

# Developing Electronic Medical Record System to Enhance the Satisfaction of Patients and Service Providers

Siham Jemal Kedir

**Abstract**—Information communication technology is dramatically transforming the health sector, especially in developing countries with few resources and burgeoning access to an internet connection. As a result, processes such as record keeping, administration, and human resources have been vastly simplified, allowing hospitals to focus on delivering urgent medical care. This paper will explore the impact of IT through a study of the electronic medical record system in the Mekelle City Health Center in Tigray Region, Ethiopia. This paper has four specific objectives: 1. developing artifacts in the Electronic Medical Record system, 2. preparing a diagram for step-by-step development of Electronic Medical Records, 3. creating a draft website with the proposed Electronic Medical Record system, and 4. Testing and evaluating the performance and user acceptance of the system. The research will be done in a qualitative manner employing interviews and in-person observation. The research has found the following major results: firstly, the medical record system has been difficult to implement. Second, the Mekelle Health Center is using a manual recording system which is time-consuming and inefficient. The old recording system in the Center leads to the dissatisfaction of patients as well as the service provider staff. As a result, to transform the manual recording system into a digital system, an electronic medical recording system has been developed. The developed system has been tested for implementation and has been successful. Consequently, the administrator of the health center is ready to implement and use the developed software to introduce a medical recording system in Mekelle Health Center.

**Keywords**—Electronic Health Record Implementation, EMR System Development, Medical Record.

## I. INTRODUCTION

### A. Background of the Study

HEALTH care is the major facet of life and every person visits a health center as a patient throughout their lifetime. Health centers keep the records of their patients manually or electronically. The electronic medical record enables the staff to add, delete, and update the history of a patient within the system. When the staff searches the patient's record on the computer, they can retrieve any information they require about the patient.

Electronic medical records are private from individuals (patients and non-concerned bodies) because they contain personal information like addresses, medical records, and birth dates. The main purpose of medical records is to reduce the workload on staff as it allows them to easily access the information they need quickly and efficiently. This also helps

to increase the efficiency and effectiveness of the organization. Electronic medical records not only manage the records of staff and patients but also play a key role in making the right decisions at the right time and in the right place for the management of the organization.

Danso [5] stated that health centers focus on the well-being and medical needs of their patients. Effective medical treatment depends on skilled doctors and nurses and high-quality facilities and equipment. Medical care relies on efficient and accurate record keeping, as without up-to-date patient information, medical personnel are unable to offer effective service. These records can range from drug records, x-rays, scans and patient registers and their privacy and accuracy are extremely important in providing good patient care [5]. Maintaining records effectively ensures smooth administration within a health center. Superfluous records are routinely transferred or disposed of, ensuring storage spaces remain uncluttered and easy to access. This facilitates quick retrieval of essential records, ultimately saving time and resources [1]. Records serve as a vital source of information for statistical reports, medical research, and health information systems. They also demonstrate the health centers' accountability for its actions. Managing Health Center Records addresses the specific issues involved in managing clinical and non-clinical records. A comprehensive records management system in a health center ensures that clinical data and administrative records on a variety of topics, such as policy, legal rights and responsibilities, support, finance, facilities, equipment, and tools, are accessible to staff. Records Management refers to an ongoing process of managing the records on a media-neutral basis in accordance with approved policies, procedures, and schedules, Records Management as a discipline establishes and enforces business rules governing the creation, safeguarding, retrieval, and disposal of records within an organization. as records over time [2]. Preservation schedules are the basis of a successful Records Management process. Records Management as a discipline involves record keeping. Record keeping is an important aspect of every organization/institution's day-to-day operation. The methodical process of creating, gathering, preserving, and discarding an organization's documents is known as record keeping. Additionally, this system guarantees their quick availability, accurate and rapid updating, preservation for evidentiary purposes, and access restriction to only authorized individuals.

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This project aims to enable EMR in the Mekelle Health Center. The Mekelle Health Center is a public medical service. The health center currently uses a manual record-keeping system which leads them to the loss of the patient's data and time-consuming service. So, to solve the problem of recording in the Mekelle Health Center an electronic medical recording system is developed, and the system allows the employees in the organization to log into the system and handle the activities done by the health center.

### *B. Statement of the Problem*

Technology has become crucial in educational development and has revolutionized learning systems [3]. Technology creates and transforms the health sector processes, which brings new opportunities to the health system. In today's knowledge and technology-leading economy, the ability to transition to an electronic system is a crucial issue. When doctors share records electronically, the medical practitioner only needs a piece of identifying information which allows for diagnosis and treatment decisions to be pieced together and tailored quickly much more effectively than what would have been written through physical notes. In addition, this saves money by cutting down on the cost of paper and labor. This is particularly important on a developing country; this money can go instead to the cost of subsidizing a patient's healthcare or administration of the hospital.

According to an assessment of the Ethiopian National Health Information System, the skill gap in online information was considered one of the factors for interactivity that affects the quality of health care provision [4]. As a developing country Ethiopia is trying to familiarize itself with that type of technological advancement. One of the sectors that desperately needs this type of technological revolution is the health sector. This study has identified that access to online information is associated with health, and it can bring missed interactivity using different available online services in health. Therefore, the focus is on Mekelle Health Center to create an online medical record system.

### *C. Research Questions*

The study will attempt to answer the following questions: What are the artifacts in the electronic record systems regarding the health care system? What are the practices and mechanisms of the record system implemented in Mekelle Health Center? What are the impacts/benefits of using the Electronic Medical Record System for Mekelle city communities and employees of health centers?

### *D. Objectives*

#### 1. General Objective

The general objective of this research project is to Develop an Electronic Medical Record Mekelle City Health Center, Tigray Region, Ethiopia

#### 2. Specific Objectives

The specific objectives of the proposed study are: To develop artifacts in the Electronic Medical Record system, to prepare a diagram for the step-by-step development of the Electronic

Medical Record system, to prepare a website with the proposed Electronic Medical Record system, and to test and evaluate the performance and user acceptance of the system.

### *E. Overview of Existing System*

Mekelle City Health Center continues to be providing a manual health center though in recent times it has not taken any measure for automation. The health center currently uses a manual record-keeping system and as a result, the Electronic Medical Record system is non-existent. This leads to the loss of the patient's data, money, and time and also results in unsecured information. However, their use of medical services has dramatically increased.

### *F. Significance of the Study*

The major contribution of this study is to update and digitize the methods through changing the manual system to digital, allowing doctors write prescriptions digitally and cohesively and record patient history minimizing workload of the employees and the system's effort, facilitating and simplifying the health center's activities and ensuring the satisfaction of customers through providing quick service while handling essential information about patients and employees.

### *G. Scope of the Study*

The scope of this research project was developing an Electronic Medical Record System in the Mekelle City Health Center, Tigray Region, Ethiopia. To complete this project effectively the team has planned the activities which are performed throughout the development of the Electronic Medical Record System.

### *H. Activities*

As the schedule indicates, only a few months are left for which to complete this project. In these months the activities are identified as advantageous to complete the project effectively and efficiently. The activities are arranged critically. Review of related projects and pieces of literature (observing related fields, reading for detailed information which helps to know what has been done in this area and to standardize this project with the current trends.) and developing the proposed system are major activities.

### *I. Limitations*

In general, the biggest limitation was the lack of time. Another limitation was the lack of adequate resources like analysis tools. The absence of being able to review reference materials in the libraries and lack of experience in conducting a large project which needs experience in object-oriented system analysis and design methodology are also the limitations of the study.

### *J. Delimitations*

Because of time, material, and financial constraints, the system includes only the development of a website for the Electronic Medical Record System with some services.

## II. LITERATURE REVIEW

### A. Overview of Electronic Medical Record System

Ajayi stated that the Information Revolution started several years ago and as a result, its impact on diverse sectors has been large [1]. This revolution has brought about the convergence of information and communications technologies (ICTs), which have remained at the center of global social and economic transformations.

The Electronic Medical Record (EMR) is one of the medical tools that seek to improve medical care by providing health centers with the kind of platform that allows for new services and new functionality. The patient information can then be updated as the patient undergoes new treatment and newer health information is discovered.

### B. Electronic Information

Electronic information is a system that stores information from internal and external sources to facilitate better decision-making [11]. The data are collected in a database and a user can access the files to gather better information as a basis for decision. The system may include financial, social, economic, scientific, or technical data stuffed to support a firm's operation and ensure an organization has the information it needs.

### C. Sources for e-Record

#### 1. E-record

An EMR is a digital version of a patient's medical history. E-records are also called machine-readable records, digital records, or automated records which means data or information captured and fixed through electronic for storage and manipulation in an automated system that requires the use of a system to render it intelligible by a person and may or may not have a paper record to back it up [5].

#### 2. Characteristics of E-record

Ohio's definition of a record found in ORC 149.011 [13] states that the term "records" includes "any document, device, or item, regardless of characteristics" Those characteristics are:

- i. Out of sight – out of mind: Physical records take up space and provide a visual motivation to manage them.
- ii. Changing media: Electronic records need to be accessible throughout their entire lifetime as defined by approved records retention schedules.
- iii. Authenticity, Accuracy, Integrity, Accessibility: Electronic records lack physical and visual clues about their origins and their authenticity. Maintaining the content, structure, and context of electronic records is, therefore, both more vital and difficult than with traditional analog records.
- iv. Legal Admissibility: Evidence that is introduced in legal proceedings is subject to Federal Rules of Evidence, specific Ohio legislation, and precedents established through case law.
- v. Disposal: Electronic records should be disposed of using the same rules specified in your records retention.

