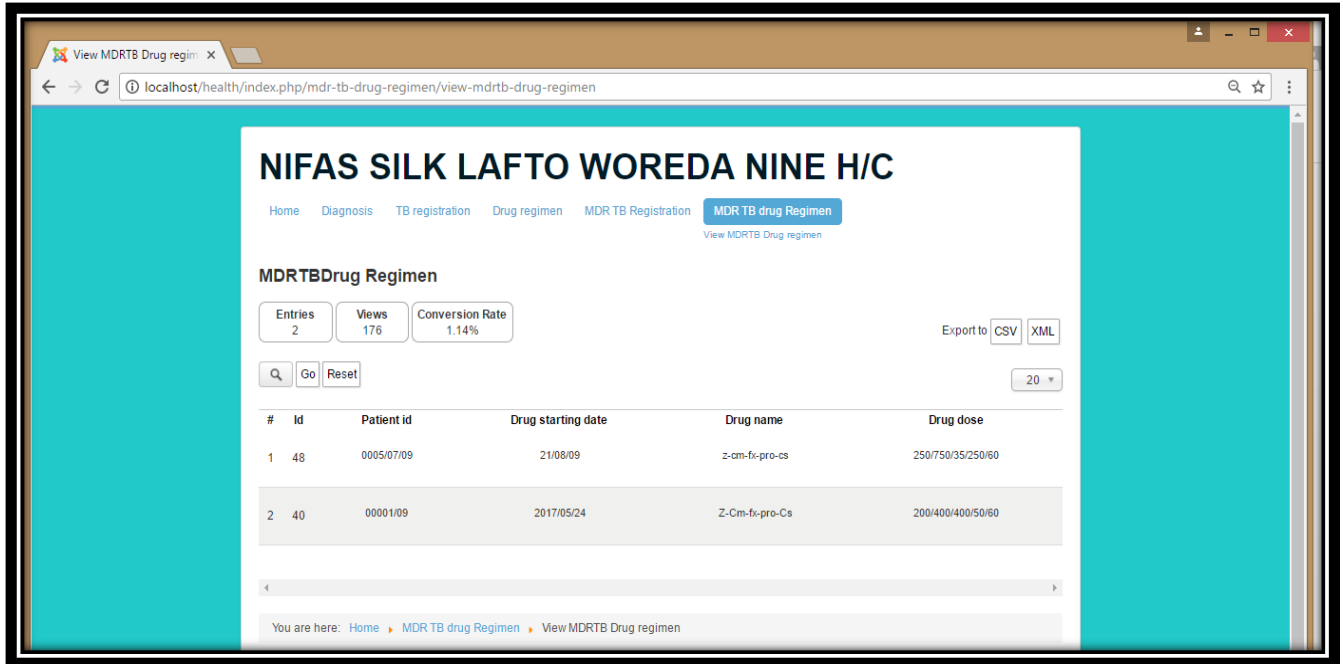


Figure 24: View MDR-TB drug regimen user interface screen

4.16. Usability Evaluation

Heuristic evaluation method was used to evaluate the prototype of usability evaluation (59). Usability is the extent to which users can use a computer system to achieve specified goals effectively and efficiently while promoting feelings of satisfaction in a given situation of use. Usability evaluation (UE) consists of methodologies for measuring the usability aspects of a system's user interface (UI) and identifying specific problems. The evaluation of the interface is certainly one of the most important aspects of software design and development. The evaluation of the interface for the patient treatment follow up system used a method of questionnaires to evaluate the interface for the prototype developed system questionnaire were used has been adopted and used, for it is cost effective (60).

Table 19: User interface evaluation

Functionality Questionnaire						
No	Test Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	The system is easy to open and access				1	4
2	The system is easy on using the different functionalities in the given privilege				2	3
3	The system saves entered data properly			1	2	2
4	The system views saved data accurately				2	3
5	The system could be helpful to search appointment				2	3
6	The design system made the user to save time				3	2
7	The design system could friendly use to improve patient data quality			1	2	2
	Overall, the interface is pleasing and easy to use				1	4
9	The design system could be helpful patient follow up in the health facility			1	2	2
10	The system could increase patient adherence to treatment				2	3
Total		Average result		6%	38%	56%
		Total agree value		94%		

From the above table 19 questionnaires help to capture the opinion of the respondents and individual interest for the system use. They evaluate the proposed system effectiveness and functionality of the system were 56 % of them respond strongly agree 38% of uses respond agree 6% users of the system respond Neutral. According to the result of user interface evaluation most of the respondents that is 94% agreed that the system prototype has a good and clear informational and functional explanation regarding the major functionalities of the system.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

This project was conducted with a designed of patients adherence follow up system which is to improve patient treatment follow up system. In the Health Center the system uses manual method which causes significant problems such a poor patient follow up, (non -adherence), time taken to generate accurate and complete report and wastage of time in maintaining paper work. Based on the finding of this project, the designed system is contribute a better understanding to solve the problem being performed by the current manual approach keeping patient data record and follow up.

