Addis Ababa University

School of Information Science and School of Public Health

M.Sc in Health Informatics Programme

Mobile Based Emergency Reporting System for Infectious Disease Surveillance

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Title Page

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LIST OF ABBREVIATIONS/ ACRONYMS

AAU	Addis Ababa University
AHR	Automated Health Record
ART	Anti Retroviral Therapy
CDC	Center for Disease Control
CDSS	Clinical Decision Support System
CHW	Community Health Workers
EPHEM	Ethiopian Public Health Emergency Management
EVD	Ebola Virus Disease
FMOH	Federal Minister of Health
GIS	Geographical Information System
GPS	Global Position system
HEW	Health Extension Worker
HIS	Health Information System
HMIS	Health Management Information System
HW	Health Worker
ISDR	Integrated Disease Surveillance Regulatory
mCare	Mobile Care
NGO	Non Governmental Organization
NNDS	National Notifiable Diseases Surveillance System
OOAD	Object Oriented Analysis and Design
ORHB	Oromia Regional Health Bureau
PDA	Personal Digital Assistants
PHEM	Public Health Emergency Management
SARS	Severe Acute Respiratory Syndrome
SQL	Structured Query Language
UML	Unified Modeling Language
UNICEF	United Nations Children's Fund
VHF	Viral Hemorrhagic Fever
WHO	World Health Organization
ZHO	Zonal Health Office

ABSTRACT

Quick detection and response to emergency infectious disease is crucial. However, manual paper based reporting and response system has many shortcomings such as inability to report emergency infectious disease on time and the possibility of errors that can be committed during data entry.

The research project therefore, aimed to design Mobile based emergence reporting for infectious disease surveillance support system for Oromia Regional Health Bureau, in order to improve the use of mobile based reporting for infectious disease surveillance for making sound decision and alert response to prevent and to control communicable diseases.

A phased development, Object Oriented Analysis and Design (OOAD) methodology and iterative approach is applied to the study of the design system. Interview and document analysis were used as a main tool to capture the business system requirement along with observation. Unified modeling language (UML) development techniques, applied in the process of requirements capture, model organization business system and design. Argo UML and Visio Software were employed in analysis and design models diagramming.

Overall a Mobile based emergency reporting for infectious disease surveillance support system is developed that can be used for Oromia regional health office, in case of emergence of infectious disease outbreak to give response, feedback and alert early warning in a timely manner.

The researcher recommends the implementation of the design by the Oromia Regional Health Bureau or any concerned body including laboratory case reports, case based reporting, event-based surveillance such as events related to occurrence of disease in human and events related to potential risks for humans health that are not included under current design to realize the benefit of Mobile based Reporting and Response system.

Keywords: surveillance response system, mobile based, outbreak, emergency infection disease, Oromia Regional Health Bureau, UML

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND

In recent years, the continuous emergences of new infectious diseases have attracted significant attention globally. Such epidemic outbreak infectious diseases include Severe Acute Respiratory Syndrome (SARS), bird flu, and Lassa fever, Ebola, Dengue outbreaks which need on time report and response [1]. Moreover, manual paper based reporting and response system have many shortcomings such as inability to report emergency infectious disease on time and the possibility of errors that can be committed during data entry.

The early detection of outbreaks of disease has been a concern of public health because of the potential to reduce morbidity and mortality. Recently, however, public health has witnessed a course of development of new detection systems designed to provide more timely detection of outbreaks [2].

Without early detection of outbreaks of disease, it is impossible to track where disease is occurring, measure steps toward disease control targets, or provide an early warning system for outbreaks and the emergence of new diseases [3].In many human health projects in resource-challenged areas, mobile technologies have emerged as a promising solution for obtaining, transmitting, and analyzing human health information in a timely fashion [4].

Unfortunately, several countries in Africa, as well as governmental and research institutions are insufficiently equipped in diagnostics, tracking, active reporting, timely healthcare delivery, and nearby and reasonably priced treatment to contest the infection and other emerging infectious diseases. The development of new tools, strategies and approaches, such as improved diagnostics and novel therapies including vaccines, are needed to prevent, control and contain outbreaks[3].

Timely and effective reporting, documentation and communication of incidence and prevalence by all stakeholders including the health facility, district and Zonal health office, regional health bureau, health ministries, international and local NGOs, UN agencies, religious leaders, global health institutions and other stakeholders are paramount in early containment response [5].

On the other hands the World Health Organization (WHO) uses the term mobile Health (mHealth) as 'medical and public health practice supported by mobile devices, such as mobile phones, Smartphone, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices'. mHealth applications and programmes make use of several aspects of mobile technology such as text messaging, voice and video services and Internet connection [6]. With the introduction of multifunctional Smartphone technologies and rapid penetration of mobile phone networks in developing countries, mobile health (mHealth) applications are widely

perceived as potential solutions for addressing the needs and challenges of health workers and health systems [7].

The application of mobile and wireless technology in the health sector has the potential to change the face of global health systems [8]. The propagation of mobile phones has provided an influential communication channel to fortify health information systems [4]. Functional and structural properties of mobile phones, such as low start-up cost, text messaging, and flexible payment plans, make them attractive to use for contacts with patients and customers in various health care processes.

Often they are used to disseminate information to patients, but when used in conjunction with health care related software apps, they can also provide real time feedback needed to monitor treatment compliance or effect, response, alert to early warning and also serve as data collection tools. Further, back end systems connected to mobile phones have the capability to serve as platform for enabling preprogrammed, portable, automated services, which can make health care, and health information systems, increasingly decentralized [3].

The use of mobile and wireless devices to support medical and public health practice and research (mHealth) is gaining increased attention as it provides opportunities to rapidly connect people, reducing therefore delay across the chain of health decisions, and positively affecting the live of millions of underserved population [9]. The Information Technology branch considered most promising for the emergency response area is clearly mobile based emergency report and response systems was to design and implement the most important [10].

With the rapid increase of mobile phone connections in developing countries, the potential of using mobile phone text messages for field data collection is now widely recognized for its immediate communication, ease of use and reducing data transmission delays [11]. Automated comprehensive emergency support system can play a vital role to save lives and economize time to reach emergency responders, the main advantage and strength of the new system comes from the mobile web services technology that would be used in the system. This technology can overcome any problems of interoperability between systems running different applications based on programming languages on different platforms [12].

1.2 STATEMENT OF PROBLEM

Quick detection and response were crucial for preventing outbreaks of infectious diseases after the occurrence of Severe Acute Respiratory Syndrome (SARS), bird flu, and Lassa fever, dengue and Ebola virus epidemic outbreaks. A Person in emergency will not be in position to inform rescue team on fly and wait for their help; perhaps he/she attempts to escape from emergency.

More dangerous condition occur when a person is unaware or not able to take action against emergency for example physically handicapped person or old age citizen who can't inform without delay from emergency place. Communication plays a great role in helping organizations engaged in emergency response and report to take necessary measures with in a limited amount of time and less cost.

Currently emergency reports are accepted mainly using phone calls and paper based which often is not timely in order to give response and feedback for the occurrence of epidemic outbreaks. No other means of accepting a report is used for emergency infectious disease surveillance reporting and response purpose in Oromia regional health bureau according to interview held with the Public Health Emergency Management (PHEM) focal person. Since phone calls can be anonymous, it increases the level of accepting false reports. This will waste the time and resource of the organizations that are required to respond to the emergency events. In particular, in the Oromia regional health bureau, the reporting and response/alert to emergency infectious surveillances disease has problem related with inefficiency.

First, those who report the emergency using phone calls do not have a registered identity. Hence, it is difficult to trust their report and to take measure and respond timely. And also there is no mechanism to register/record phone calls which results in incomplete reports.

Second, it is difficult for the reporters to express the location where the epidemic/outbreak happened or where the emergency need is required.

On the other hand, in current approach health data was collected by paper or pre-designed form this will create delay to respond to the reported issue on time. And also can be lost or damaged in the way to near-by health center. For that Mobile phones based emergency infectious disease surveillance system can be used as the data collection platform, reporting and responding feedback to health facility and health organization.

In this project, attempt is made to address the problems with more efficiency and economical solution and to give alert response in a timely manner. A real time system which reports emergency automatically and also records sufficient data like person in emergency, location, time and type of emergency and communicates this message to health facility and health organization is developed. The overall attempt is to design mobile based emergency reporting and alert response of infectious surveillance disease system for Oromia regional health bureau.

1.3 OBJECTIVES

1.3.1 GENERAL OBJECTIVE

General objectives of This Project is to design a Mobile based emergency reporting system for infectious disease surveillance; The Case of Oromia Regional Health Bureau.

1.3.2 SPECIFIC OBJECTIVES

- To collect and specify business requirement for Emergency Infectious Diseases Surveillance System.
- To analyze and prepare the requirements so as to produce Requirement and Specification and Design (RSD) for Emergency reporting Infectious Diseases Surveillance System.
- To design mobile based Emergency report and response Infectious Diseases Surveillance system

1.4 SIGNIFICANCE OF THE PROJECT

For Students: the proposed system analysis and design document serves as baseline for future implementation of the software of mobile based emergency reporting system for infectious disease surveillance.

For the Health Facility: the new proposed document i.e. analysis and design of mobile based emergency reporting system for infectious disease surveillance will help for all health facilities to include the felt need and process of early warning, reporting and giving feedback. And also help them to outsource the implementation phase of the proposed project for external entity and meanwhile, to follow the implementation of there need.

For Health Research, statistics and teaching: the proposed analysis and design document is valuable to design software that will help in the collection of statistics data on health care /services and the incidence of diseases. Furthermore, the proposed document will help for teaching health informatics students.

For Non Governmental Organization (NGO): this system Analysis and Design document of mobile based emergency reporting system for infectious disease surveillance will help NGO's who are working in area of health sector software development as initial document to identify the best programming language to use and to design new software.

1.5 PROJECT SCOPE AND LIMITATIONS

1.5.1 PROJECT SCOPE

The mobile based emergency reporting, of infectious disease surveillance system is to be designed for the Health Workers and Users. The project focuses only on the requirements analysis and system design for Mobile Based emergency reporting of infectious disease system to the Oromia Regional Health Bureau.

For the purpose of accepting and sending reports or data from mobile devices, give feedback and response, the system will only use SMS as a means of accepting data from mobile devices.

1.5.2 LIMITATIONS

The study lack adequate related works on the mobile based emergency report system for infectious disease surveillance system design research project for the limited discussion that follows. In addition, system design document is developed and documented. However, software programming, testing and implementation was not carried out due to time and resource limitation.

1.6 DOCUMENT ORGANIZATION

This project report is outlined as follows; Chapter two discusses Literature review and related works on use of mobile based emergency reporting and response of infectious diseases surveillance. Chapter three presents the methodology used. Chapter four discusses the result of the project, which contains system analysis including business use case and system use cases, system design such as class diagram and sequence diagram, persistent of data management and discussion of results. Chapter five presents the conclusion, recommendation, and future work.

CHAPTER TWO

LITERATURE REVIEW AND RELATED WORKS

2.1. HEALTH INFORMATION SYSTEM AND EMERGENCY INFECTIOUS DISEASE SURVEILLANCE

Health information systems record and report information on the health of a population from a variety of demographic, logistical, program management and health status indicators, the results are used for national health planning and policy setting. Public health surveillance is an essential component of the health information system with objectives and methods that inform action for public health [16]. Developments in information and communication technologies provide opportunities for dramatically improving the way disease surveillance is conducted.

Disease surveillance systems are the product of a dynamic interaction between the generation of information and action to solve identified problems, and can be considered to be a component of the broader health information system (HIS) [17]. Although other types of information are collected and reported to focal points in a national system, surveillance systems primarily look at data for defining trends in public health events, identifying personal characteristics (such as age, gender and location), and mapping the location of disease incidence. Although surveillance systems do not necessarily need to be fully integrated into the health information system, they need to produce information for it.

The main role of disease surveillance is to predict, observe and minimize the harm caused by outbreak, epidemic, and pandemic situations, as well as increase knowledge about which factors contribute to such circumstances. Disease surveillance is the foundation for prevention and control. The changes that have occurred in the health sector in the last twenty years have included the emergence of new diseases that have resulted in the need to review mechanisms for surveillance and response to these diseases. This is particularly so in the African Region, where it is recognized that while a lot of progress has been made towards improving national and regional capacity for effective surveillance and response, communicable diseases remain high priorities for national public health programs [18].

The communicable diseases that remain high priorities for public health emergency programs that are of interest at national and international levels. In Ethiopia 20 diseases (immediately reportable where as 7 are weekly reportable) are selected to be included into routine surveillance.