#### 3. Type of E-record

E-records can include but are not limited to the following

things:

- i. Unstructured electronic documents (i.e. doc, docs, .pdf, .msg, .JPEG, etc.)
- ii. Structured electronic content (i.e. ERP, CRM, etc.)
- iii. Web site content
- iv. Text messages, tweets, Wikis & Blogs
- v. Voice mail, audio and video recordings
- vi. Scanned images of documents

### D. E-record in Health

An electronic record in health is the systematic collection of patients' and populations' stored health information in digital format. These records can be shared across different healthcare fields and centers. Records are shared through a network-connected information system. E-records in health may include a range of data including medical history, and laboratory test results.

EMR systems are designed to store data accurately and to capture the state of patients across time while reducing the risk of data duplication. This is because there is only one file that can be modified, allowing for the file to be more up to date and decreases the chance of lost paperwork [12].

### E. Policy on Using E-record

The World Bank, a post-secondary institution, and the United Nations, among other organizations, use E-records but how they deal with them are vastly different. A lot of government policies are unclear from a local community perspective. The key factor of any successful policy formulation and implementation involves the participation of a range of stakeholders [6]. Stakeholders play an important role in motivating the policy, while motivation influences the capacity reasoning of policy.

### F. Barriers of E-record in Health care

Amatayakul [2] has listed basic barriers to electronic recording such as human barriers (healthcare professionals). This mainly stems from a lack of awareness of the importance and benefits of using EMRs as well as a lack of knowledge of using EMRs and inexperience using computer applications.

Financial barriers (money and funding) include the high initial cost of EMR implementation as well as the lack of capital resources to invest in EMRs. EMR adoption and implementation consume a lot of a hospital's resources and pay-off might be marginal at first. Legal and Regulatory Barriers (Laws and Policies) include a lack of policies/procedures that govern EMRs on the hospital level or a lack of laws or legislation that govern EMRs on a national level.

Organizational Barriers (Hospital Management) include workflow redesigns to match with EMR implementation which can be time-consuming. Hospital management sometimes do not have the necessary experience to choose & implement the best EMRs or provide the necessary training for the staff on using EMRs.

Technical Barriers (Computers and IT) can include a lack of manuals or guidelines for using EMRs. Computers and networks also need quite a lot of maintenance and care. There are not a lot of computer terminals (connections) and the ones

that exist are old and slow. Finally, professional barriers (Working at Hospitals): include the lack of motivation to learn and train on using EMRs as well as the lack of time allowed for learning and training on using EMRs. EMRs add more professional responsibilities.

#### G. Health E-record Management

The management of e-records in health plays a role in ensuring systematic control when creating, receiving, maintaining, using and disposing of records. It ensures the organization has the records it needs when they are needed.

#### H. Health E-Record Practices

Practicing the e-record in the health center will be a challenging matter because it is not widely practiced in the region. It has the perception that it is difficult to manage because it needs a high budget and requires highly qualified staff. Considering all these things, health centers are afraid of implementing software for their new recording system.

#### I. Ethiopian ICT Policy for Online Information Bandwidth

ICT policies influence Ethiopian online information provision, especially in internet availabilities. Government policies in online or internet facilities have been highly influential in online information dissemination. Within Ethiopia, governments control most of the online information infrastructures and defend different policies that influence the acquisition and private use of these infrastructures [8]. With policies encouraging ICT ownership and investment, it is expected that ICT will be more readily transferred to all population segments. Privatization is another major ICT policy issue in Ethiopia. The government owns and manages key infrastructures needed for the transfer of online technologies like the telecommunications operator who provides phone lines for the Internet, websites, and e-mail. As governmental policies restrict privately owned IT services, these can become unusually expensive and often lack quality due to the absence of competition. Research on the effects of ICT policy on online information patterns generally indicates that policies supporting ICT development will help the growth of the national bandwidth of online information or internet services [5].

### III. METHODOLOGY

#### A. Description of the Study Area

Mekelle Health Center was founded in 1972 E.C. by Italian donors, and it is one of the oldest public health centers in Mekelle. It provides services for different types of illnesses and issues (medical, laboratory, midwifery, and childcare services) for those who live around Mekelle. The health center has a total of 59 medical and administrative staff. Mekelle is the capital city of the Tigray region. It is located north of the capital city of Ethiopia, Addis Ababa. The director of Mekelle Health center indicated that Mekelle city has an estimated total population of 400, 000 with up to 200-300 patients seen per day.

#### B. Data Collection Methodology

The methods utilized to collect data are both qualitative and

quantitative.

*Interview:* Interviews were conducted with the Administration of Mekelle Health Center and Unit heads of the health center to get information and identify special features and problems in the existing system, and to identify barriers with the current service provision. Attitudes toward the current system about services provided, flexibility, accessibility, time, and others were also measured.

*Observation:* Since the developers of the system are also service providers of Mekelle Health Center, it is relatively simple to observe activities in the medical center like service provision, accessibility of information materials as well as benefits and drawbacks of the activities in the center. Due to its ease, this method of data collection was used extensively.

#### C. Study Design

The study was designed using the theoretical framework of Design sciences (DS) as DS creates and evaluates IT artifacts (in this case developing a prototype) and is consistent with the Design Science Research Method (DSRM) [9]. Thoroughly it captures the readiness and requirements that affect EMR s in the Mekelle Public Health Center.

#### D. Source Population

The source population is employees in Mekelle Public Health Center.

#### E. Study Population

The study participants were health professionals employed at the health center. Six individuals from each designated group (units within the center) were selected and interviewed.

#### F. Sample Size Determination

Guest et al. propose that the sample size for qualitative research studies, especially in homogeneous groups, ranges from 5 to 20 interviews and 12 participants in homogenous groups are acceptable to avoid saturation [4]. Therefore, the ideal sample size of the target respondents is determined to be 6 interview participants from each unit head and overall, the Mekelle Health Center administration.

#### G. Data Collection Tool and Procedure

In this study, basic data collection procedures are used. A qualitative study using semi-structured interviews, observation, and document analysis were the main data collection tools utilized.

### IV. PROPOSED SYSTEM

#### A. Functional Requirements

This project can pose a solution and opportunity to the health center by overhauling the previous archaic system of recording patient data and transitioning to a design that is effectively more seamless, cheaper, and more capable of protecting patient privacy. These capabilities will include ensuring data are well organized: which is beneficial for both the patients and the employees of the organization. This is particularly important as employee absences can often result in delays in receiving patient information as information is within an employee's

knowledge rather than in a cohesive and easily accessible online database. Another capability included the creation of patient profiles. This will allow for the information of new patients to be stored in a cohesive database. This process will also simplify searching for a patient's profile. In the existing system, if a patient has lost their ID card, finding their information is extremely difficult. If a customer's information was not found the customer could be forced to pay additional money. In the new system, this will be minimized.

The system will also allow for recording a patient's status and will allow medical professionals or other entities of the organization to share profiles. between them. It will also save time and increase efficiency as the professional is not burdened with the requirement of searching the card room for the patient's information and will instead receive the patient's laboratory results while he is at his desk. Generating patients' reports will also be done relatively easily.

#### *B. Nonfunctional Requirements*

In addition to the benefits described above, the system will also be able to provide the following nonfunctional requirements:

- **Accessibility:** The system should be accessible all the time and should be accessible only by the organizations' employees not by anyone else.
- **Usability:** The system allows the organization's employees to manage patients by adding, updating, deleting, and ordering referrals, diagnoses, and lab tests.
- **Documentation:** Patient data (anonymized) can provide critical information to government, post-secondary institutions, and other research bodies wishing to conduct studies on the health outcomes of the citizens of the city.

#### *C. Hardware and Software Considerations*

Most software systems define two sets of system requirements: minimum and recommended. As a system is used more and faces increasing demand, higher processing power and system requirements will be needed over time. Minimum software requirements allow the system to function but demands such as adding more patients to a register, or adding space for more notes, call for increased power. Here the requirements can be viewed in two directions, the user side and the administrator/organizational side.

#### *D. Hardware Requirements*

Hardware is a common set of requirements. The most widely used components of specifications established by an operating system or software program relate to the hardware, or physical computer resources. A hardware compatibility list (HCL) is frequently included with a hardware requirements list, especially for operating systems. For a particular operating system or software, an HCL details hardware elements that have undergone evaluation, are deemed compatible, and sometimes aren't. There are sub-sections of hardware requirements such as: processing power: x86 architecture, Intel Pentium CPUs, Memory & Secondary storage, RAM: 512 MB and above, 50GB Hard disk and swap space (if RAM is insufficient).

- **Peripherals,** such as CD-ROM drives and network devices, as well as the necessary software requirements.
- **Platform:** Typical platforms include a computer's architecture.
- **Operating system,** such as Microsoft Windows XP, Programming languages and Runtime libraries.
- **Web browser:** It supports all Internet browser applications, but MS window Internet Explorer is recommended.
- **Other requirements** include desktop/laptop computers having a minimum of 128MB of RAM and a typical storage capacity and processing speed, uninterrupted power supply, Internet connection (dialup, if possible, broadband), and database server computers and web server computers having more than 256MB of RAM and high storage capacity and processing speed.

#### *E. Quality Issues*

To keep the quality of the system when it functions, there are basic considerations determined as requirements for reliability, user requirements, and system portability.