The project identified main requirements from the health facility which the information includes, patient diagnosis, drug regimen ,searching of schedule appointment date and patient treatment follow up system associated with electronically record. The system supports to provide fast services and enhance health worker performance and speedy retrieve records.

Additionally, in this project used different forms and the national TB prevention and control guideline were used as an input in order to determine the requirements for the new system. This project conducted using object oriented approach for undertook gathering user requirement analysis and design phases. The system is analyzed using diagrams such as business use case, context diagram, system use case diagram, and the design phase emphasize system architecture to fulfill the requirements using UML artifacts of class diagram, sequence diagram and designed user interface prototype. All section or components on the user interfaces built to fit in to the software requirements. A designed system was used three-tier Architecture model.

The user interface prototype shows a portion of an interactive computer system that communicates with the user. Design of the user interface includes any aspect of the system that is visible to the user. The investigator evaluate the effectiveness of the system includes different factors, such as performance of the users, to improve patient treatment follow up, treatment outcome, further prevention of MDR-TB/XDR spreading to the communities.

Generally the designed system could enhance accessibility of patient data and information with the reduction of the unnecessary time wasted and it makes timely use of information by decision makers, which improves the standardized health service.

5.2. Recommendations

This project made to designed of patient adherence follow up system in order to improve the current paper based follow up system. According to the findings the following recommendations should be taken in consideration by Woreda Nine Health Center managing bodies and other stakeholders:

A. The Health center:

- ❖ The Health Center should work on the implementation of the system
- ❖ The Health Center should provide a better infrastructure (Network, electric power) to deploy the system.
- ❖ The Health Center should provide hardware and software in order to install the system
- ❖ The Health Center itself have to be committed to follow up the final goal of full development system acceptance and usage

B. The Federal Ministry of Health and Regional Health Bureau

- ❖ The Federal Ministry of Health and Regional Health Bureau of Addis Ababa should support the Health Center and TB treatment follow up system with necessary hardware, network infrastructure for the implementation of the system. In addition, assigning sufficient budget and manpower is necessary for the sustainability of the system.
- ❖ The Federal Ministry of Health, Regional Health Bureau, the Health Center and other stockholders should work to implement the system, and on the capacity building on health professionals.

C. Researchers

- ❖ Researchers or students should be continue the project to complete all the rest part of system implementation, by using this project as an input for next phase of software development process.

5.3. Hardware and Software Requirements

This portion provides the hardware and the software requirements needed for effective and efficient running of the system. As this system is using three tiered architecture for the full functionality of the system; best performance is needed these below listed are recommended for the implementation

5.3.1. Hard ware Requirements

It is quite obvious that in order to realize the functionalities of the system acquiring hardware is a mandatory. The minimum specification of the hardware required to implement the system are specified in two categories:

Machine specification for server and workstation one server computer

- ❖ Minimum of 2 dual core 2.4GHz
- ❖ Pentium Xeon Processor
- ❖ A minimum of 3 GB of RAM and greater than 3 TB hard disk.
- ❖ Mouse, keyboard, Monitor
- ❖ Network interface card (NIC)
- ❖ Back up device

Client computers

- ❖ Operating System Windows XP and above
- ❖ Minimum of 3.4 GHz
- ❖ Pentium IV processor
- ❖ A Minimum of 1 GB RAM and 80 GB hard disk.
- ❖ Scanner
- ❖ Printer

5.3.2. Software Requirements

In order to obtain the required functionalities of TB follow up system, it will not be enough to have the above listed hardware which is not functional without software.