These diseases include;

disease which have high epidemic potential (anthrax, avian human influenza, cholera, measles, meningococcal meningitis, pandemic influenza, smallpox, severe acute respiratory syndrome(SARS), viral hemorrhagic fever(VHF), and yellow fever);

Required internationally under IHR2005 (smallpox, poliomyelitis due to wild-type poliovirus, human influenza caused by a new subtype, SARS);

Diseases targeted for eradication or elimination (poliomyelitis due to wild-type poliovirus, dracunculiasis, neonatal tetanus (NNT));

Diseases which have significant public health importance (rabies, dysentery, malaria, typhoid fever, relapsing fever, typhus and severe malnutrition);

Diseases that have available effective control and prevention measures for addressing the public health problem they pose. [19]

To strengthen the availability of surveillance information to detect outbreaks in order take action to limit their impact on the health of those affected. Successful control of infectious diseases needs effective and efficient surveillance.

In order to monitor, evaluate and improve infectious disease surveillance and response, Integrated Disease Surveillance and Response (IDSR) have recommended the following steps to be undertaken: recognize targets and indicators, examine the quality of surveillance activities at the district level, supervise surveillance and response activities, evaluate the surveillance and response system, and take action to improve surveillance and response system [18].

To express how mobile phones can be used recognizes this and get betters the flow of surveillance information between and within levels of the health system, and eventually support the capacity of ORHB to conduct effective surveillance activities.

2.2.USE OF MOBILE HEALTH IN HEALTH CARE SYSTEM

Mobile health is a term used for the practice of medicine and public health, to improve the quality of and access to care by supporting mobile devices. This term is most commonly using in reference to using mobile communication devices, such as mobile phones, tablet computers and PDAs, for health services and information [20].

mHealth has been integrated into the field of healthcare in a try to address the wide variety of challenges facing developing country systems, such as skilled worker shortages; a lack of timely reporting for surveillance and diagnostics; an entry of counterfeit drugs; poor treatment adherence; and poor deliver and supply chain management [21].

mHealth programs make use of several aspects mobile phone technology; a specification of the needs of the target users in presented table below.

Table 1: types of mHealth applications in health care systems

Type of communication	Level of interaction		source
	One-way	Two way	
Text messaging	-Appointment reminders -Treatment reminders -Health promotion -Emergency notifications -Surveillance -Community mobilization	Appointment confirmations - Treatment compliance - Patient diagnosis (using algorithms) - Patient records	Cole-Lewis & Kershaw, 2010;Terry 2008
Voice services	- Automated health information lines	- Health call centers / staffed info lines - Emergency toll-free lines - Mobile telemedicine - Patient monitoring	
Voice and video services		Mobile telemedicine - Emergency services	
Internet connection	- Health promotion - Information initiatives	- Population surveys - Patient monitoring, - Surveillance - Patient records - Civil registration and vital Statistics and Decision-support systems	

Source: (WHO, 2012). Working paper series 2013 [22].

From the above table, text messaging has been the most widely adopted application of mHealth, the reason suggested by many being its ease of use, low cost, and public interests. Text messaging is also more accessible than other mobile health technologies with high percent of mobile phones have text messaging capability [22].

Mobile technologies may be used by patients, healthcare providers, the general population, or a combination of all involved parties, when used by the general population; services tend to be more simplistic in nature: awareness messages, treatment and/or appointment reminders, or help lines and Healthcare workers may use the technologies for more advanced purposes, such as patient surveys, population surveys (e.g. vaccination rates), diagnosis algorithms, and mobile telemedicine [20].

Mobile phone technologies can now be used to follow disease occurrence and alert officials if case records indicating a need for action are reached [22].

The mHealth field ranges from simple mobile phone-based applications for the transfer of health information on basic handsets via short message service (SMS) to highly complicated diagnostic applications that rely on advanced equipment and robust back-end data systems. In low-resource settings throughout Africa and the developing world, governments, non-governmental organizations (NGOs) and private-sector actors have piloted programs in which health workers and patients use mobile technology to transmit and collect information that allows them to make better decisions [23].

2.3.RELATED WORKS

The past decade has seen growing interest in the field of mobile health which is the provision of health-related services via mobile devices. There are a number of mHealth initiatives in public health currently being piloted and used in various parts of the world.

2.3.1. NATIONAL NOTIFIABLE DISEASES SURVEILLANCE SYSTEMS (NNDSS)

The National Notifiable Diseases Surveillance System (NNDSS) is a comprehensive Public Health disease surveillance system that presents influential capabilities to public health officials to monitor the occurrence and spread of diseases.

The system provides functions for collection, management, analysis, interpretation and dissemination of health related data. And also the system facilitates the progress and maintain. This help center for disease control and prevention (CDC) programs to identifying specific disease trends. [24].

2.3.2. DISEASE SURVEILLANCE AND MAPPING PROJECT

The Disease Surveillance and Mapping project covers the implementation of mobile disease surveillance and mapping project to aid Botswana's fight against malaria with the use of mobile phone technology.

The program equips health workers with mobile devices that collect malaria data and can be viewed in a geographic map of disease transmission to generate more context-aware information about outbreaks in order for workers to respond accordingly.

This makes health workers to report real time disease outbreak data, and send out SMS disease outbreak alerts to all other healthcare workers in the district, and set asides facilities to submit regular reports back to the MOH.

This enables MOH officials to promptly collect and analyze context aware data on malarial outbreaks, track developments in real time and quickly dispatch medicines and mosquito nets, and monitor treatments using GPS coordinates. [25].

2.3.3. THE 'EBOLATRACKS SMS SYSTEM'

This automated SMS system implemented in Western Australia (WA Health) to actively monitor travelers returning from Ebola Virus Disease (EVD) affected countries, and contacts of any locally diagnosed EDV cases in WA.

WA Health then provides these individuals with an Ebola Tracks monitoring pack, which includes information about EVD, an explanation of the purpose of the system and its operation, a digital thermometer, instructions on how to take and report temperature by SMS to WA Health. The SMS functionality utilizes an SMS entrance to send and receive messages via mobile telephone networks.

To date, the system has sent a total of 1,108 messages soliciting symptom information, of which 1,008 (91%) received a return SMS; the remaining 100 outgoing EbolaTracks messages received no reply or were uninterruptable and required telephone follow-up by the Department of Health to confirm that the participants remained well and a febrile. Of the 1,008 responses received, 1,007 replies indicated the individuals were well and a febrile; one participant reported an elevated temperature.

The potential value of using SMS systems for active monitoring of Ebola contacts is not limited to industrialized countries; mobile phone use is widespread in many parts of Africa and any country with a moderate to high level of mobile phone coverage ought to be able to benefit from this approach. In WA, EbolaTracks has proven useful and efficient for monitoring travelers arriving from WA [26].

2.3.4. GLOBAL MHEALTH INITIATIVE

The John Hopkins University Global mHealth Initiative has 125 registered projects spanning entire institution. They include: Use of SMS reminders to get better timely vaccine coverage in rural Africa;

Integrated mobile phone based data system that links rural community health workers and their customers (mCare); Mobile application package that can rapidly capture, analyze and record water quality parameters in remote regions; Raising awareness and marketing male medical circumcision to reduce HIV transmission risk in sub-Saharan Africa (Brothers for Life);

Communication program designed to investigate the low bandwidth potential of SMS technology to facilitate communication, enable situational awareness, and rescue survivors during disasters (Disaster Link); A virtual, interactive, mobile-phone based "Immunization Record" to Improve vaccination rates in rural Bangladesh (mTikka); Develop virtual patient records with regards to localized language and semantics (Mobile EMR); A mobile intervention tool designed to reduce hospital readmissions; SMS service to provides information on male circumcision; Information and counseling services via telephone for people [27].

2.3.5. DATA COLLECTION, REPORTING, AND DISEASE SURVEILLANCE

‘’Interventions using mobile communication technologies in both developed countries and developing have investigated the use of mobile phone-based apps, mobile phone functions (SMS and voice), and PDAs. In these interventions, the technology was used to collect or report health data (e.g., influenza vaccination, tuberculosis, and HIV) and for disease surveillance (e.g., tracking infectious disease, communicable disease, and respiratory infections)

For interventions using the SMS and or voice functions of mobile phone, mobile based reporting system for report accepting data; using SMS and telephone in collecting self-reported data, receive information from delivering laboratory results and the second for patients’ weekly symptoms reports.

In addition, SMS texts communication provides a quantitative assessment of data entry accuracy using SMS when compared with Internet and voice. Another one investigated the effectiveness and efficiency gains in using mobile apps for detecting disease outbreaks in near-real-time; and tested the reliability, validity, acceptability, and practicability of SMS messaging for collecting patients’ infant feeding method and future feeding plans [28]”.

2.4.REVIEW OF SYSTEMS

All the above reviewed systems deal with mobile based data collection. However, most of the systems do not use forms/templates for data entry. Rather free text messaging with the built in SMS interface of mobile phones are used. As a result of this, data entry could be error prone and guiding information or manual is required to help the data collector on how to collect and report the data.

The way the reported data is managed by these systems at the server side differ. Some of the systems do not treat the collected data directly in a full-fledged data base system that can also be used to make it instantly accessible for designated or responsible health workers and also analyze the collected data and generate reports in required format.

As requirement for different applications differ, none of systems reviewed can be used for the emergency reports and response for infectious disease for the system that I considered. It is therefore necessary to design and implementation a system that fits to the emergency infectious disease surveillance reports and response alert message system identified.

CHAPTER THREE
METHODOLOGY

The proposed project was designed using Object-oriented analysis and design (OOAD) methodology with Rapid Application Development (RAD) approach often using the Unified Modeling Language (UML).

OOAD applies object-modeling techniques to analyze the requirements for a context for example, a system, and a set of system modules, an organization, or a business unit and to design a solution.

Unified modeling language (UML) development techniques are applied in the process of requirements capture, model organization business system and design. Argo UML and Visio Software will be employed in analysis and design models diagramming.

3.1. STUDY SETTING

The Project was conducted from January 2015 to may 2015Oromia Regional Health Bureau, Public health emergence management main process, epidemic disease surveillance subunit and focused on mobile health care report system.

3.2. SOURCE AND STUDY POPULATION

The source population was Health institutions of Oromia Regional State in general. Study population, starts from health post worker up to ORHB, main process of PHEM participating in Public Health Emergence Management, Epidemic Disease surveillance activities in Oromia Regional State health institutions.

3.3. DATA COLLECTION AND ANALYSIS

To accomplish the objectives the requirements gathered were carefully analyzed based on guide lines and Interviews of stakeholders and ORHB Public Health emergence surveillance disease unit and also woreda health office.

To identify user requirements for the design of mobile based emergence reporting infectious disease surveillance system the following activities were undertaken.

Review the paper based reports of notifiable disease from the health facility (health post and health centre) received daily and weekly by public health emergence management focal person at woreda level and zonal health office after that to Regional Health Bureau by phone calling and paper based. After reviewing the reports, the focal person must give response/ feedback.

This reviewing paper based report was used to gather accurate information about how the system actually operates, particularly about processes. The workers at health facility systematically watched and recorded the behaviors and characteristics of operations and processes in the health facility. Document reviewed including report from at health post, health centre, and woreda level, were reviewed to look upon the usual data recording, completion, processing and reporting process. This technique was used for the reason that of the system was designed in order to make mobile based SMS report and response system of emergency infectious disease and that document review is inexpensive since the data is already there, permits examination of trends over the past, and doesn't interrupt program or client's routine in program.

Interviews were conducted with Public Health Emergence Management focal persons at Regional Health Bureau, Health Extension workers at Health Post with woreda, Public Health Emergence Management focal person at health centre to find out what difficulties they encountered with existing system. This interview information was collected by using closed and open ended questions.

This technique was chosen for the following reason

- ✓ it permits clarification of questions
- ✓ has high response rate than written questionnaires
- ✓ it is suitable for use with both literate and illiterate

To analyze the requirements first consider Health Extension workers are responsible to conduct house to house visit, educate families, and monitor health condition of families and report cases such as disease outbreaks which is seen in villages. The current practices are that data is collected using paper based forms. The collected data can then be reported to health centers, woreda health offices, regional health bureau, etc. depending on the type of case.

After that using Object Oriented analysis such as Use Case are recognized, described and Use Case Diagrams, to show improved design Class Diagrams, Sequence Diagram and there description was done. The data required in the course of developing the project was collected properly and In order to establish user requirements, at the end meetings will be held with ORHB public health emergence surveillance disease unit.

3.4. ETHICAL CONSIDERATION

The study protocol got ethically approved from Addis Ababa University, College of Health Science through school of Public Health Research ethics committee. Information sheet and consent forms were used to ensure participant willingness to participate in the study.

3.5. METHOD OF DISSEMINATION OF RESULTS

The results from the project will be disseminated in a public defense and the report will be available at the Addis Ababa University School of Information Science and School of Public Health Library. Attempt will also be made to publish on local as well as international publication outlets.