- **Requirement for reliability:** Computers with good processing speed, memory and storage capacity for backup and Local Area Network (LAN) and internet connection.
- **User requirement:** Technical issues, for example user friendly pages, layout convention and analysis of the algorithm.
- **System Portability:** The capability of a system to be easily moved and operated in different environments or on different platforms with minimal modifications.

#### *F. Security Issues*

##### *1. System Security*

This issue encompasses measures taken throughout the application's life cycle to prevent exceptions in the security policy of the system through flaws in the design, development, deployment, gradation, or maintenance of the application. To prevent threats, vulnerability, and attacks, the system will provide different access privileges for the system administrator and the health center staff. The system also will have countermeasures that address a threat and mitigate risk.

In general, to make the system asset safe the system will follow a role-based security which means the access level and privilege for each builder of the collection is predefined by the system administrator. The end users of the system most of the time will not be asked for authorization login.

##### *2. Physical Security*

The asset or data of the system or the developed bio data of the patient will be kept in the server on which the system is running. The server and the other devices that are needed to develop the EDR are kept in secured and air-conditioned rooms. Any user who uses the system shall have a username and password. Any modification (Insert, Delete, and Update) must be done by a user who has administrative rights. The card section can create new patients' profiles, but they cannot delete any patient information. The administrator will have full access to the system.

## Use Case Diagram



Fig. 1 Use case

### G. User Interface and Human Factors

The user interface shall be visible for at least 5 seconds after getting to the network. The system will be easy to use and there will not be any complicated steps for the user.

### H. Performance Characteristics

A good information system should be able to enhance communication among employees and deliver complex material throughout an organization.

### I. Error Handling and Extreme Conditions

The system is in place to prevent failure and prevent it from recording redundant data on the system. The team members have tried their best to find necessary solutions. For instance, every new patient recording in the text box should be filled to fill in all important data.

In general, the system uses necessary validation. In another way, if an individual tries to access the system with the wrong password or username, a message will appear that the system is

prevented from being accessed by an authorized user.

## Class Diagram

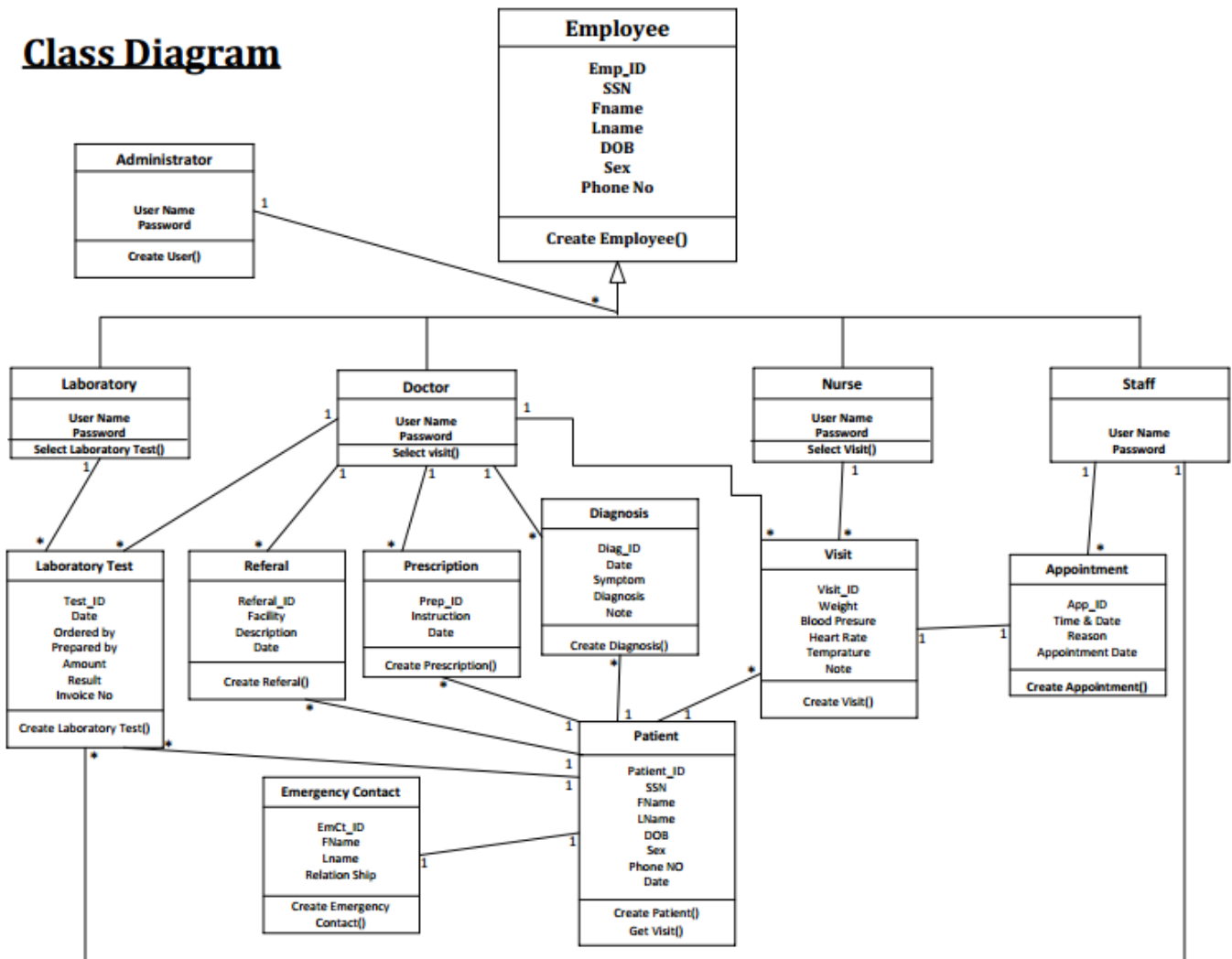


Fig. 2 Class diagram

### J. System Modification

In the future, it is hoped that the system can be modified to work on smartphones, make it open-source software, and train people how to use the system.

### K. Feasibility Study

To bring the successful completion of this project's goals and objectives the feasibility issues listed below have determined the project viability or the discipline of planning, organizing, and managing resources.

### L. Technology and System Feasibility

This involves questions such as whether most of the technology needed for the system exists in the Mekelle Health Center. Because the system is customized according to the Mekelle health center system there will be no difficulty building the EMRS, and also the staff and other concerned bodies have or will have enough experience using this system.

### M. Operational Feasibility

Currently, there is no existing system in the case of Mekelle Health Center so this system will be implemented in the center for the first time. The system will provide adequate thought at the desired time to the user and also give the needed information in a timely usefully formatted way. The system also has security to give access privileges providing an account for an authorized person. There is a place that does not need security or privilege to access for all uses like general information.

### N. Technical Feasibility

This system provides a helpful description to the user about how to use the system. Other technical modifications to the system are done by the developers.

### O. Economic Feasibility

As cost/benefit analysis shows the system is developed at minimum cost while providing ample benefits to the patients and employees of the center. Although money to train

employees on the use of the system will be required, this cost will be offset by the savings generated through the benefits described above.

*P. System Diagram/Model*

3. Use Case Diagrams

A use case diagram is a visual representation used in software engineering to depict the interactions between users (or other systems) and the system being designed. It helps to identify and clarify the requirements of the system by showing how different actors (users or external systems) will use various functions of the system.

4. Use Case Description

Staff, administrators, nurses, and laboratories will log in to their accounts and staff will be able to manage patients and appointments. Doctors will be able to create diagnosis,

laboratory and referral, and manage prescriptions. Laboratories can create and search laboratory orders. Admins manage the whole user.

5. Class Diagram

A class diagram provides a clear overview of the system's structure, helping software developers and stakeholders understand the organization of classes and their relationships in the software architecture.

6. Sequence Diagram

A sequence diagram effectively captures the flow of control between objects, detailing the sequence of operations and the interactions needed to achieve a specific functionality within the system. It helps in understanding how various parts of the system collaborate to carry out a process or a use case.