Software needed for Server

- ❖ Operating System Windows 2003 Server (SP2) and above
- ❖ Apache
- ❖ PHP
- ❖ MySQL Server 5.0

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Annex I

Participant Information Sheet

ADDIS ABABA UNIVERSITY

SCHOOL OF PUBLIC HEALTH AND SCHOOL OF INFORMATION SCIENCE

DEPARTMENT OF HEALTH INFORMATICS

My name is _____ I am a student at Addis Ababa University and I am currently conducting a project for the partial fulfillment of master's degree in health informatics. The purpose of this project is an electronic record management information system TB/MDR-TB patients follow up at woreda six health center I would like to ask you some questions related to designing TB patient adherence follow up information system the topic I mentioned above and all of your responses to questions will be kept strictly confidential throughout the project. Participation in this project is voluntary and you can choose not to answer any individual of the interview. I look forward for your full participation as the answers you give on this form will help in better understanding of the situation of designing TB patient adherence follow up system.

Consent Form

My name is _____. I am informed this interview is part of project that proposes design of designing TB patient adherence follow up at your health center. I have been told that the project will help in better understanding of the situation of design of an electronic record management information system TB/MDR-TB patients follow up its will help in designing an electronic patient follow up for future which will benefits health care organization, all health professionals, TB patients and community .At last I am assured that confidentiality of my response is maintained. Therefore, I am consent to participate in the project by signing this form.

Thank you for allowing us to share your precious

The Study participant's Signature _____ Date _____

Annex II: Interview

In-depth Interview Guide

A. Interview questions

Interview Guide for Medical Directors and Disease prevention head

Interview Questions

Purpose: The interview questions will help to assess the current system and to design future patient electronic record information system for Woreda nine health center General Information

General Information

Particular of Interviewee: _____

Position/Responsibility: _____

Academic _____

Age _____ Sex _____

Years of experiences _____

1) What is the currently service delivery in the health center?

2.) What is the problem in the current recording and follow up system?

3) Please describe your general opinion on the system?

4) Is a budget in place to provide reasonable coverage for the system support services?

5) Do you have enough staff in place to implement, provide support for, and maintain the new system?

6) What key operational changes would you like to see with the implementation of the system? _____

B. Interview Guide for User of System.

Recipients: User of system (health provider)

General Information:

Particular of Interviewee: _____

Position/Responsibility: _____

Academic _____

Age _____ Sex _____

Years of experiences _____

1) What is the current service given in the unit?

2) Who give the service?

3) What are the role of health provider in the unit?

4) What is the current recording system?

5) Has all essential information been recorded, are all entries signed and dated?

6) Do you have treatment follow up procedure in the Current system?

7) Do you have lost follow up tracing mechanism in the current system for TB/MDR-TB patients?

8) What is your opinion on the current paper based recording follow up system?

9) Do you think there are problems in the current system in the process of patient registration treatment follow up and report generation?

10) If yes number nine what do you think the solution for the problem?

11) Please mention the feature you need in the new system?

12) Do you think the system program is helpful to your activities? Please explain

13) Do healthcare professionals understand the benefits of the system and are they enthusiastic about using the new system?

14) What are the formats used to record and report data?

15) How your general knowledge and skills in information communication technology for the electronic based record use?

16) Please provide your recommendations or suggestions on how to further improve the ICT system?

Have you take basic computer skill training

Yes_____ No_____

If yes what type of training did you take and for how long?

Type of training	Duration					
	< 3 month	3 month	6 month	1 year	> 1 year	Other
Word						
Excel						
Access						
EMR						

D. Interview Guide for Unit HMIS or HIT Technology

Particular of Interviewee: _____

Position/Responsibility: _____

Academic _____

Age _____ Sex _____

Years of experiences _____

1) Infrastructure

1.1 Is there a power backup generator in the facility? Yes [] No []

Is there a functional software in the facility? Yes [] No []

If yes describe _____

Is there hard ware in the facility? Yes [] No []

If yes describe _____

Is there internet connection available in the facility? Yes [] No []

If yes describe the type and capacity. _____

2). is there IT professional availability in the facility? Yes [] No []

If "No" what is the plan? _____

D. Observation and document review guide

Recipients: TB coordinator and other health professionals

SN	Process to be Observed	YES	NO	REMARK
1	HMIS TB Patient registration carried out according to standard?			
2	Patient health records are placed in its places?			
3	Retrieval of lost follow up TB patients tracing is it time taking?			
4	Is there TB/MDR-TB treatment follow up according to standard like drug preparation			
5	Do all health professionals assess, Diagnose and treat patients according to standards?			
6	Do they use all formats in TB clinic?			
7	Does reporting generation process is time taking			