3.6. OPERATIONAL DEFINITIONS

Integrated Disease Surveillance and Regulatory (IDSR) is an approach adapted to strengthen national disease surveillance system coordination and streamlining all surveillance activities and ensuring timely provide surveillance disease data to all disease prevention and control programs.

Epidemic More cases of disease than expected in a given area or specific group of people over a particular period of time

Epidemic Detection is immediate notification of increase of cases number based monitoring chart.

Outbreak An epidemic limited to localized increase in the incidence of disease, e.g., village, town

Infectious Diseases A disease transmitted only by a specific kind of contact/Any infectious disease that develops and spreads rapidly to many people

Notifiable Disease most Countries have their own list of diseases that must be reported by physicians, clinics, hospitals, and/or laboratories to health authorities. The diseases on the list are called notifiable or reportable diseases. The diseases on the list vary from country to country, depending on what diseases of public health importance are prevalent in an area.[13]

Surveillance The ongoing systematic collection and analysis of data about an infectious disease that can lead to action being taken to control or prevent the disease

Mobile Health The term used for the practice of medicine and public health supported by mobile devices such as mobile communication devices (mobile phones, tablet computers and PDAs) for health services and information.

Actors are a person, organization, or external system that plays a role in one or more interactions with the system.

CHAPTER FOUR
MODELING AND DISCUSSION OF RESULTS

This chapter aims to identify the requirements progressively. First, major business requirements were determined. Second, those requirements elicited using UML functional analysis models to support business processes and workflows and use cases to describe the basic functions of the information system. Both logical models support to understand the function or external behaviors that serve to model the problem domain of the system. Third, design models of system use case descriptions, sequence diagram, class diagram, were used in order to show structural design of the new system. Lastly, result of the design model with respect to existing system is discussed.

4.1. REQUIREMENT SPECIFICATION AND ANALYSIS

A requirement gathered through review of document and interviews. Health extension workers are responsible to conduct house to house visit, educate families, monitoring health condition of families and report cases such as emergence infectious disease which is seen in villages.

The current practice is that data is reported using paper based forms. The collected data can then be reported to Health Center(HC), Woreda Health Office (WorHO), Zonal Health Office(ZHO), Regional Health Bureau(RHB), etc. depending on the type of case.

Taking into account the functioning and the drawbacks of the current health data collection system, the requirements, the actors and the operations of the system are identified and appropriate tools are used to analyze the system. Some of the main analysis results are presented below.

Requirements include both the functional requirements and non-functional requirements.

Functional requirements (behavioral requirements);

Define what the system does, namely, the functions (actions) of the system. They describe all the inputs and outputs to and from the system as well as information concerning how the inputs and outputs are interrelated.

Non-functional requirements;

On the other hand, non functional requirements define the quality of the system. They include the description of the system's usability, reliability, performance, security, maintainability, portability, implementation, interface, operations, packaging and legal obligations.

4.1.1. FUNCTIONAL REQUIREMENTS

The system should be able to provide the following Main Functional Requirements of mobile based emergency reporting system for infectious disease.

- General SMS management report unit
- Alert management unit

i. SMS management unit

This unit handles the automatic acceptance of SMS messages from the health facility/ field workers (HEW, CHW….) such activities

- Accept and send SMS messages, Generate acknowledgment number and confirmation massage
- Processing the received SMS message _ automatically processes the SMS messages received and convert it to a meaningful and required report,
- Generate SMS templates for automatic message creation when necessary and Search/filter SMS messages, emergency reports, templates, notifiable disease, disease outbreaks using threshold values, disease case definition ,alert case

ii. Alert management unit

This unit is responsible to send alert SMS message to subscribed or registered users based on their requirements. Send feedback/alert SMS

4.1.2. NON-FUNCTIONAL REQUIREMENTS

Non-Functional requirements illustrate user observable aspects of the system that are not designated to the functional behavior of the system. The requirement includes from Easy to use interface to carry out basic task, Reliability, Integrity, Security to allow only authorized users, and Good usability such as similar screens.

Generally, Non-Functional requirements of the system can be viewed as follows;

i. User interface and human factors

The system should be short and have understandable template for urgent reporting of emergency infectious disease surveillance generated.

ii. Documentation

System users and the general public benefiting from the system will receive short and correctly organized documentation on how to use the system. System administrators will receive documentation about the database representation. If there is a problem occurred, the

documentation generates to help the system administrations to understand system's structure and maintain easily.

iii. Security Issues

The system should be protected with different security features (techniques) on both the software and hardware part. On the software part, any user who wants to login to the system must have a user name and password. This protects the system from any unauthorized access. A user in any section will be given the right to access and/or modify the data related to that section. In addition, the system allows only one user to use a single user name at a time.

Generally, the system should be secure to a level that, even when it is available online, critical information should not be available to non-authorized users.

On the hardware part, the Server is expected to be placed in a secured room. The room should establish physical access procedures to ensure only system administrators obtain physical access.

iv. Quality Issues

Since the system is used for emergency reporting of infectious disease surveillance, it should be healthy and reliable to a certain level.

Generally, the system will be reliable and accurate in providing information to the users.

4.2. SYSTEM ANALYSISMODEL

4.2.1. USE CASE MODEL

Actors

An actor describes any entity that interacts with the system. In this case, the interaction of actors with the system is through either the mobile application which runs in the mobile device or through the web based database interface which is accessible to authorized health professionals or to the system administrator.

Table 2; list of actors and their goal

Actor	Description	Goal
Health extension worker/CHW	is a personnel who is assigned at kebele or village level health post to provide health service to the community	To send SMS report, to accept/receive SMS feedback/notification message, get assistance
Health worker/professional	Refers to professionals who give service at the health center and woreda health office/Zonal health office. This includes medical doctors, Nurse staff, Health officer, Environmental Health , senior staff in the health facility	To give assistance, send SMS report, to view detail report, give assistance, accept/receive feedback, get SMS report
PHEM focal person	is an individual who is in charge of monitoring the Public Health Emergency Management disease surveillance activity at a selected health facility	To accept SMS report, view detail report, send feedback and send SMS report
System Administrator	is a person who maintains and administers the system.	To accept SMS report, generate SMS report, Add/Edit/remove SMS report Template, search outbreak/Alert message, register system user, send confirmation message

4.2.2. USE CASE DIAGRAM

To represent the functional requirement of the system, Use case model is used. It describes a function provided by the system that yields a visible result to the actors. In proposed system, the following use cases are identified

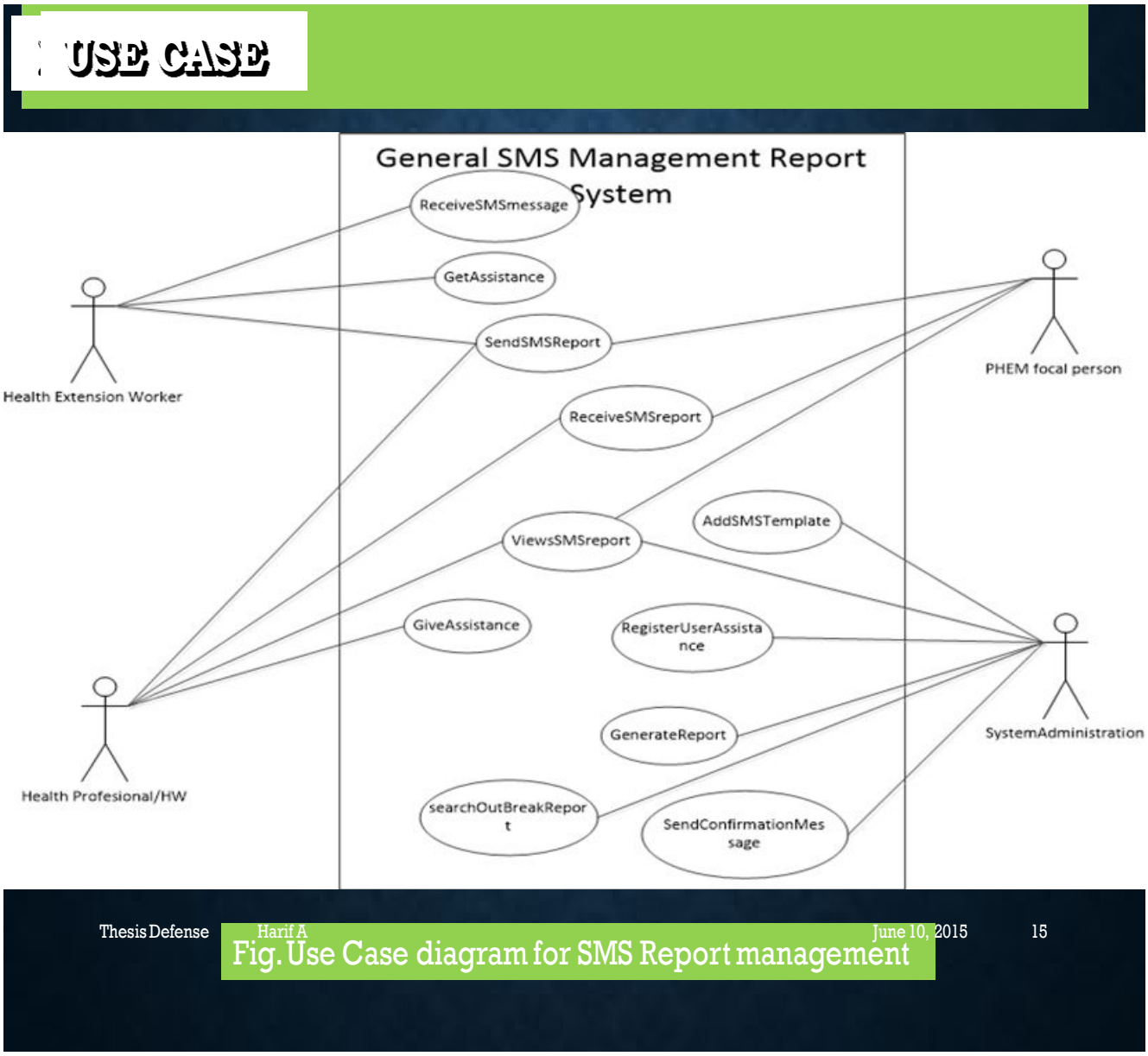


Figure 1 : Use Case Diagram for SMS Report system.

Use case Description

The description of each use case are listed below

Table 3: Use case for Adding SMS Template

Use case ID	**UC-01**
Use case name	Add SMS templates
Participating actors	System Administrator
Description	The System administrator wants add SMS template, so health workers can use it in future communication.
Entry condition	The System administrator in logged in
Main course	1. The System administration selects on "Add SMS template report" 2. The system displays the "Add template report" selection button 3. The System administration selects the type/subject of template that created and clicks next 4. The system displays the template editing form 5. The System administration edits the template and clicks the next 6. The system previews the template to the system administrator 7. The system administrator clicks finish 8. System stores the new template and displays an acknowledgment of successful creation of template.
Alternative	
Exit conditions	A new template is added
Special requirements	

Table 4; use case for sending SMS Report

Use case ID	UC-02
Use case name	Send SMS message Report
Participating actors	Health Worker
Description	The Health workers wants send SMS Report message or any other message, so he/she can use it in future communications.
Entry condition	The system must started and Health workers select SMS report Templates
Main course	1. The Health worker activates the "SMS report form" functionality from his/her mobile phone. 2. Then fills the " SMS report form" from the select subjected. After the form is filled, the health worker sends it to the health center. 3. The sent report is saved in the mobile temporarily. 4. The PHEM focal person or Health worker accept the SMS report an and saved then clicks next 5. Finally the system sends acknowledgment to health worker who sends the report, when the report is delivered at the central system.
Alternative	2a. the system displays an error message if the SMS report form not filled correctly the system back to step 2 until he/she fill correctly
Exit conditions	The health worker receives acknowledgment for the SMS reported.
Special requirements	

Table 5: Use case for Viewing Report Detail

Use Case ID	UC-03
Use case Name	View report Detail
Participating actors	System administrator
Description	The System administrator should be able to view Report detail, including the SMS transaction between the system and the client/health workers, if there are emergency outbreak disease reports, generally the health worker history will be displayed.
Entry condition	The System administrator must be logged in, the health extension workers/client must exist in system
Main course	1. The System administrator clicks on Message menu detail button 2. the system responds by displaying a Receive message(In box), Sent message (feedback/alert of outbreak, confirmation message, SMS report) or out box detail form and prompts the system administrator to select the specific client 3. the System administrator select the received SMS report message and clicks show detail 4. The system responds by displaying the detail of the report. 5. The system administrator view report and print/save
Alternative	3a. if the receive SMS report message have line list of outbreak was confirmed. The system Administrator identified location contact health worker then epidemic notification generated by the system and send to respected location, health worker and
Exit conditions	The system administrator views the report detail
Special requirements	