**System Sequence Diagram  
 For Managing Laboratory**

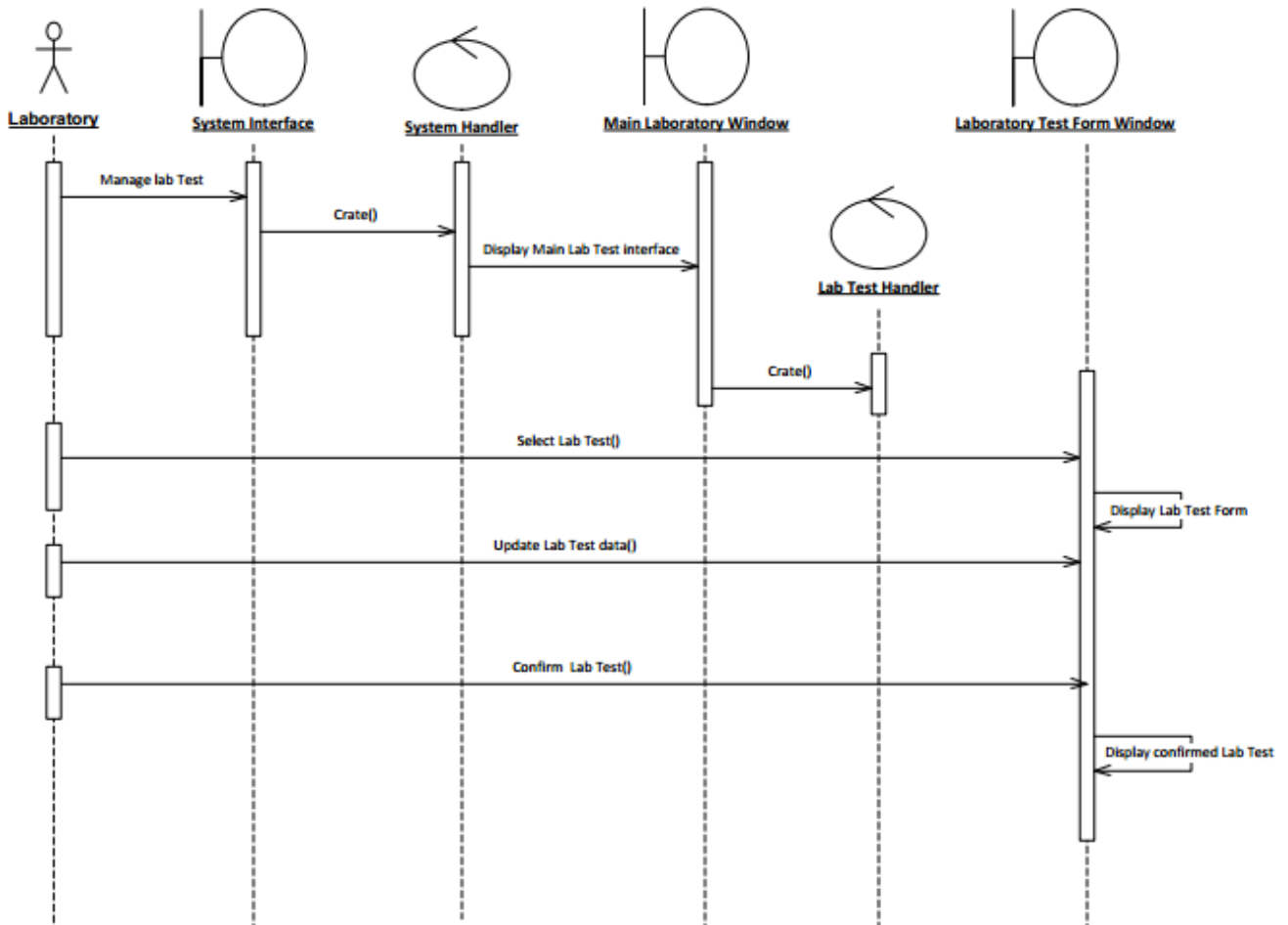


Fig. 3 System sequence diagram for managing laboratory



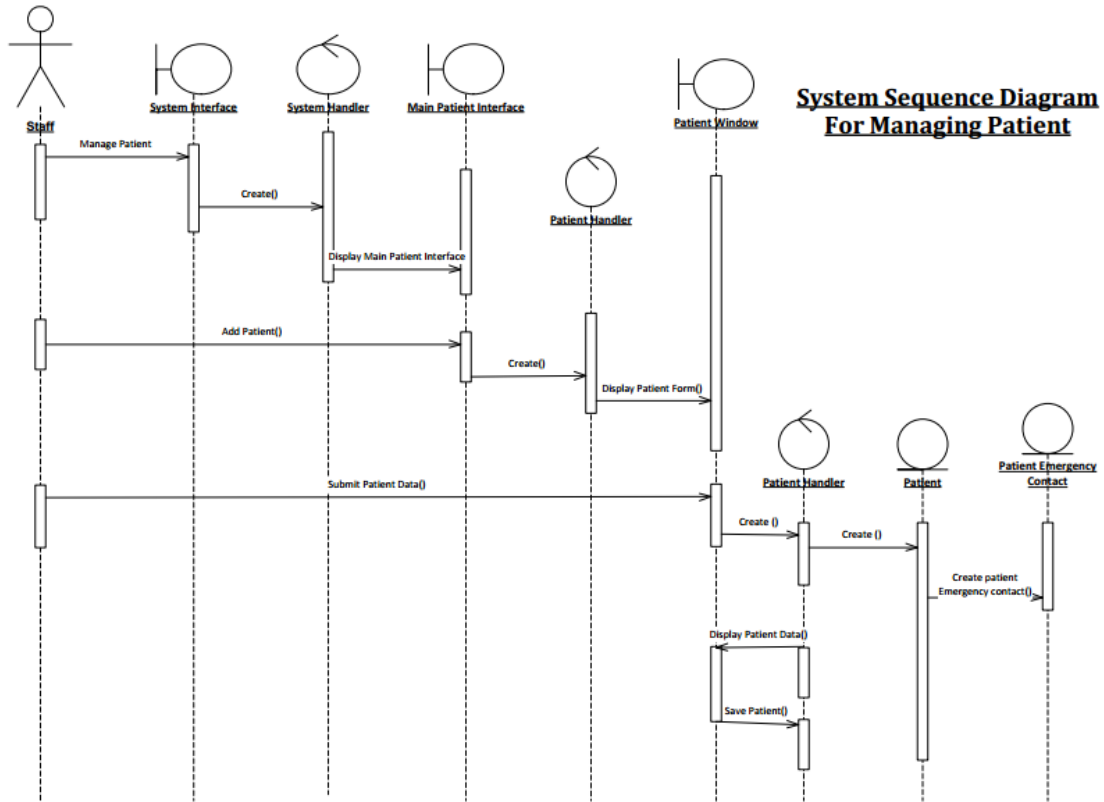


Fig. 4 System sequence diagram for managing patients

**System Sequence Diagram For Managing Prescription**

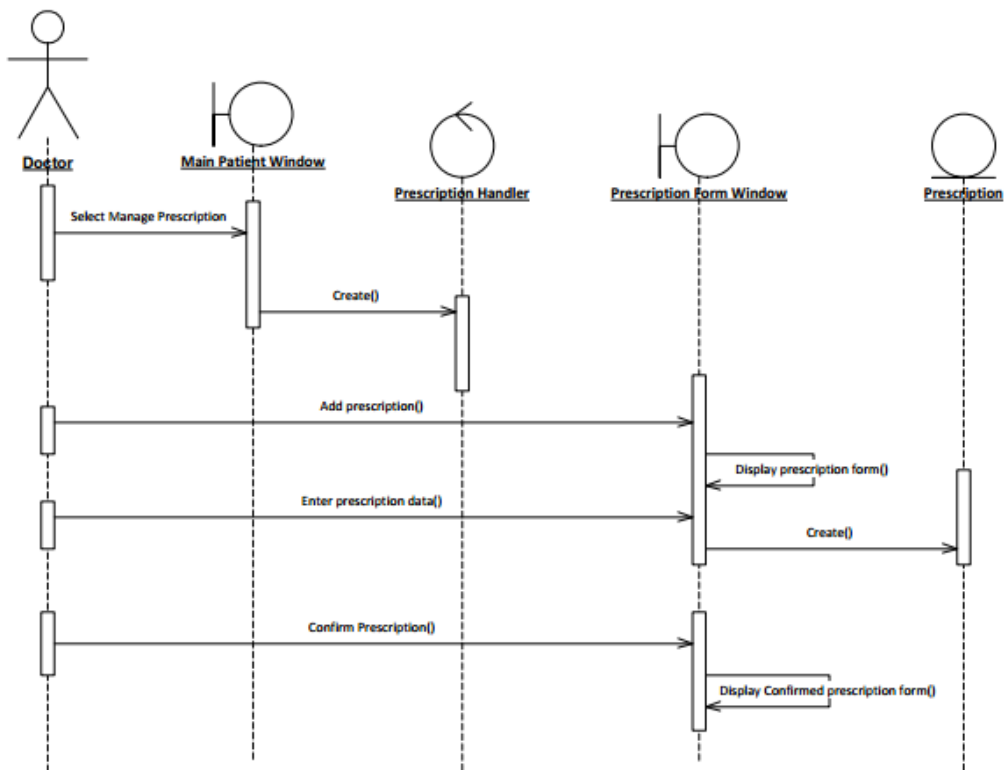


Fig. 5 System sequence diagram for managing prescriptions

### System Sequence Diagram For Creating Laboratory Test

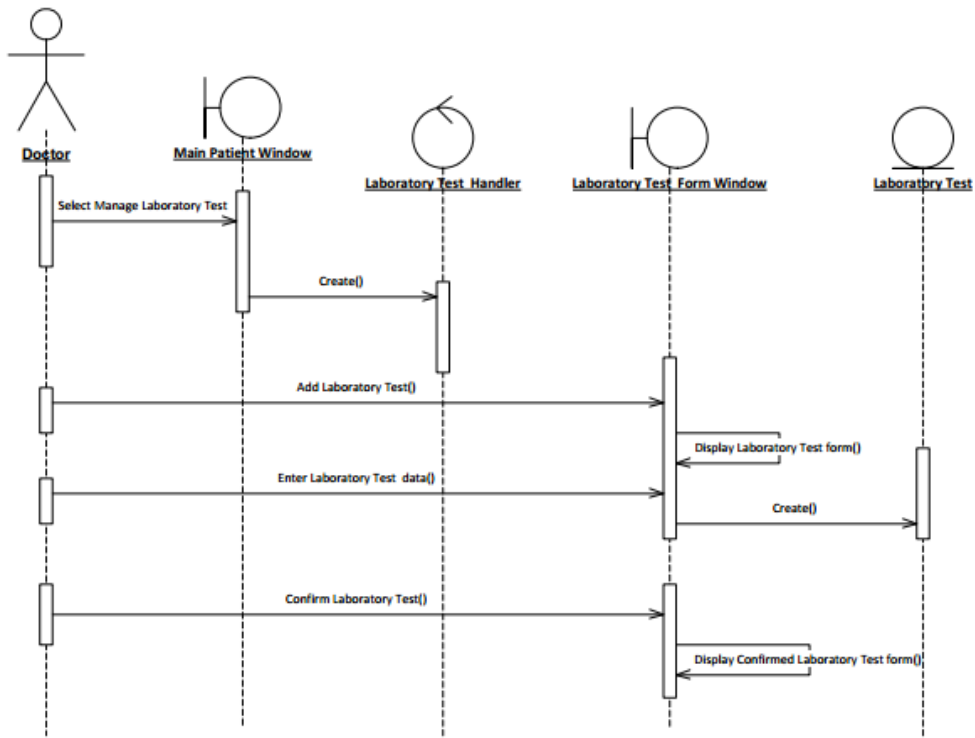


Fig. 6 System sequence diagram for creating laboratory test

### System Sequence Diagram For Managing Referral

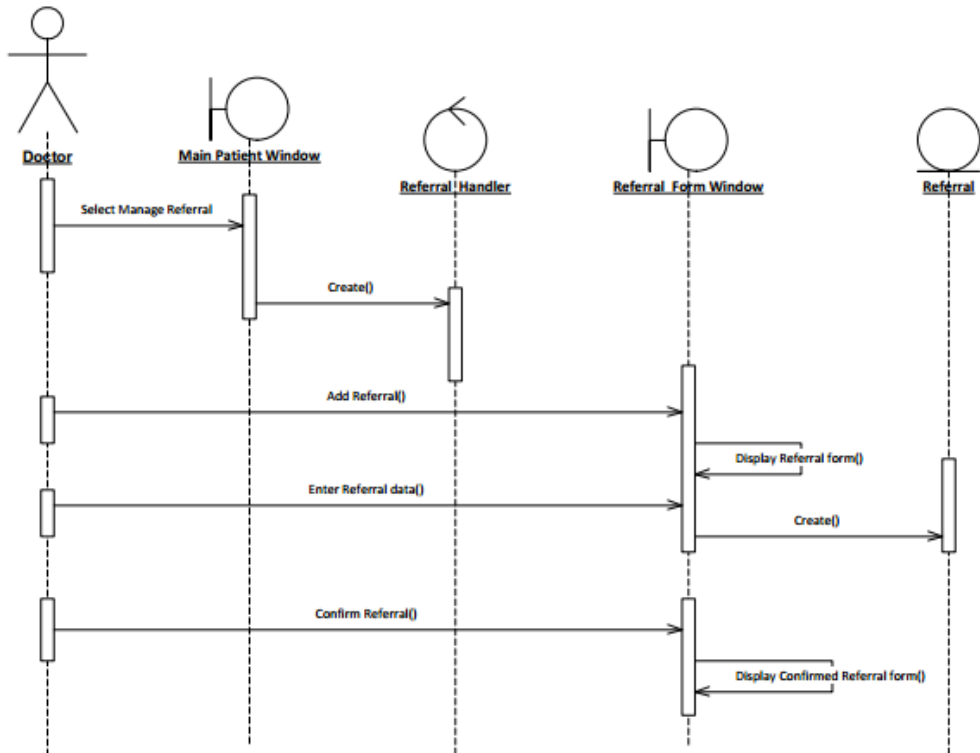


Fig. 7 System sequence diagram for managing referral

**System Sequence Diagram  
 For Managing Diagnosis**

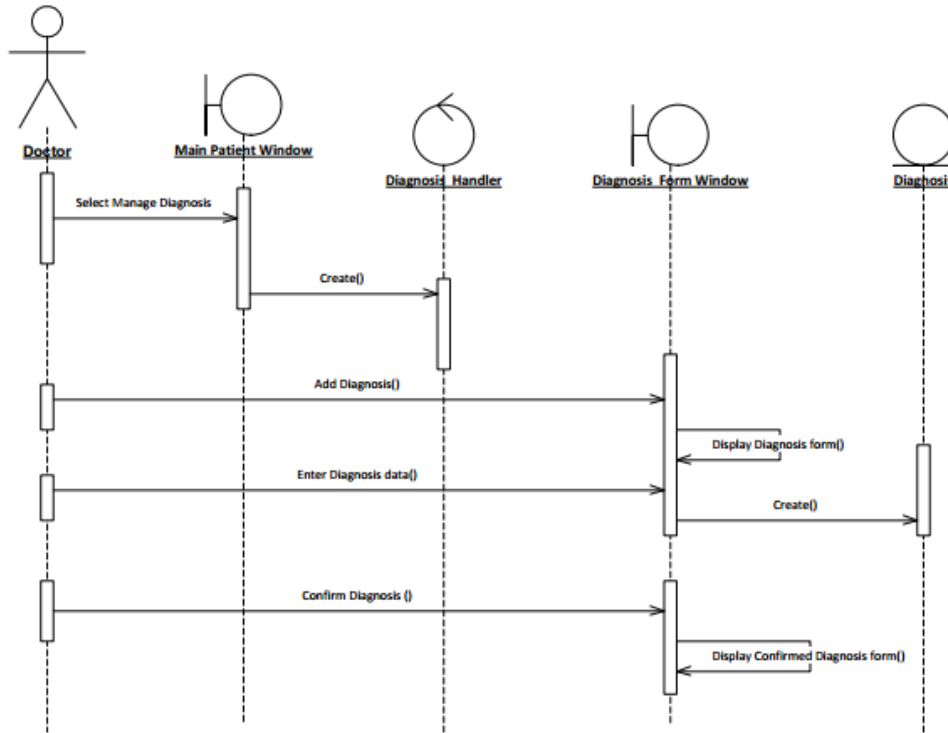


Fig. 8 System sequence diagram for managing diagnosis

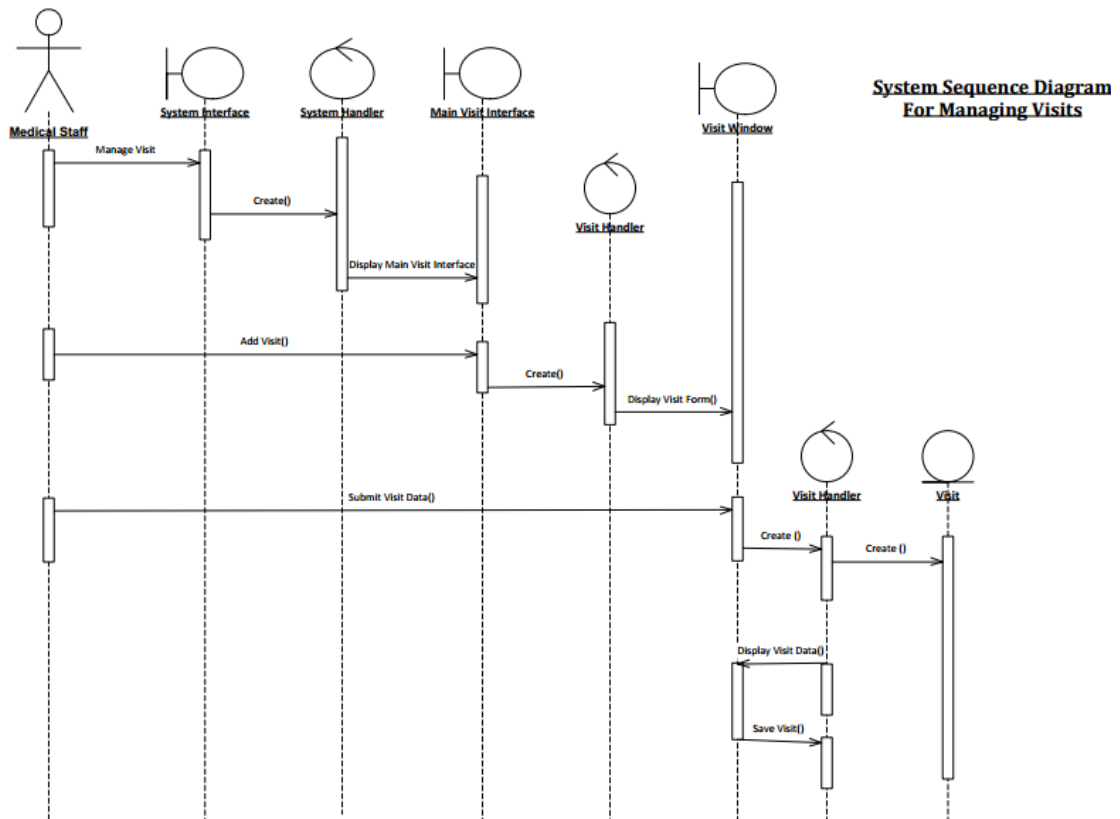


Fig. 9 System sequence diagram for managing visits

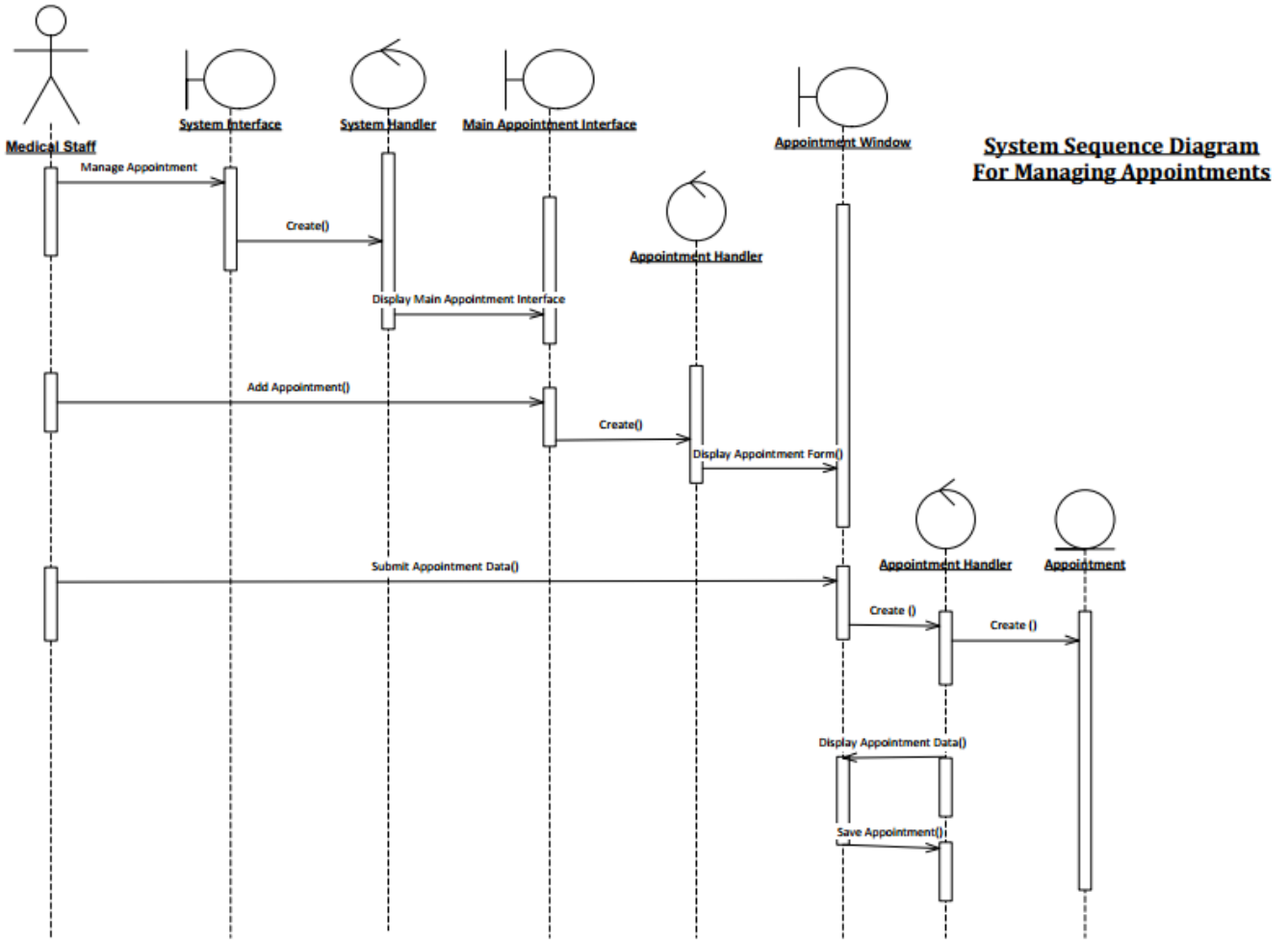


Fig. 10 System sequence diagram for managing appointments



Fig. 11 User interface

## V. DESIGN CONTENTS

### A. Introduction

The design contains what is needed for the employees to log in and access their accounts easily. The purpose of the system is to store patients' records and control the actions of the staff members from anywhere at any time. It saves time, energy, and money. It motivates the patients to book their appointments and prescriptions and discourages the use of physical paperwork.

### B. Purpose of the System

It motivates the patients to book for their appointments and prescription. They do not need to hold on to paperwork.

### C. Design Goals

The goal of the design is to make it as welcoming as possible. It has been made to be a simple way to log in and access any information that suits their business.