User interface evaluation question

The below mentioned table was developed to collect the required response from the stakeholders of the system to help in assessing and evaluating the user interface for the newly developed system prototype

Functionality Questionnaire						
No	Test Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	The system is easy to open and access					
2	The system is easy on using the different functionalities in the given privilege					
3	The system saves entered data properly					
4	The system views saved data accurately					
5	The system could be helpful to search appointment					
6	The design system made the user to save time					
7	The design system could friendly use to improve patient data quality					
	Overall, the interface is pleasing and easy to use					
9	The design system could be helpful patient follow up in the health facility					
10	The system could increase patient adherence to treatment					
Total		Average result				

Annex III

Forms Used in the Current System (Forms used to design the system)

Unit TB registration book first page

TUBERCULOSIS AND LEPRASY CONTROL PROGRAM ETHIOPIA

TB culture & susceptibility testing request

Patient identification

Patent full name _____ age ____ sex ____

Region ____ zone/sub city ____ Woreda ____ kebele ____ H/NO ____ TELE _____

Referring Health Facility _____ Co-infection _____

TB DISEAS TYPE& TREATMENT HISTORY

Site pulmonary TB Extra pulmonary [specify] _____

Registration Group new relapse After default after failure of retreatment
 after failure of first retreatment other [previously RX unknown outcome]

Previous TB drug use new first line second line MDR TB contact

REQUEST FOR TESTING AT REFERENCE LABORATORY

Reason Diagnosis follow up at __ months during treatment Follow up at __ months after Rx

Specimen Sputum other (specify) _____

Date specimen collected _____ [Ethiopian Calendar.]

Requested Test Microscopy culture Drug susceptibility test [DST]

Person requesting examination name _____ profession _____

Laboratory Result

Date specimen received ____/____/____ [Ethiopian Calendar.] _____ Culture number _____

Microscopic examination result

Negative	positive			
	1-9	1+	2+	3+

Ziehl nelson [zn] fluorescence
 Direct smear concentrated smear
TB culture result

<i>contaminated</i>	<i>Negative</i>	<i>positive</i>				
		<i>Mycobacterium tuberculosis complex [mtbc]</i>				
		<i><50colonies Actual count</i>	<i>50-100 colonies 1+</i>	<i>100-200 colonies 2+</i>	<i>200-500 colonies 3+</i>	<i>>500</i>

TB Drug

		<i>Control [DRUG]</i>	<i>NO</i>	<i>Isonized</i>	<i>streptomycin</i>	<i>RIFampicin</i>	<i>Ethambutol</i>
<i>Growth</i>	<i>10</i>						
<i>Dilution</i>	<i>10</i>						
<i>Result</i>							

Legend :S=sensitive R=Resistant C=contaminated ND=not done

Date reported _____ [Ethio.Cal] Name/Signature _____

Revised by _____.

NATIONAL TUBERCULOSIS AND LEPROSY CONTROL PROGRAMME

Tuberculosis referral and transfer form

From _____ To _____

Name _____ Age _____ SEX _____

Region _____ ZONE _____ Woreda _____ kebele _____

Farmer association _____ House number _____ woreda TB number _____

Category of pt - New Relapse Re after default Failure Others

Type of TB P/POS P/NEG E/P Re Rx

Drug regimen SCC LCC

Date of starting treatment _____

Current treatment

A) Intensive phase

Drugs	Dosage	Total daily dosage given

B) continuation phase

Drugs	Dosage	Total daily dosage given

Sputum result

other lab result-

Month	Date	Result	Lab.ser.no
1			
2			
3			

X ray findings _____

symptoms

physical findings

Remark _____

Date _____ name _____ signature _____

Receiving unite cut and send this portion to the referring unit when result of Rx is known

From health unit _____ to health unit _____

The following Pt has attended for further Rx

Result Rx cure Defaulted

Name _____

Rx completed Transfer out

Woreda Tb number _____

Died Failure

Date _____ name _____ signature _____

DECLARATION

I the undersigned, declare that this project work is my own original work and effort and that it has not been presented for a degree in any other university, where other sources of information have been used, they have been duly acknowledged

Name of the student

Azeb Bahre

Signature

Date

Advisors Signature

Professor Fikre Enquesslassie

Signature

Date

Ato Gtachew Jemaneh

Signature

Date