Table 6: Use case of get assistance

Use Case ID	UC-04
Use case Name	Get assistance
Participating actors	Health worker
Description	getAssistance enable the health worker to get assistance from the health professional on how to how to treat a particular case.
Entry condition	The system must be started and the actor must be logged in to the system
Main course	1. Health worker activate the get Assistance functionality from his/her mobile phone 2. Fill the get assistance form to report the symptom and other information about the patient. 3. Send the request to the health professional at the health center. 4. The health professional can receive the requested assistance from the web-interface and create a response to the request by invoking give response use case. 5. Finally send the response to the health worker.
Alternatives	3a. The system displays an error message if the filled form is invalid and redisplays the form to the user.
Exit conditions	The health worker gets response for the requested assistance.
Special requirements	
Frequency of use	

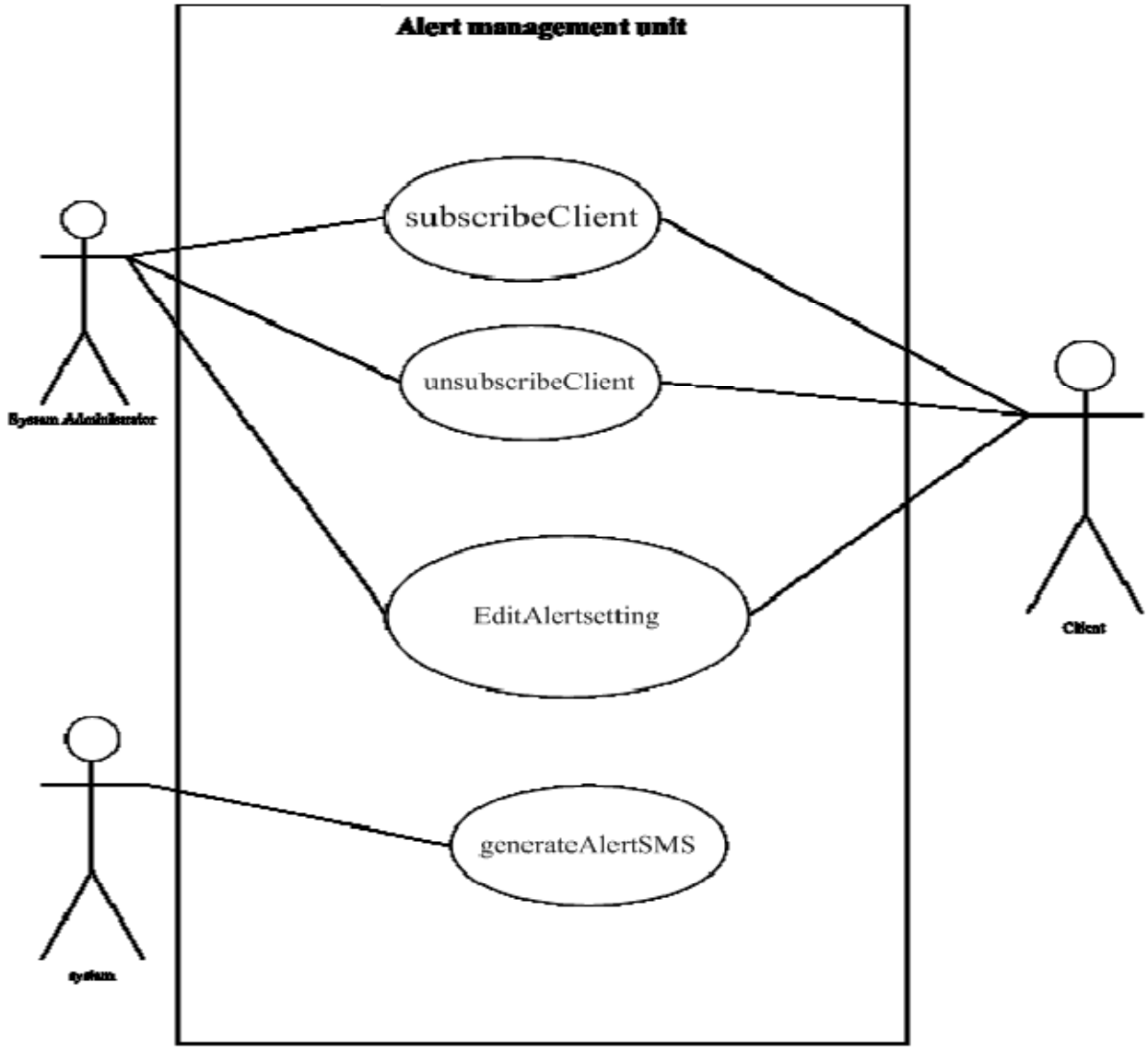


Figure 2: Use Case Diagram of Alert SMS report

Table 7: Use Case Outbreak Alert Setting

Use Case ID	UC-05
Use case Name	Edit Outbreak Alert setting
Participating actors	System administrator
Description	User to set the alerting feature of the system for the client
Entry condition	The System administrator is logged in to the system, the client must be subscribed to receive alert
Main course	1. System administrator selects alert button 2. the system displays a alert subscription form 3. System administrator selects Edit Alert setting option 4. system displays list of clients to be selected 5. System administrator selects a client, and fills the detail of the alerting feature like location preferences and reporting period and selects save button 6. the system saves the Alert setting of the client
Exit conditions	New alert setting is updated to the system
Special requirements	

Table 8: Use case Generate Alert

Use Case ID	UC-06
Use case Name	Generate Alert
Participating actors	System
Description	The system will automatically generate alerting message based on the alert setting of the client
Entry condition	The system user is logged in to the system, the client is subscribed to receive alerts
Main course	1. system periodically checks the alert setting of the clients that are subscribed to receive alert SMS messages 2. according to the alert setting, if the system finds out that the alerting has reached, automatically the alert message is generated 3. the generated alert message is ready to be sent 4. the system sends the message to the client
Exit conditions	Alert message is sent
Special requirements	

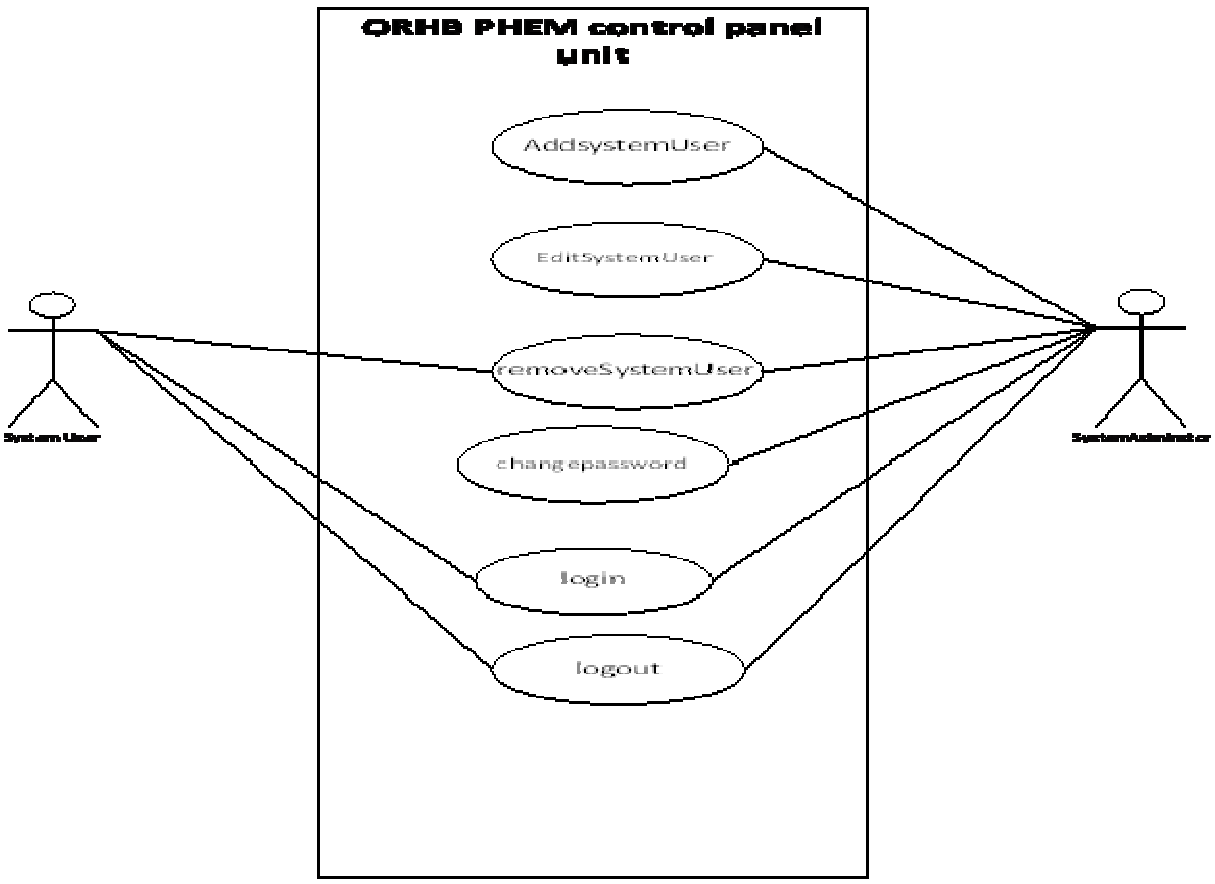


Figure 3: Use Case Diagram for ORHB PHEM control unit

Table 9: use case login

Use Case ID	UC-07
Use case Name	Login
Participating actors	All system Users
Description	Any user who wants to access the system's functionalities should be able to login to the system
Entry condition	The user needs to be already registered
Main course	1. The system displays a login form 2. The user enters his/her credentials 3. The user clicks on login button 4. The system takes the user to his/her dashboard
Alternative	3a. the system displays an error message 3b. go to step number 1
Exit conditions	The user is logged in
Special requirements	

Table 10: Use case of Add System Users

Use Case ID	UC-08
Use case Name	Add system users
Participating actors	System Administrator
Description	As the system is designed to be operated by more than one user, the system administrator should be able to add system users.
Entry condition	The System Administrator is logged in to the system
Main course	1. The Administrator clicks on add User Button 2. The system displays the add user form 3. The Administrator enters the user details and selects the job title 4. The Administrator clicks save button 5. The system adds the user to the system 6. The systems displays an acknowledgment
Alternative	
Exit conditions	A new user is added
Special requirements	

Table 11: Use case of Change password

Use Case ID	UC-09
Use case Name	Change password
Participating actors	System user
Description	The system users in their own behalf can change their own passwords
Entry condition	The system user is logged in to the system
Main course	1. The user clicks on change password menu 2. The system displays change password form 3. The user enters his/her previous password and the new password 4. The user clicks change 5. The system stores the new password 6. The system displays an acknowledgement
Alternative	
Exit conditions	The new password is stored
Special requirements	

4.3.SYSTEM DESIGN MODEL

This section consists of design of class diagram and sequence diagram of the system model. Functional requirements are grouped in such a way that they could be constructed as subsystems and the non functional requirements defined in the analysis are transformed into design.

4.3.1. CLASS DIAGRAM

The following Class diagrams, describes the structure of the system in terms of classes names, attributes, operations and their associations.