### D. User Interface Design

The user interference was made in a welcoming and comfortable way. The colors were chosen to suit the purpose of the website and also allow for ease of access (simple font, lack of bright distracting colors, clear design layout).

### E. Admin

An admin is a person responsible for overseeing and

managing the operations and functionalities of a system, organization, or network.

### Add New Employee

Form fields: First Name, Last Name, DOB (mm/dd/yyyy), Sex (Male), e-mail, Tel-Phone (Phone), SSN, Kebele, K-Kelema, Date (mm/dd/yyyy). Submit button.

Fig. 12 Add new employee

### Add New Doctor

Form fields: Username, Password, Employee ID. Submit button.

Fig. 13 Add new doctor

Website header: TEST CLINIC. Navigation: Home, Adminstrator, Staff, Nurse, Doctor, Laboratory, Employee, Patient History, Search Employee, Search Patient. Sidebar: Add, Patient, Diagnosis, Laborder, Prescription, Referral, Visit, Appointment, Emergency Contact, Blood Chemistry, Complete Blood. Form: Add New Staff, Username, Password, Employee ID, Submit.

Fig. 14 Add new staff

### F. Doctors

Doctors are responsible for accurately and thoroughly documenting patient encounters, medical history, diagnoses, treatments, and any other relevant information in the EMR. This includes entering notes, orders, prescriptions, and other clinical data into the system.

### New Diagnosis

Form fields: Patient ID, Employee ID (doctor), Date (mm/dd/yyyy), Symptom, Diagnosis, Note. Submit button.

Fig. 15 New diagnosis

### New Prescription

ID:  Date:

prescription 1	dose 1	time 1
prescription 2	dose 2	time 2
prescription 3	dose 3	time 3
prescription 4	dose 4	time 4

Ordered by:

Fig. 16 New prescription

### New Referral

Date:

Patient ID:

Referred By:

Referred From:  Referred To:

Description:

Treatment Given:

Fig. 17 New referral

#### G.Laboratory

The laboratory can receive and process orders for diagnostic tests directly from the EMR. This helps ensure that test orders are accurately captured and can be efficiently processed. The laboratory can directly upload and integrate test results into the patient's EMR.

#### Laborder

Ordered By:

Patient:

Test Type:

Date:

Fig. 18 Lab order

#### Patients' Emergency Contact

ID	First Name	Last Name	Phone	Relation Ship	Patient ID
1	bhatar	singh	914703030	brother	2
2	123				0
3	ftsum	feleke	0914732432	friend	8

Fig. 19 Patient's emergency contact

#### Patients

ID	First Name	Last Name	Age	Sex	e-mail	Phone	SSN	Kebele	K/Ketema	Date
5	abdat	osman	21	Male	hggfvhghg	12345	123444	11	k/weyana	2018-05-09
7	g/kiros	g/mariam	55	Male	e@email.com	0914589056	1345	04	dearo	2018-05-07
8	brhane	hivot	28	Male	brea@gmail.com	0914705050	345/1998	18	hawelti	2018-05-02

Fig. 20 Patients



Laborder

ID	Ordered by	Patient ID	Name ID	Test Type	Date	Approval	Test Status
2	admin	5	abdat osman	cbc	2018-05-07	Approved	
3	admin	11		bct	2018-05-07		
4	doctor	5	abdat osman	cbc	2018-05-09	Approved	Tested
5	doctor	5	abdat osman	cbc	2018-04-10	Approved	Tested
6	doctor	8	brhane hiwot	cbc	2018-05-02	Approved	Tested
7	doctor	8	brhane hiwot	cbc	2018-05-01	Approved	Tested
8	doctor	5	abdat osman	BCT	2018-05-06	Approved	Untested
9	doctor	5	abdat osman	CBC	2018-05-08	Approved	Untested
10	doctor	5	abdat osman	Urine	2018-05-05	Approved	Untested
11	doctor	5	abdat osman	Stool	2018-05-09	Approved	Untested
12	doctor	8	brhane hiwot	Serology	2018-05-02	Approved	Untested
13	doctor	9		CBC	2018-05-01	Approved	Tested
14	doctor	9		BCT	2018-05-16	Approved	Untested
15	doctor	5	abdat osman	Urine	2018-05-19	Approved	Untested
16	doctor	8	brhane hiwot	BCT	2018-05-29	Approved	Untested

Fig. 21 Lab order result

Search For Employee

search for employee...