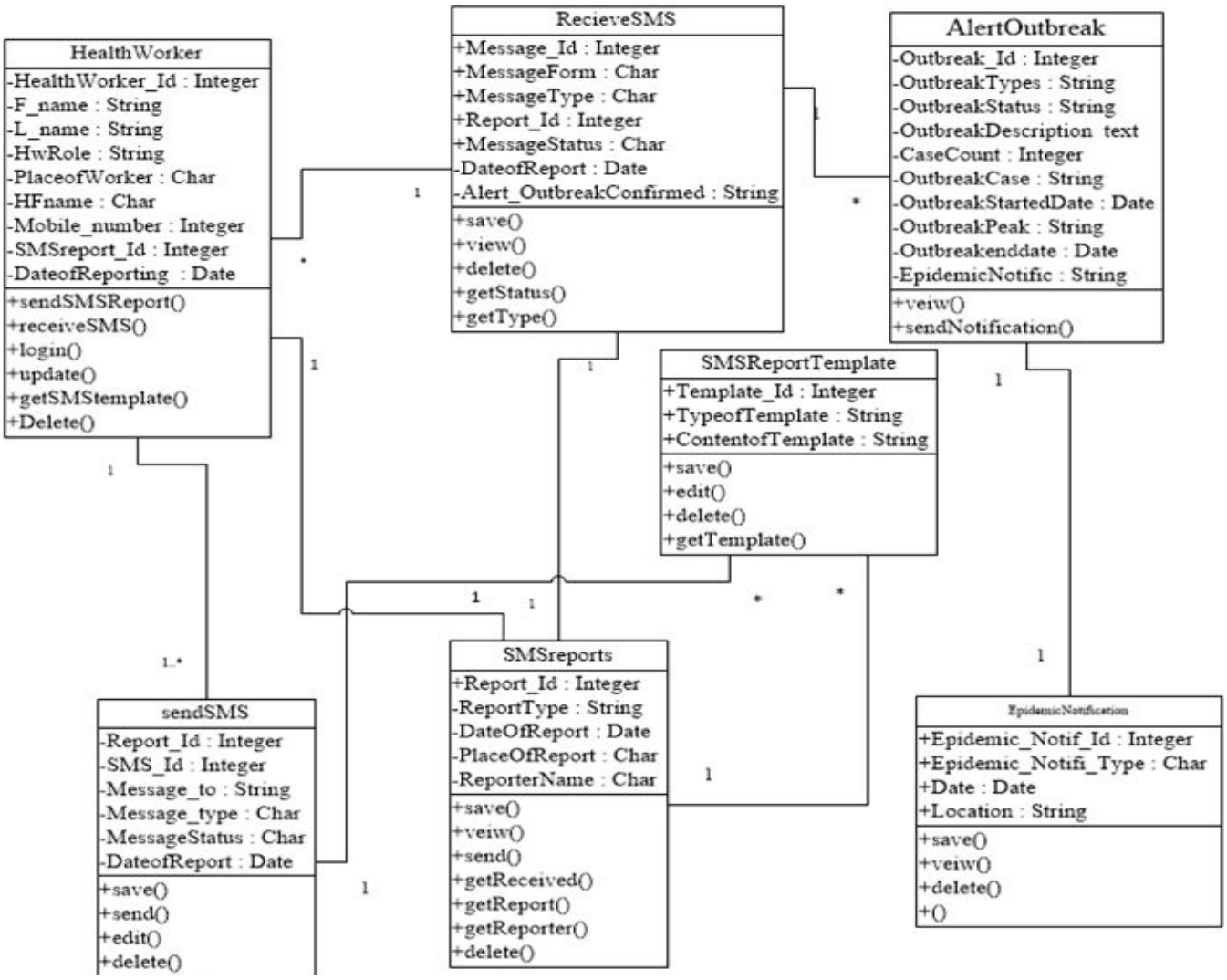


Figure 4; Class Diagram of SMS Reporting System Design

4.3.2. SEQUENCE DIAGRAM

Sequence diagram is used to describe patterns of communication among set of object which are participated in the use case. Communication between objects is represented by message passing between the objects. Objects are represented as columns with the vertical line to represent the life time of the object. In the following section, sequence diagram is shown.

Sending report of SMS

Interaction between objects which are identified from send SMS report. The sequence diagram shows how the health worker report SMS from her mobile phone.

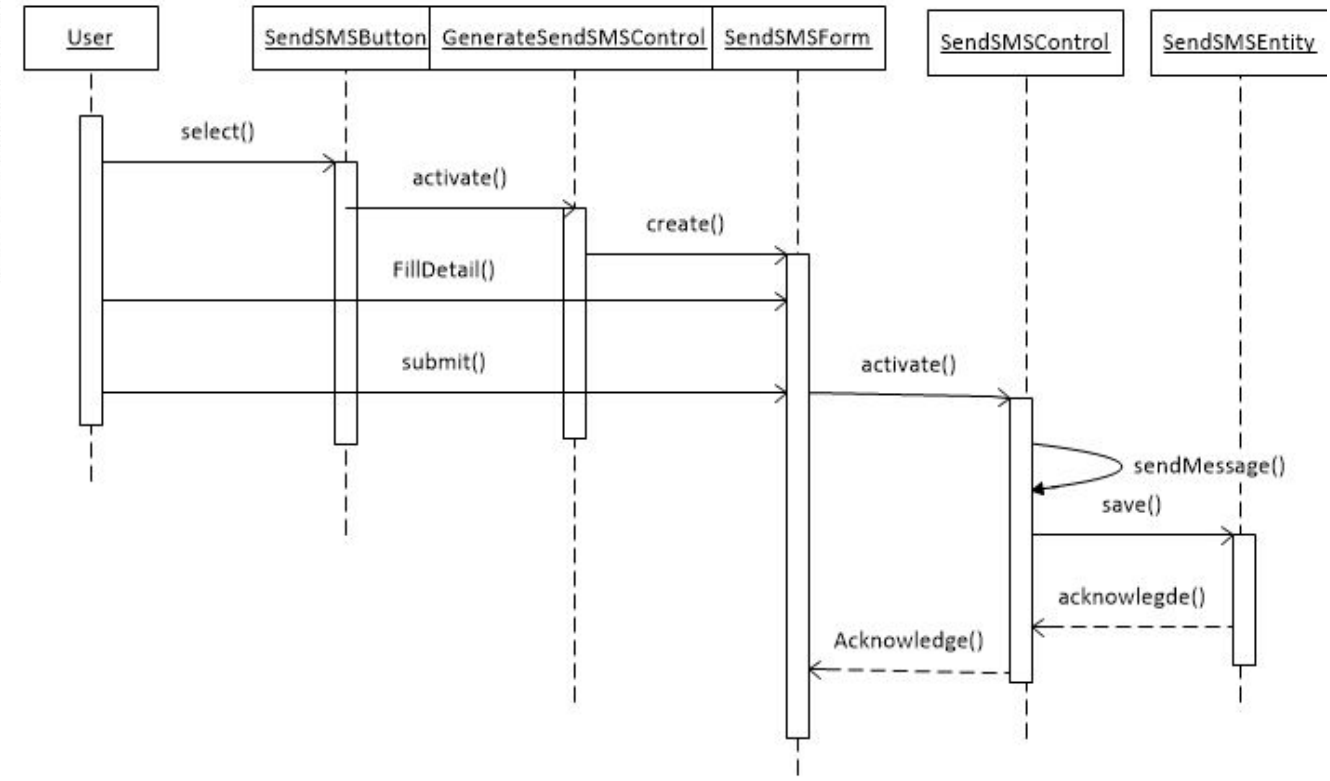


Figure 5: Sequence Diagram of sending SMS report.

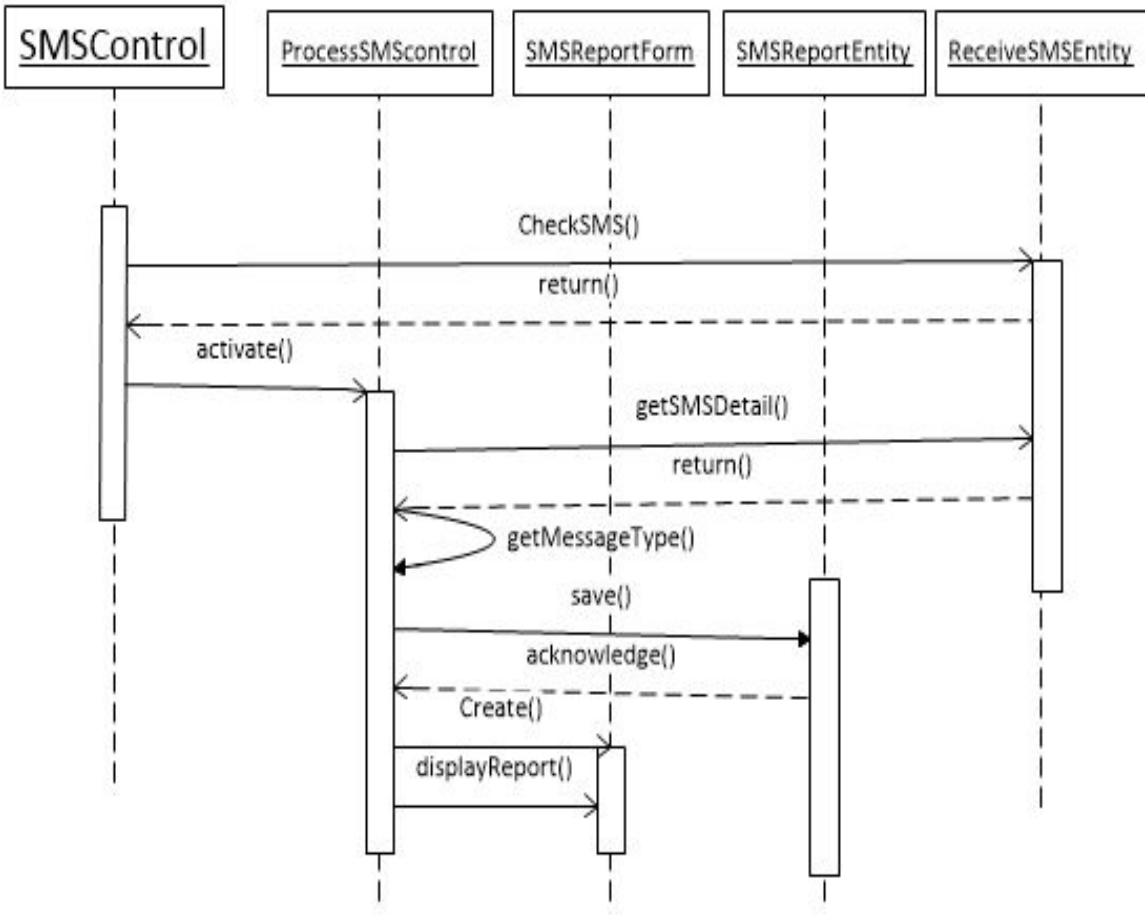


Figure 6: Sequence Diagram for processing SMS message

Get Assistance

To request assistance, the actor, Health Worker, first initiates the use case. The he/she request assistance by submitting a filled form. The sequence diagram for the getAssistance shown figure below