ID	First Name	Last Name	Birth day	Sex	e-mail	Phone	SSN	Kebele	K/Ketema	Date
0	Anwar	Bladgigne	1999-05-23	Male	Anwarbargo@gmail.com	0912345678	1253/2004	11	5	2018-02-03

Fig. 22 Search for employee

Lab Order

ID	Ordered by	Patient ID	Name	Test Type	Date	Test	Tested
8	doctor	5	abdat	BCT	05/06/2018	<input type="button" value="Test"/>	<input type="button" value="Tested"/>
9	doctor	5	abdat	CBC	05/08/2018	<input type="button" value="Test"/>	<input type="button" value="Tested"/>
10	doctor	5	abdat	Urine	05/05/2018	<input type="button" value="Test"/>	<input type="button" value="Tested"/>
11	doctor	5	abdat	Stool	05/09/2018	<input type="button" value="Test"/>	<input type="button" value="Tested"/>
12	doctor	8	brhane	Serology	05/02/2018	<input type="button" value="Test"/>	<input type="button" value="Tested"/>
14	doctor	9	readonly	BCT	05/16/2018	<input type="button" value="Test"/>	<input type="button" value="Tested"/>
15	doctor	5	abdat	Urine	05/19/2018	<input type="button" value="Test"/>	<input type="button" value="Tested"/>
16	doctor	8	brhane	BCT	05/29/2018	<input type="button" value="Test"/>	<input type="button" value="Tested"/>

Fig. 23 Lab order

Blood Chemistry Test

Physician:  Doctor:

Patient ID:  Date:

Patient Status:  Room No:  Bed No:

Bun	<input type="text" value="Bun1"/>	<input type="text" value="Bun2"/>	Glucose	<input type="text" value="Glucose1"/>	<input type="text" value="Glucose2"/>	Uric acid	<input type="text" value="Uric acid1"/>	<input type="text" value="Uric acid2"/>
Creatinine	<input type="text" value="Creatinine1"/>	<input type="text" value="Creatinine2"/>	RBS	<input type="text" value="RBS1"/>	<input type="text" value="RBS2"/>	Acid phosphoates	<input type="text" value="Acid phosphi"/>	<input type="text" value="Acid phosphi"/>
Sgot	<input type="text" value="Sgot1"/>	<input type="text" value="Sgot2"/>	FBS	<input type="text" value="FBS1"/>	<input type="text" value="FBS2"/>	Amylase	<input type="text" value="Amylase1"/>	<input type="text" value="Amylase2"/>
Sgpt	<input type="text" value="Sgpt1"/>	<input type="text" value="Sgpt2"/>	PP	<input type="text" value="PP1"/>	<input type="text" value="PP2"/>	Lipase	<input type="text" value="Lipase1"/>	<input type="text" value="Lipase2"/>
Bilirubin	<input type="text" value="Bilirubin1"/>	<input type="text" value="Bilirubin2"/>	Sodium	<input type="text" value="Sodium1"/>	<input type="text" value="Sodium2"/>	Lipid Profile	<input type="text" value="Lipid Profile1"/>	<input type="text" value="Lipid Profile2"/>
Alkaline Phosphatase	<input type="text" value="Alkaline Pho"/>	<input type="text" value="Alkaline Pho"/>	LDL Chol	<input type="text" value="LDL Chol1"/>	<input type="text" value="LDL Chol2"/>	Chloride	<input type="text" value="Chloride1"/>	<input type="text" value="Chloride2"/>
GGT	<input type="text" value="GGT1"/>	<input type="text" value="GGT2"/>	HDI Chol	<input type="text" value="HDL Chol1"/>	<input type="text" value="HDL Chol2"/>	Calcium	<input type="text" value="Calcium1"/>	<input type="text" value="Calcium2"/>

Fig. 24 Blood chemistry test

### Complete Blood Test

Physician:	lab		Doctor:	D Name	
Patient ID:	Patient ID	Date:	mm/dd/yyyy		
Patient Status:	Ambulatory	Room No:	Room No	Bed No:	Bed No
Hemoglobin	Hemoglobin1	Hemoglobin2	Platelets	Platelets1	Platelets2
Hematocrit	Hematocrit1	Hematocrit2	ESR	ESR1	ESR2
MVC	MVC1	MVC2	Bleeding Time	Bleeding Time1	Bleeding Time
MCH	MCH1	MCH2	Coagulation	Coagulation1	Coagulation2
MCHC	MCHC1	MCHC2	Fibrinogen	Fibrinogen1	Fibrinogen2
RBC	RBC1	RBC2	PT	PT1	PT2
Reticulocytes	Reticulocytes1	Reticulocytes2	PTT	PTT1	PTT2

Fig. 25 Complete blood test

### Serology Test

Physician:	lab		Doctor:	doctor name	
Patient ID:	patient id				
Date:	mm/dd/yyyy	Patient status:	Ambulatory	Roomno:	roomno
		Bedno:	bedno		
vdr:	vdr	rpr:	rpr	heterophile:	heterophile
rheumatoid:	rheumatoid	cold:	cold	creative:	creative
aso:	aso	widal:	widal	well:	well
brucella:	brucella	australian:	australian	hbs:	hbs
hbe:	hbe	hcv:	hcv	toxoplasma:	toxoplasma
igm:	igm	coombs:	coombs	direct:	direct
indirect:	indirect	hiv1orv:	hiv1orv	hla:	hla

Fig. 26 Serology test

### Stool Examination

Physician:	lab		Doctor:	doctor	
Patient ID:	patient id	Patient Name:	pname	Age:	age
		Sex:	Male		
Status:	Ambulatory	Roomno:	roomno	Bedno:	bedno
		Date:	mm/dd/yyyy		
request:	request	appearance:	appearance		
consistency:	consistency	pus:	pus		
mucus:	mucus	gross:	gross		
occult:	occult	ova:	ova		
bacteria:	bacteria	concentration:	concentration		

Fig. 27 Stool examination

#### H.Nurse

Nurses access the patient record to review and update the patient's information such as appointments, new visit and

patient's emergency contact. They review and update medication orders as needed.



## Appointments

ID	Date	Appointmnet	Patient ID	Name	Visit	✓
4	2018-05-23	2018-05-24	8	brhane hiwot	Visit	✓
3	2018-05-03	2018-05-09	5	abdat osman	Visit	✓
2	2018-05-15	2018-05-16	5	abdat osman	Visit	✓
1	2018-05-07	2018-05-12	5	abdat osman	Visit	✓

Fig. 28 Appointments

## Patients

ID	First Name	Last Name	Age	Sex	e-mail	Phone	SSN	Kebele	K/Ketema	Date
5	abdat	osman	21	Male	hggfvhghg	12345	123444	11	k/weyane	2018-05-09
7	g/kiros	g/mariam	55	Male	e@email.com	0914589056	1345	04	dearo	2018-05-07
8	brhane	hiwot	28	Male	brea@gmail.com	0914705050	345/1998	18	hawelti	2018-05-02

Fig. 29 Patients

## New Visit

Date:

Patient ID:  Employee:

Weight:  Blood Pressure:  Heart Rate:  Temperature:

Note:

Fig. 30 New visit

## Patients' Emergency Contact

ID	First Name	Last Name	Phone	Relation Ship	Patient ID
1	bhatar	singh	914703030	brother	2
2	123				0
3	ftsum	feleke	0914732432	friend	8

Fig. 31 Patients' Emergency contact

## Appointments

ID	Date	Appointmnet	Patient ID	Name	Employee
1	2018-05-07	2018-05-12	5	abdat osman	staff
2	2018-05-15	2018-05-16	5	abdat osman	staff
3	2018-05-03	2018-05-09	5	abdat osman	staff
4	2018-05-23	2018-05-24	8	brhane hiwot	staff
5	2018-05-25	2018-06-13	9		staff
6	2018-05-26	2018-06-02	7	g/kiros g/mariam	staff
7	2018-05-26	2018-06-05	5	abdat osman	staff
8	2018-06-02	2018-06-06	5	abdat osman	staff

Fig. 32 Appointments

### I. Staffs

Staff can access and update the patient record, review and update medication orders, create and update notes, as well as manage the appointment schedule.

## VI. IMPLEMENTATION

### A. Introduction

This chapter highlights the actual system implementation. The system was transformed from a user requirement for a

functional product. The goal of the system implementation was to ensure that the correct application reaches the end user. This chapter will also highlight how the testing is done to confirm that it meets the user requirements.

### B. Coding

Coding, also known as computer programming, is the process of writing and developing instructions that a computer can understand and execute. It involves creating a set of rules or algorithms that tell a computer how to perform a specific task or solve a problem.

#### Add New Patient

Fig. 33 Add new patients

### C. Hardware and Software Acquisition

Acquiring hardware and software was relatively easy but the main restriction was the lack of time.

## New Appointment

Fig. 34 New appointment

#### Emergency Contact

Fig. 35 Emergency contact information

### D. Data Preparation

The data were prepared shortly using several mechanisms such as PHP codes, HTML, MySQL, and Java scripts. The data were prepared carefully and have been tested, which worked well.

```

<?php
session_start();
if (isset($_POST['submit'])) {
    $user = $_POST['username'];
    $pwd = $_POST['pwd'];

    $con = mysqli_connect("localhost", "abdat", "password", "prms");
    if (!$con) {
        die("Can Not Connect:" . mysqli_connect_error());
    }
    if (empty($user) || empty($pwd)) {
        echo "Please enter Username and Password";
    } else {
        $user = strip_tags($user);
        $user = $con->real_escape_string($user);
        $pwd = strip_tags($pwd);
        $pwd = $con->real_escape_string($pwd);

        $sql = $con->query("SELECT emp_id, username FROM admin WHERE username='$user' AND password='$pwd'");
        if ($sql->num_rows == 1) {
            while ($row=$sql->fetch_assoc()) {
                $_SESSION['admin_id'] = $user;
            }
            header('Location: adminhome.html');
        } else {
            echo "Enter correct Username or Password";
        }
    }
}
    
```

Fig. 36 Sample Coding

## Log In

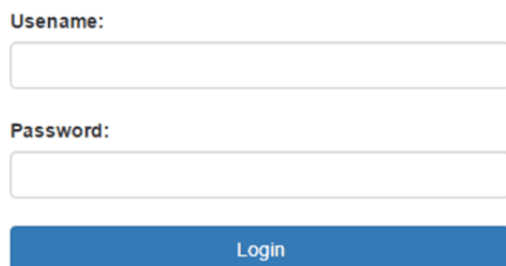


Fig. 37 Log in Interface

## Add New Patient

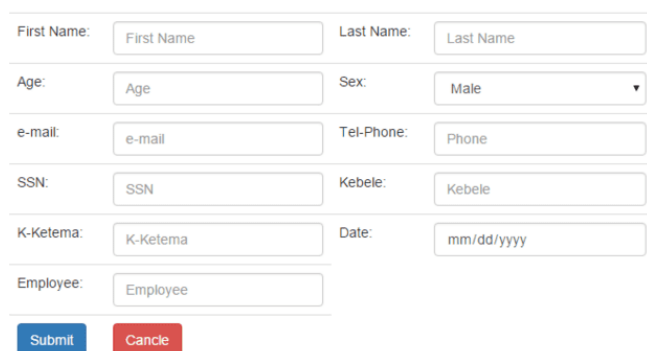


Fig. 38 Adding new patient

### E. Installation

Installing the system was a little more difficult due to the limitation of time. This was especially pertinent as servers and browsers were needed that the system could work on.