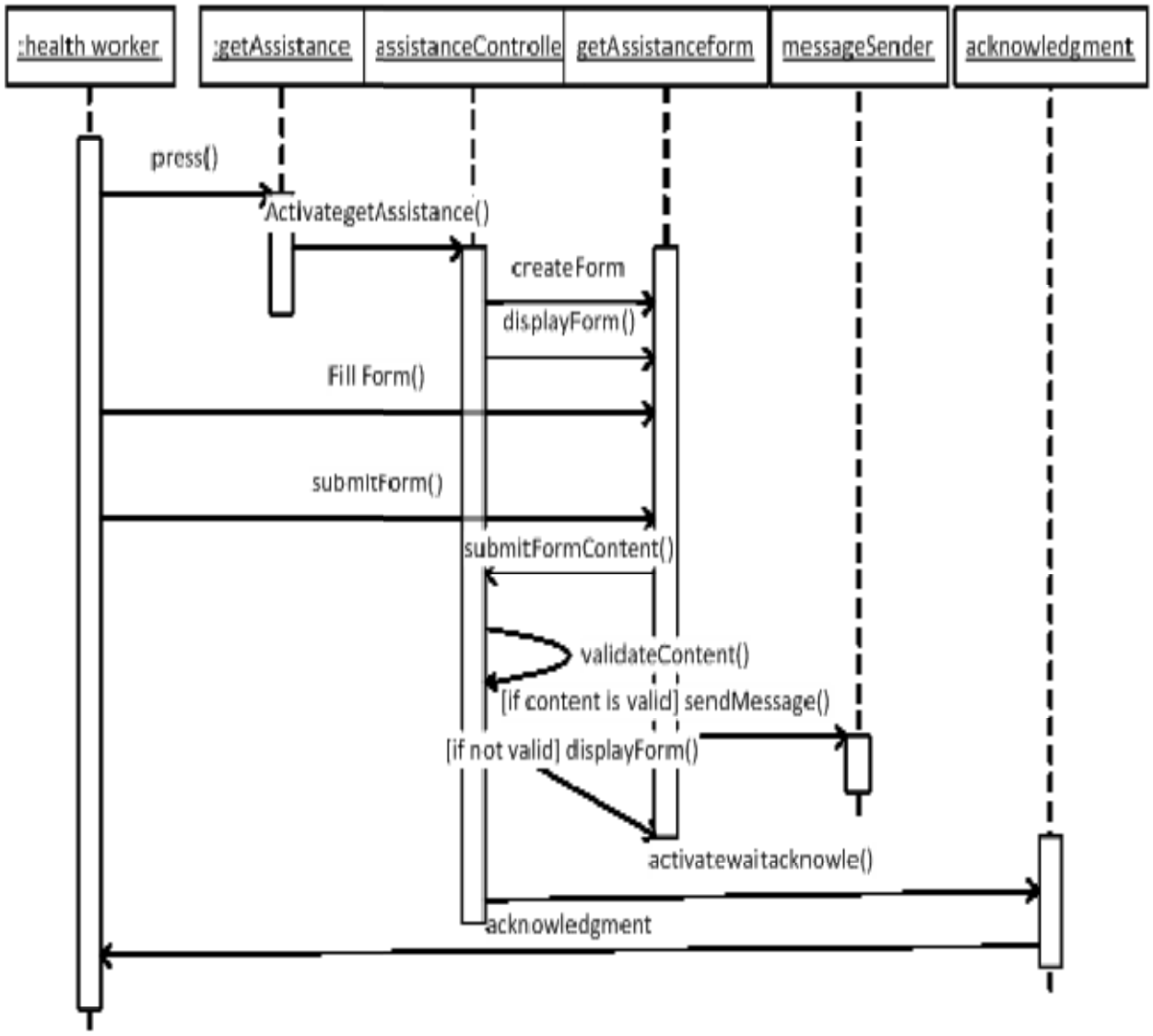


Figure 7: sequence diagram of get Assistance

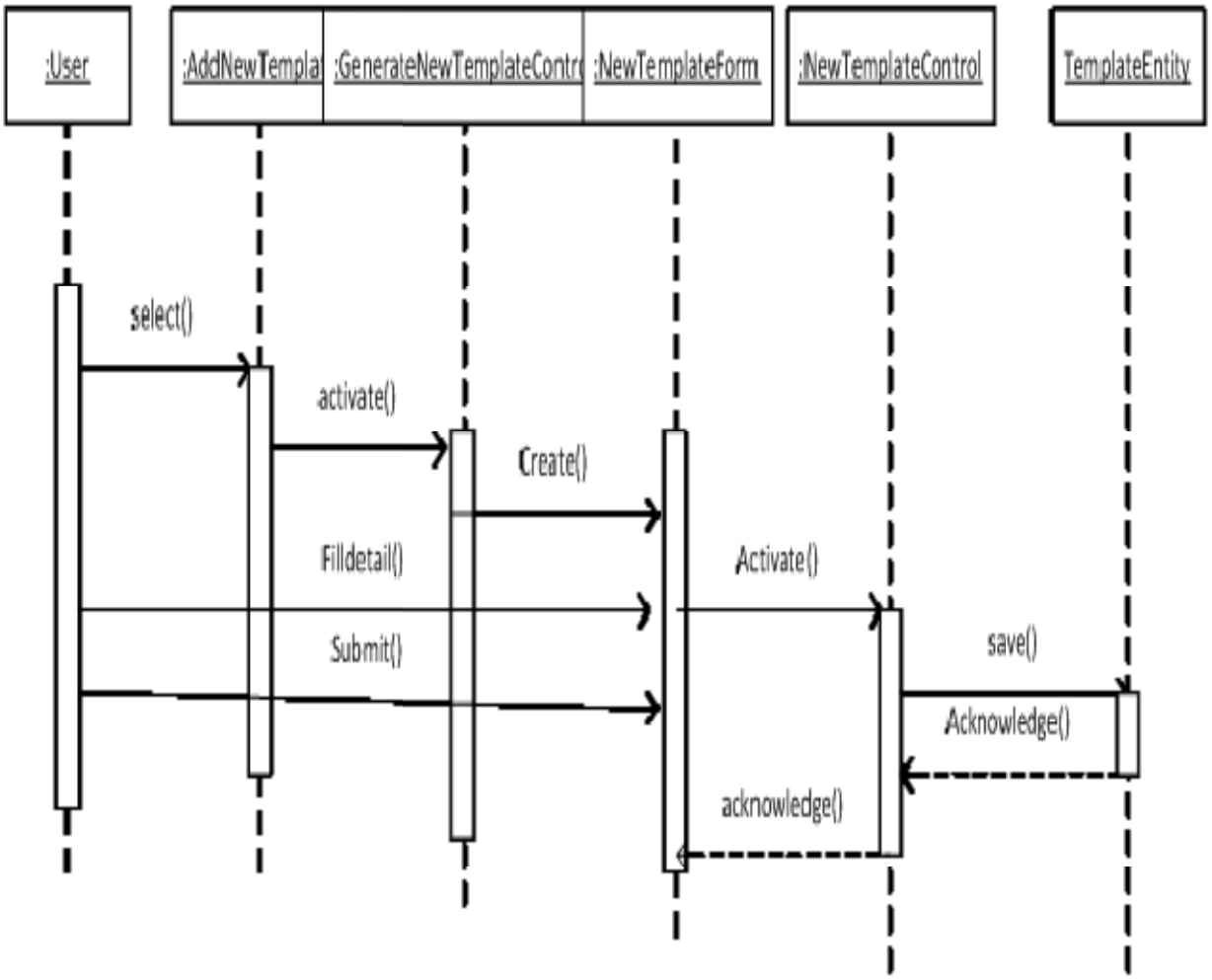


Figure 8; sequence Diagram of Adding Template

4.3.3. GENERAL SYSTEM ARCHITECTURE

This section general system designs necessary to achieve both the design goals and the functional requirements.

The general architecture of the system is as described on Figure Below

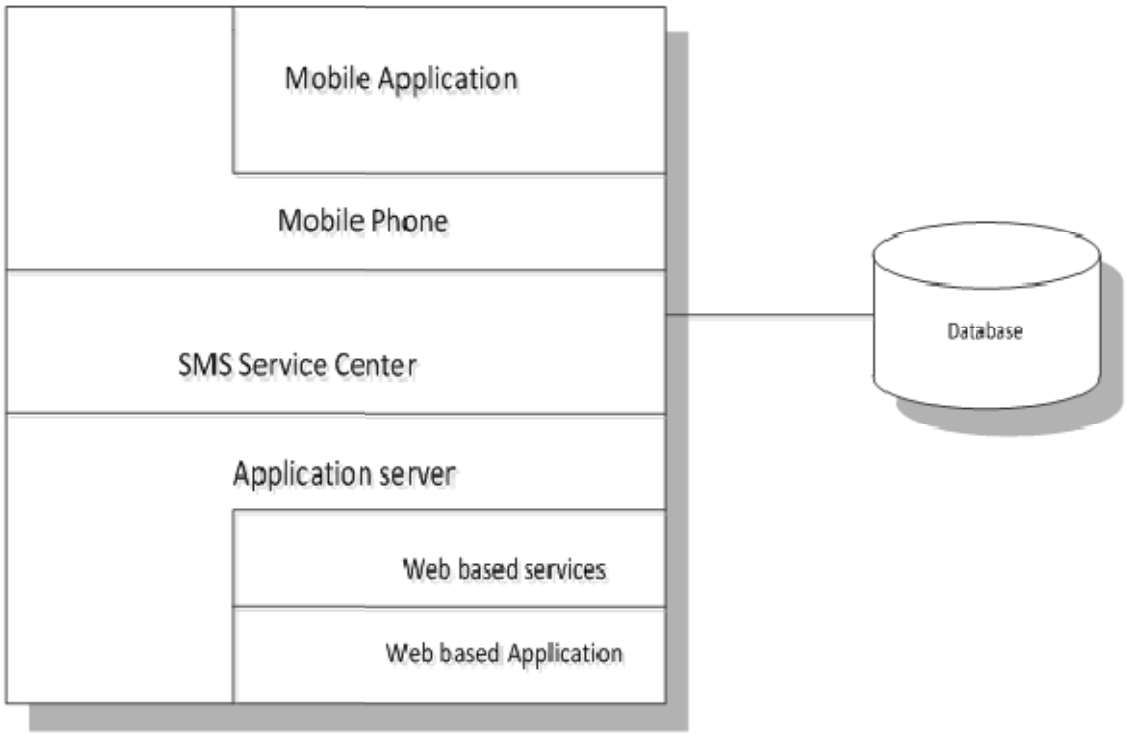


Figure 9; General Architecture of the systems

At the upper layer of the architecture are the Mobile phone devices. This layer defines any mobile device with SMS functionality will be able send SMS reports. Within the Mobile Phone Devices layer has the mobile application. After mobile application developed it will be installed on the mobile device then using the Mobile Application the health extension workers/health workers will be able to first fill in the SMS template/forms provided with the application and send the data. The application extracts the filled data and sends it as SMS messages to the central server.

At the next layer of the SMS service center which is provided by the SMS service of the mobile network. When the SMS is sent from the client it passes though this layer. This layer stores the messages and forwards it to the recipient phone or GSM modem. If the receiver's phone or the GMS modem is not reached, out of service or switched off, the stored message waits until the receiving cell phone or GMS modem is switched on or moves into range of the network coverage. This process guarantees the submission of messages.

At the last layers, the application server accepts the SMS message from the SMS service center either through the use of the wireless GSM modem or through an appropriate GSM mobile device. The web based application automatically receives the message and stores it to the pre-designed Database. The received message can then be made accessible through the web based application by anyone with access privilege.

4.4.PERSISTENT DATA MANAGEMENT

To store collected data for later analysis and reporting, persistent data management is required. The client side record management system is on mobile device.

The server side relational database includes the tables for storing reported Health workers, send SMS report, receive SMS report/feedback, SMS report template, Alert outbreak line list, epidemic notification, and its corresponding reply made by the health professional in the health center and a table to store system user's personal data.

4.5.DESIGN AND IMPLEMENTATION RECOMMENDATIONS

The researcher recommends the implementation to be client server based where the system user at client Mobile application uses browsers to access and insert data etc as privileged by the administrator. The deletion of any major change to the record should only be allowed to be done by the administrator because of the significance of the document.

The server side could be implemented using MySQL database application, Macromedia Dreamweaver, PHP scripting Language and HTML.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

Quick detection and response of early warning were crucial for preventing emergency infectious disease surveillance.

Currently this emergency infectious diseases data report and response uses mainly paper forms and phone calls. That has many shortcomings such as inability to report emergency infectious disease on time and the possibility of errors that can be committed during the intermediate data entry.

This study shows a wide range of emergency infectious disease that mobile based reporting system services like SMS message are used to report health record from remote sites right away. This method has much compensation to report emergency infectious disease outbreaks from the areas where there are limited resources, since mobile networks are more widely available.

Considering the requirements indentified, a mobile based emergency infectious disease reporting and response system was analyzed and designed.

Analysis models used are use case narration, use case description, and use case diagram to describe the basic factious of the mobile based emergence reporting system, to illustrate detail description of activities and functions running in emergency infectious disease.

The design model transcribes the analysis model in such a way that it is going to be implemented and system class diagram and sequence diagram for emergency infectious diseases surveillance data reporting and response needs of the ORHB, Oromia Regional State of Ethiopia.

5.2. RECOMMENDATIONS AND FUTURE WORKS

During the study of this project it was found that manual paper based reporting and response system have many shortcomings such as inability to report emergency infectious disease on time and the possibility of errors that can be committed during data entry.

For that Easy and timely report and response/alert generate on emergency infectious disease system can be realized if the designed system was implemented.

It is also recommended that hands on training with manual and help facility should be given to the health workers so that they can capture data by themselves to use the system in order to maintain more accountability.

Even though effort has been made to cover major activities of Public Health Emergency Management of infectious diseases surveillance reporting and response of notifiable disease there are also areas that are not incorporated in the current design such as laboratory case reports, case based reporting, event-based surveillance such as events related to occurrence of disease in human and events related to potential risks for humans health , etc Mobile based Reporting system should be incorporated in the future design and implementation.

The other is since this project only uses text based reporting, it would be good to use an additional means of messaging like MMS (Multimedia Messaging Service) which makes it possible to send messages with multimedia content. This will make the reporting process more descriptive and trust worthy.

REFERENCE

1. WHO/HSE/PED/CED/2014.05 INTERIM VERSION 1.1 Ebola and Marburg virus disease epidemics: preparedness, alert, control, and evaluation June, 2014
2. WHO Report on Global Surveillance of Epidemic-Prone Infectious Disease May 2002.
3. Gunther Eysenbach Eva Waterworh and Gunnar Klein. Mobile Technologies and Geographic Information Systems to Improve Health Care Systems: A Literature Review, 2014 JMIR mHealth and uHealth.
4. Piette, J.D.; Lun, K.C.; Moura, L.A., Jr.; Fraser, H.S.F.; Mechael, P.N.; Powell, J.; Khoja, S.R. Impacts of e-health on the outcomes of care in low- and middle-income countries: Where do we go from here? Bull. World Health Organ. 2012, 90, 365–372.
5. Michael M. Wagner, Fu-Chiang Tsui, Jeremy U. Espino, Virginia M. Dato, Dean F. Sittig, Richard A. Caruana, Laura F. McGinnis, David W. Deerfield, Marek J. Druzdzel, and Douglas B. Fridsma, The Emerging Science of Very Early Detection of Disease Outbreaks, Nov, 2001
6. World Health Organization: mHealth. New Horizons for Health through Mobile Technologies, Global Observatory for eHealth series, Volume 3. Geneva: WHO; 2011.
7. Sasaki D. Berhane Gebru: disease surveillance with mobile phones in Uganda. MobileActive.org, 30 July 2008
8. Colin Robertson,1 Kate Sawford,1 Samson L.A. Daniel,2 Trisalyn A. Nelson, and Craig Stephen ,Mobile Phone–based Infectious Disease Surveillance System, Sri Lanka sept, 2010
9. Ya-pin Li1., Li-qun Fang1., Su-qing Gao2, Zhen Wang2, Hong-wei Gao1, Peng Liu2, Ze-rui Wang2, Yanli Li1, Xu-guang Zhu2, Xin-lou Li1, Bo Xu2, Yin-jun Li1, Hong Yang1, Sake J. de Vlas3, Tao-xing Shi1 Wuchun Cao1 Decision Support System for the Response to Infectious Disease Emergencies Based on WebGIS and Mobile Services in China.
10. Githinji .Using mobile phone text messaging for malaria surveillance in rural Kenya
11. Tambo et al. Need of surveillance response systems to combat Ebola outbreaks and other emerging infectious diseases in African countries. Infectious Diseases of Poverty 2014,
12. Ngabo, Fidele, Judith Nguimfack, Friday Nwaigwe, Catherine Mugeni, Denis Muhoza, David R. Wilson, John Kalach, Richard Gakuba, Corrine Karema, and Agnes Binagwaho. 2012. Designing and implementing an innovative SMS-based alert system (RapidSMS-MCH) to monitor pregnancy and reduce maternal and child deaths in Rwanda. The Pan African Medical Journal 13:31.
13. World Health Organization. mHealth: New Horizons for Health through Mobile Technologies: Based on the Findings of the Second Global Survey on Ehealth (Global Observatory for eHealth Series Volume 3); World Health Organization: Geneva, Switzerland, 2011.

14. Janine Lachner, Hermann Hellwagner. Klagenfurt University Department of Information Technology Universitätsstraße 65-67, 9020 Klagenfurt, Austria. Information and Communication Systems for Mobile Emergency Response
15. Washington, D.C. and Berkshire, UK: UN Foundation-Vodafone Foundation Partnership; 2009.Vital Wave Consulting. mHealth for Development: The Opportunity of Mobile Technology for Healthcare in the Developing World.
16. WHO (1997). Design and Implementation of Health information Systems. World Health Organization, Geneva.
17. WHO, CDS, EPR, LYO (2006). Communicable disease surveillance and response systems, Guide to monitoring and evaluating p 11-13.
18. WHO & CDC, IDSR (2010). Technical Guidance for Integrated Disease Surveillance Response in the African Region. 2nd edition. Available at
19. Ethiopian Health and Nutrition Research institute, public health emergence management centre. Public Health Emergency management guidelines for Ethiopia. Feb 2012.
20. WHO, Geneva, mHealth: New horizons for health through mobile technologies, Global Observatory for eHealth series - Volume 3, November 2011.
21. Germanakos P.,Mourlas C., and Samaras G… A Mobile agent Approach for Ubiquitous and personalized eHealth Information System, proceeding of the Workshop on personalization for eHealth of the 10th international conference on User; (2005)
22. Caroline Marshal, Don Lewis, Maxine Whittaker: mHealth technologies in developing countries: a feasibility assessment and proposed framework Working Paper Series • Number 25 • June 2013 • Working Paper
23. Vital Wave Consulting: mHealth in Ethiopia strategies for a new framework Report October 2011
24. http://wwwn.cdc.gov/nndss/ Accessed March 17, 2013
25. Jeannine Lemaire. The second report of scaling up Mobile Health.
26. http://www.eurosurveillance.org/Euro Surveillance. accessed 2015; 20(1):
27. Changhong Yang, Jun Yang, Xiangshu Luo and Peng Gong Use of mobile phones in an emergency reporting system for infectious disease surveillance after the Sichuan earthquake in China ,Aug 2009
28. José António Nhavoto, MSc and Åke Grönlund, PhD Mobile Technologies and Geographic Information Systems to Improve Health Care Systems: A Literature Review. Published online May 8, 2014,
29. Gunther Eysenbach Reviewed by Eva Waterworh and Gunnar Klein Mobile Technologies and Geographic Information Systems to Improve Health Care Systems: A Literature Review Monitoring