### F. Testing

The main concern of this project is to develop problem-solving software for the patient record management system. This process involves correctness, reliability, and security. Therefore, each module has been tested in line with the functions and forms of the system for its performance, reliability, and correctness. In this phase, every possible error that might occur has been tested.

### G. Startup Strategies

Some strategies are needed to start up the system. One main strategy is the health care centers need to have an Xampp server and any kind of browser that works with the system. It must secure the patients' information and take it seriously. On the other hand, the employees should be members of the healthcare centers and the utmost importance must be placed on ensuring that usernames and passwords are not shared with anyone.

### H. Maintenance

Maintaining the system might be difficult and should be taken seriously. The health center requires the budget to train existing and new employees with lectures and materials chosen carefully.

## VII. CONCLUSION AND RECOMMENDATION

### A. Conclusion

Based on the major findings of the study, several implications could be derived from the e-record practices. As discussed in the previous chapters the main problem addressed was the difficulty in dealing with patients' medical documents. This situation drove the need to develop the Patient Information Management System to be used at the Health Center in Mekelle. The project has implemented most of the objectives specified in the earlier chapters mostly surrounding patient privacy, system efficiency, and cost-savings. The patient record management system offers many benefits to the user and can capture data, store, view, add, and delete the records entered in the database, and can also be used to post information to the database. Problems met during Data Collection include the release of sensitive information which required the use of safeguarding mechanisms to ensure that this information was distributed and accessed by as few people as possible. In addition, conducting a literature review was difficult as few projects and books were written about patient records management systems, especially within the context of a developing region like Mekelle. Problems met during system design included lack of time to complete the work, and limited numbers of computers with internet in the faculty, making it difficult to download PHP codes from the internet.

Mekelle Health Center still has many manual practices that are causing unnecessary delays for both patients and workers. The majority of the staff at the Center would agree to the need for a complete EMR system that is accessible anywhere in Mekelle and can handle patient records and reporting. Patients and medical practitioners are interested in a web based EMR system for government hospitals that have a patient portal so patients can access their reports and make appointments for their check-ups themselves. More studies need to be carried out regarding options for web based EMR systems that would meet the requirements of developing nations such as Ethiopia.

### B. Recommendations

The finding of the study explicitly implied that there were problems in medical e-record system practice especially in regard to capturing, recording, and documenting of medical practices. This resulted in various problems related to the provision of e-records in the healthcare system at large. Training of all the members of the staff in the hospital to familiarize themselves with the system will also be important. This being a new system, some members of staff might feel threatened that the digitized patient records management system will replace their jobs. Education by the management of the hospital to ensure that staff know how this system will operate and how it will supplement and ease their efforts is crucial.

For the efficiency of the hospital, users of the system need to be thoroughly educated about the use of passwords and staff names, as well as the need to ensure that the greatest precaution is used to safeguard them. Access to the server room should be physically secured against unauthorized persons; the server

room should be dust-free and should be fully protected and should have an air conditioner to prevent the server from overheating. Backup media like CDs, Diskettes, and Flash disks can be used for backups and storage of data.

*C. Recommendations for Future Studies*

Like any other research project study, this study has inevitably had its limitations that could lend as pathways of understanding for future studies as well as researchers who are interested in conducting research projects in this area. Furthermore, the information generated will also inform future validation studies, to increase the acceptability of system practices in the local language in the Tigray region.

APPENDIX

የአገልግሎት መታወቂያ ካርድ  
 SERVICE IDENTIFICATION CARD  
 የጤና ድርጅት ስም  
 FACILITY NAME  
 በጤና ድርጅት የተመዘገቡበት ቀን  
 DATE OF REGISTRATION  
 የህክምና ካርድ ቁጥር  
 MEDICAL RECORD NUMBER  
 ስም ስድሜ ስጾ  
 NAME AGE SEX

Fig. 39 Service identification card

MEKELE HEALTH CENTER  
 REFERRAL SLIP  
 Name \_\_\_\_\_  
 Age \_\_\_\_\_ Sex \_\_\_\_\_ Address \_\_\_\_\_  
 Date \_\_\_\_\_ Card No. \_\_\_\_\_  
 History of Present illness  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 Impression \_\_\_\_\_  
 Lab results \_\_\_\_\_  
 Treatment given \_\_\_\_\_  
 Reason for referral \_\_\_\_\_  
 Referred by \_\_\_\_\_ Signature \_\_\_\_\_

Fig. 41 Referral slip

MEKELLE HEALTH CENTER  
 Prescription Paper  
 Receipt No. \_\_\_\_\_  
 Sig. \_\_\_\_\_  
 Name \_\_\_\_\_ Date \_\_\_\_\_  
 Age \_\_\_\_\_ Sex \_\_\_\_\_  
 MRN \_\_\_\_\_  
 Out-Patient  In-Patient Ward \_\_\_\_\_ OPD No. \_\_\_\_\_  
 City \_\_\_\_\_ Woreda \_\_\_\_\_ Kebele \_\_\_\_\_ Tel. No. \_\_\_\_\_  
 Diagnosis \_\_\_\_\_  
 RX \_\_\_\_\_  
 For dispenser use only  
 Unit Price Subtotal  
 TOTAL \_\_\_\_\_  
 Prescribed by \_\_\_\_\_ Dispensed by \_\_\_\_\_  
 Full Name \_\_\_\_\_  
 Qualification \_\_\_\_\_  
 Signature \_\_\_\_\_

Fig. 40 Prescription paper

ገዢው ገዢ  
 Ser-THB  
 ብሄራዊ ክልላዊ መንግስት ትግራይ  
 TIGRAY REGIONAL GOVERNMENT  
 ቢሮ ፋይናንስና ኢኮኖሚ ልማት  
 BUREAU OF FINANCE & ECONOMIC DEVELOPMENT  
 ትብብር  
 RECEIPT VOUCHER C NO 4602531  
 ስም መንግስታዊ ቤ/ዕለጸጸት  
 Name of Public Body \_\_\_\_\_  
 ተቀባይ ካለ  
 Received From \_\_\_\_\_  
 አድራሻ ክልል ዞን ወረዳ ጣቢያ ገዛ ቁጥር  
 Address Region Zone Woreda Kebele House No \_\_\_\_\_  
 ልክዕ ገንዘብ ብላግዝ (ብር)  
 Amount in Figure (Birr) 44  
 ልክዕ ገንዘብ ብሬደል (ብር)  
 Amount in Word (Birr) አርባ ስድስት ማዕታት ማዕታት  
 ምክንያት ለታዎ  
 Purpose \_\_\_\_\_  
 ለታዎ ዝተገበረሉ ሜላ ብቻክ ብትብብር ብገንዘብ ብተረጎገዘብ ብገደግደግ  
 Type of Receipt Check Deposit slip Cash Transfer  
 ገብላብ ክፍሉ ጥራሕ /For Accounts use Only/ Printed by Ataklti Tesfaye 0914 301382  

መደብ ብጀት	መደብ ሌላብ	ደብት	ክሬዲት	መብርሂ
Budget Category	Acc. Code	Debit	Credit	Remark
	436		43	
	37		8	
Total			44	

 ምን ክታዎን ዘላለዎ  
 Prepared by Name & Signature \_\_\_\_\_  
 ምን ክታዎን ገንዘብ ተቀባይ  
 Received by Name & Signature \_\_\_\_\_  
 ምን ክታዎን ብገንዘብ ምእት-ው ዘረጋገጸ  
 Approved For Bank Deposit Withholding & Signature \_\_\_\_\_  
 ጥንኡ ገዢ  
 Original-to Payer  
 ካልላይ-ገብላብ ክፍሉ  
 2nd Copy-to Account  
 ባልላይ ለብ ጥራ-ዝ ይቕመጥ  
 3rd Copy-Remains in Pad

Fig. 42 Receipt voucher



### Questions

- 1) When was the hospital established?
- 2) How many employees are available in the hospital?
- 3) What recording system are they using currently?
- 4) What are the problems that they (health center) are not using EMR?
- 5) What is their readiness if we implemented the system?
- 6) What is their awareness of technology?
- 7) What kind of information does the health center have about EMR?
- 8) What kind of ICT knowledge do the employees have?
- 9) What kind of service is given in the health center?
- 10) What will the new visitor (patient) have to do when first visiting the hospital?

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