ANNEXES

I. Annexes two User Interface Prototypes

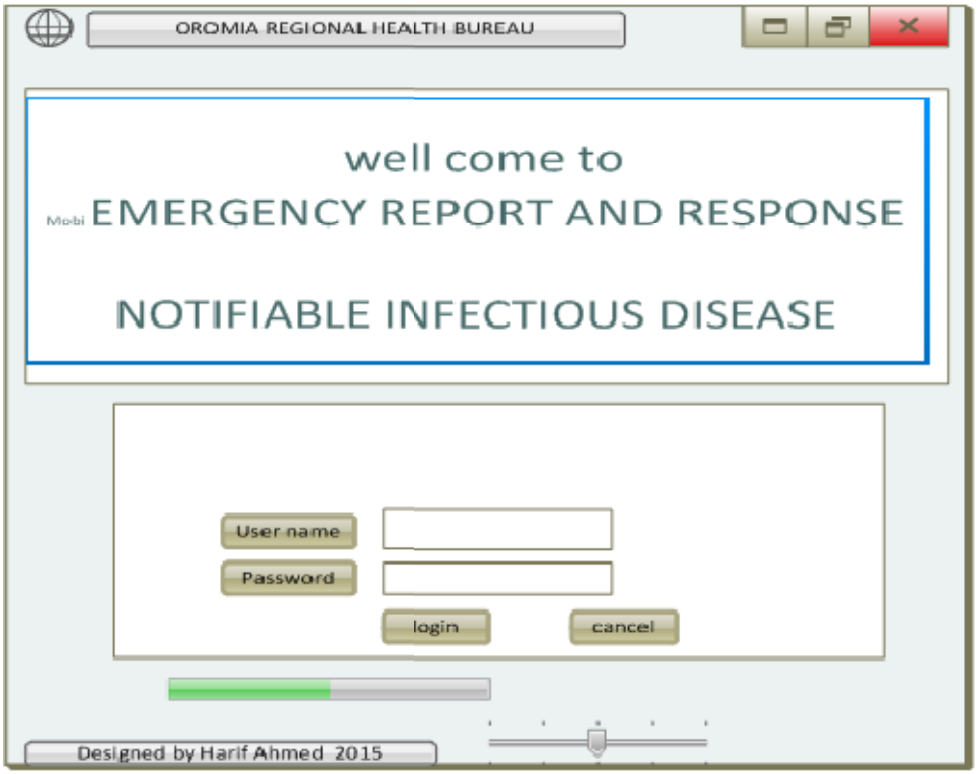


Figure 4: user interface of user/administrator login

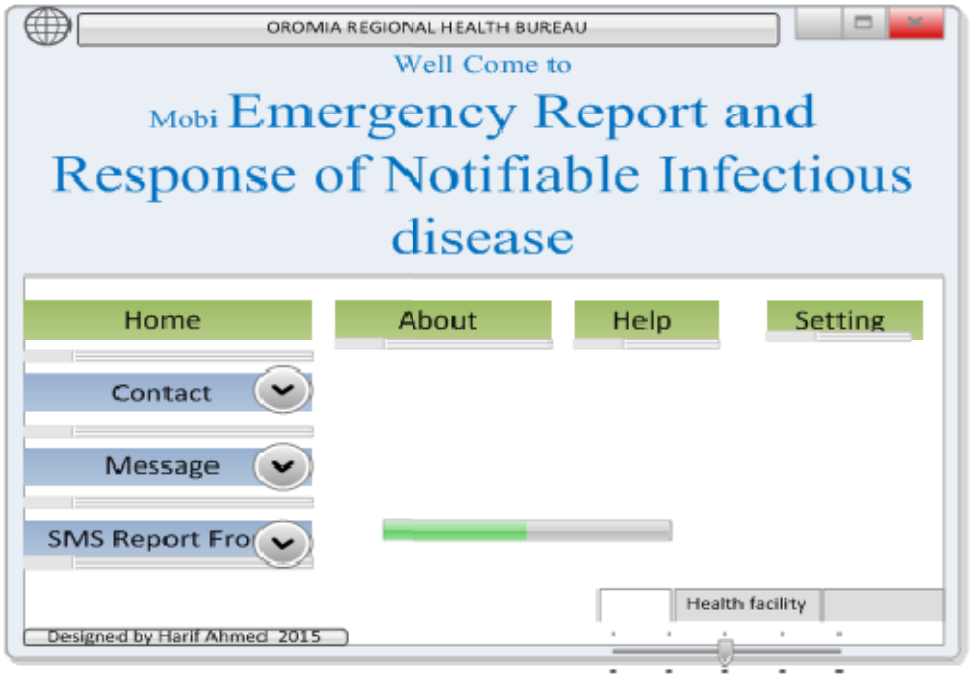


Figure 10: user interface of main menu

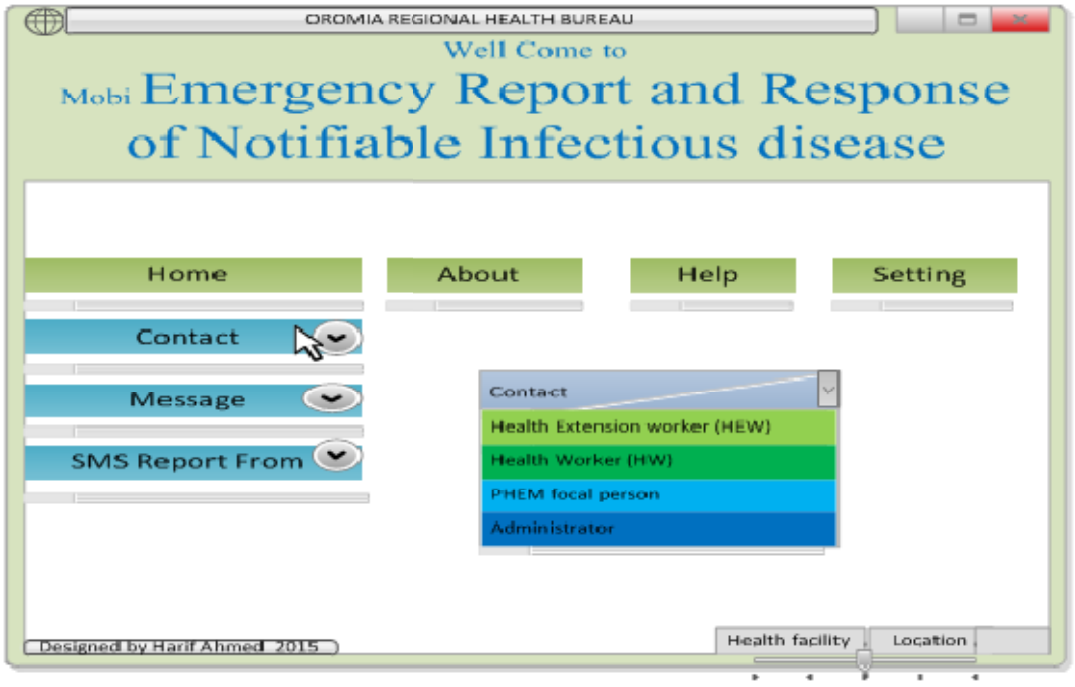


Figure 11: user interface of select maim menu of contact

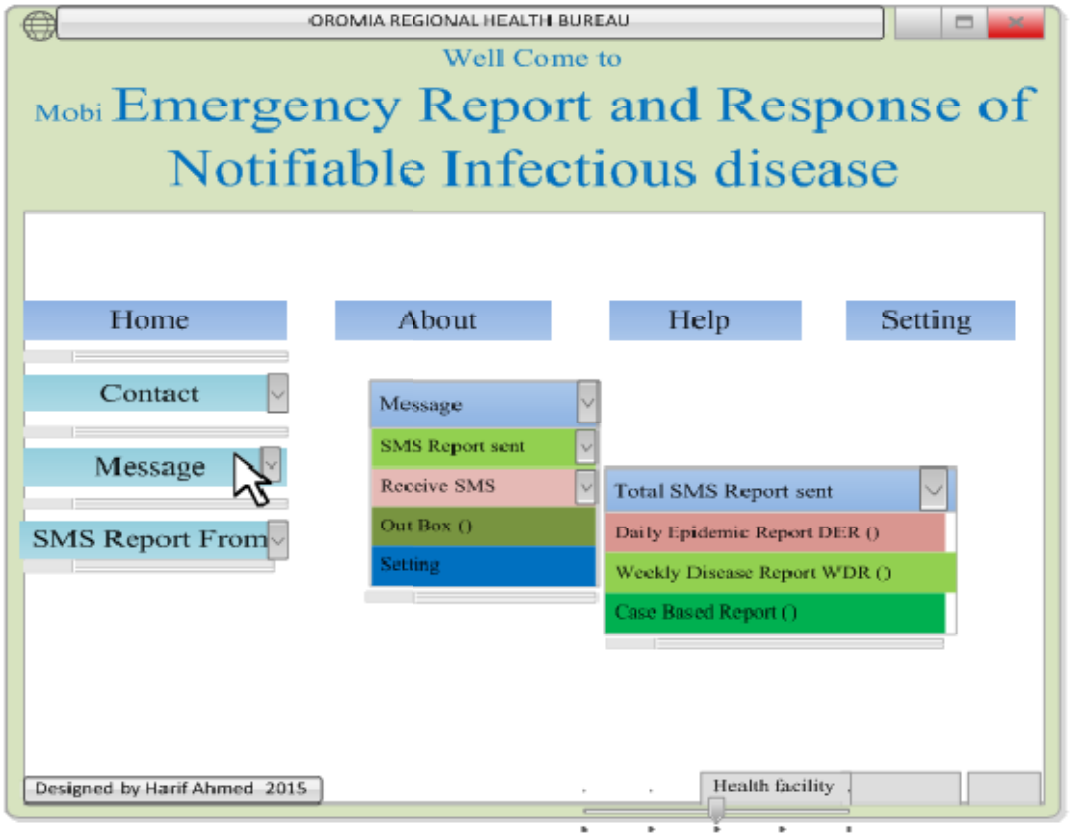


Figure 12: user interface of select from main menu, select message menu

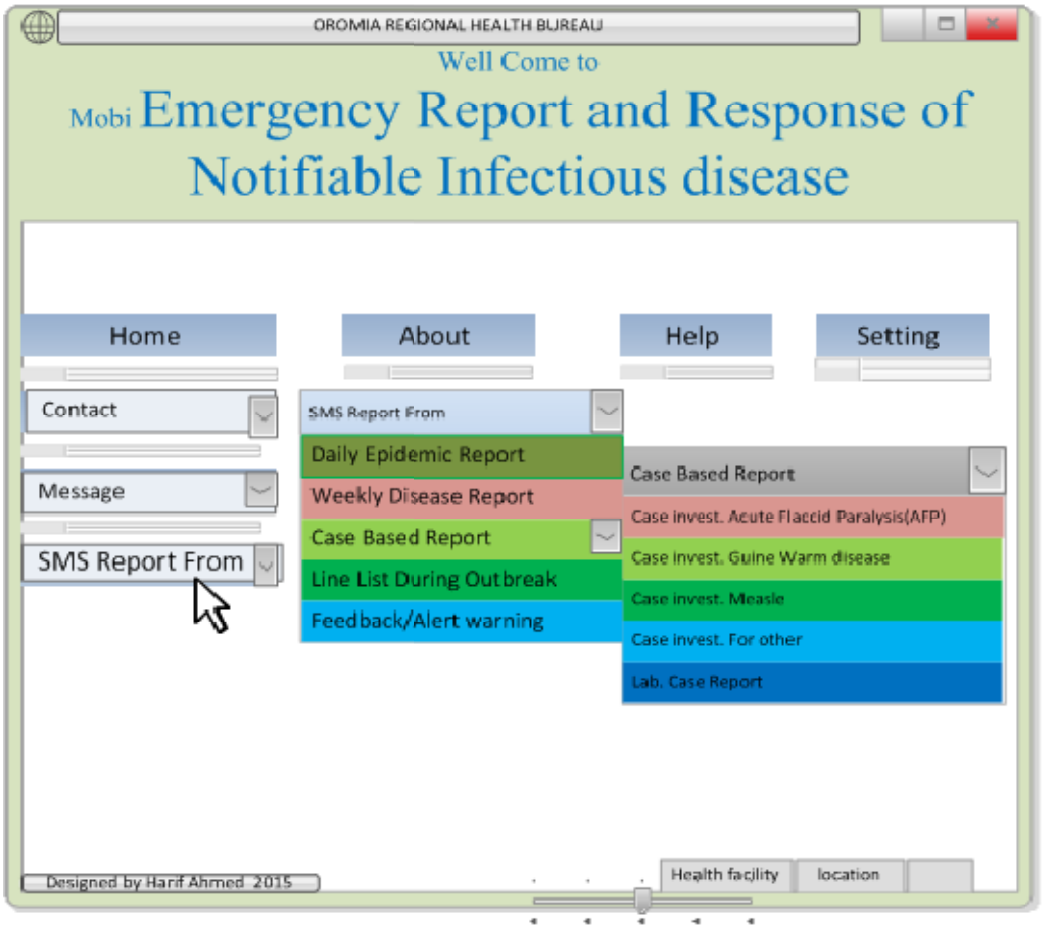


Figure 13: user interface select from main menu, select of SMS Report From.

II. Annexes threeReport form/Template

a. Weekly Report Form for Health Extension Workers

Weekly Report Form for Health Extension Workers (WRF_HEW)

Health Post name		Woreda	
Kebele		Zone	
Start of week from Monday _____/_____/_____toSunday_____/_____/_____ (day)(month)(Year in Ethiopian Calendar)(day) (month)(Year in EC)			

1. Record below the total number of cases for each disease/condition for the current week.

Indicator		Total Cases
Total Malaria (confirmed by RDT +clinically diagnosed as malaria)		
Total malaria suspected fever cases examined by RDT		
Number of fever cases positive for malariaparasites (by RDT)	P. falciparum	
	P. vivax	
Meningitis (suspected)		
Bloody Diarrhea		
Acute febrile illness (other than malaria and meningitis)		
Severe Acute Malnutrition (MUAC < 11cmand/orBilateral Edema in under 5 years children (new cases only))		

RDT = Rapid Diagnostic Test;MUAC = mid upper arm circumference

2. Summary for Immediately Reportable Diseases/Conditions:

DISEASE	C	D	DISEASE	C	D	DISEASE	C	D
AFP/Polio			Fever + Rash			Hemorrhagic Diseases		
Anthrax			Neonatal Tetanus			Guinea worm		
Acute Watery Diarrhea			Influenza Like Illnesses			Other (specify):_____		
Rabies			Other (specify):_____			Other (specify):_____		

C= case; D = death

Look at the trends, abnormal increase in cases,improving trends?Actions taken and Recommendations:

_____

_____

_____

Date sent by Health Post: _____ Date received at Woreda: _____

Sent by: _____ Received by: _____

Tele: _____Tel: _____

b. Weekly disease report form for Health Centre/Hospital

Weekly Disease Report Form for Outpatient and Inpatient Cases and Deaths (WRF)

Health facility name and type		Woreda	
Zone		Region	
Start of week from Monday _____/_____/_____toSunday_____/_____/_____ (day)(month)(Year in Ethiopian Calendar)(day) (month)(Year in EC)			

1.Record below thetotal number of cases and deaths for each disease/condition for the current week.

Indicator		Out • Patient	In • Patient	
		Cases	Cases	Deaths
TotalMalaria (confirmed andclinical)				
Total malaria suspected fever cases examined by RDT or Microscopy				
Number cases positive for malariaparasites (either by RDT or Microscopy)	P. falciparum			
	P. vivax			
Meningitis				
Dysentery				
Typhoid fever				
Relapsing fever				
Epidemic Typhus				
Severe AcuteMalnutrition /MUAC < 11cmand/orBilateral Edema in under 5 years children (new cases only)				

RDT = Rapid Diagnostic Test;MUAC = mid upper arm circumference

2.Report timeliness and completeness (to be filled only by Woreda Health Office and Zone/Regional Health Bureaus)

Indicator	Government			NGO Health Facility	Others
	H. Post	H. Center	Hospital		
Number of sites that are supposedto report weekly					
Number of sites that reported on time					

3.Summary for Immediately Reportable Case-based Disease / Conditions: (Total cases and deaths reported on case-based forms or line lists during the reportingweek)

DISEASE	C	D	DISEASE	C	D	DISEASE	C	D
AFP/Polio			Measles			SARS		
Anthrax			Neonatal Tetanus			Small pox		
Cholera			Pandemic Influenza			Viral hemorrhagic fever		
Dracunculiasis (Guinea worm)			Rabies			Yellow fever		
Other (specify):			Other (specify):			Other (specify):		

C = case; D = death; SARS = severe acute respiratory syndrome NOTE: Official counts of immediately notified cases come only from case forms or line lists.

c. Daily Epidemic Reporting Form

Daily Epidemic Reporting Format for Woreda (DERF – W)

Region _____Zone:_____ Woreda:_____Reporting Date_____/ _____/ _____
(day)(month)(Year • EC)

Reported Cases for the Day

Epidemic Disease	Name of Kebeles Affected	Date of onset of the Epidemic	<5 years		5-14 years		15-44 years		45+ years		Total		
			M	F	M	F	M	F	M	F	M	F	M+F

Reported Deaths for the Day(facility and verified community deaths)

1. Laboratory investigation and Result

Lab specimen taken?YesNo	Type of specimen (specify)	Number taken	Result
When? ___/ ____/ _____ (day) (month)(Year • EC)	For which disease		

Main determinant of the epidemic

_____

Control measures taken

_____

Name and signature of the reporter_____ Tel _____

d. Threshold levels for declaring an epidemic for disease under surveillance

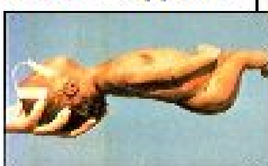
Name of the diseases	Action threshold level
AFP	A single laboratory confirmed wild polio virus case
Anthrax	A single suspected or confirmed anthrax case
Avian human Influenza	A single suspected or confirmed Avian human Influenza case
Cholera	Single suspected or confirmed cholera case
Dracunculiasis/ Guinea Worm	Single suspected or confirmed guinea worm case
Measles	Five suspected measles cases in one month OR3 confirmed measles cases in one month
NNT	A single suspected NNT case
Pandemic influenza	A single confirmed Pandemic influenzacase
Rabies	A single suspected or confirmed rabies case
Smallpox	A single suspected or confirmed smallpox case
SARS	Single suspected or confirmed SARS case
VHF	Single suspected or confirmed case of Ebola or Marburg or Lassa fever or Rift Valley Fever or Congo-Crimean hemorrhagic fever or dengue hemorrhagic fever.
Yellow fever	Single suspected or confirmed case of Yellow fever.
Dysentery	Unusually increased in number of the cases ORDoubling of cases on subsequent weeks
Malaria	Crossing the norm line OR Doubling of cases compared to the same week of the previous year
Meningococcal Meningitis	If Population< 30,000: five cases in a week OR Doubling of cases over 3 week period, If Population> 30,000: AR of 10/100,000 populationper week
Relapsing fever	Unusual increase of the cases OR Doubling of cases on subsequent weeks
Severe Acute Malnutrition	To be determined locally at kebele level
Typhoid fever	Unusual increase of the casesOR Doubling of cases on subsequent weeks
Typhus	Unusual increase of the cases OR Doubling of cases on subsequent weeks

e. At the Community/health post case definition for immediately report

Table 3-3 Community Case Definition for Immediately and Weekly Reportable Diseases / Conditions for Health Posts and community levels.

ወዲያውኑእናበየሳምንቱሪፖርትየሚደረጉበሽታዎች/ ሁኔታዎችየማህበረሰብየበሽታመግለጫበጤናኬላናበማህበረሰብደረጃየሚያገለግል

ቁ. I	በሽታ/ሁኔታ Disease/Conditions	የበሽታመግለጫ Case Definition
I.Immediately Reportableወዲያውኑሪፖርትየሚደረጉ		
1	Acute Flaccid Paralysis አጣዳፊየልጅነትልምሻ 	Any person with sudden onset of paralysis of the limbs. አጣደፊየሆነየእጅየእግርወይምየሁለቱምመዛል /መዝለፍለፍ/የተከሰተበትማንኛውምሰው
2	Anthrax አባሰንጋ	A person who gets ill within 7 days after eating meat of sick animals or close contact with animals that have bleeding from nose, mouth and anus. የታመመእንስሳሥጋበልቶወይምከአፍንጫቸውከአፈቸውእናከፊንጥጣቸውደምየሚፈሳቸውእንስሳት ጋርየቅርብንክኪአድርጎ 7 ቀናትውስጥየታመመማንኛውምሰው
3	Acute Watery Diarrhea አጣዳፊተቅማጥናትውከት	Any person 5 years of age or more with profuse acute watery diarrhea and vomiting. መጠኑየበዛአጣዳፊናውሃመሰልተቅማጥእንዲሁምትውከትያለውዕድሜው 5 አመትናከዚያበላይየሆነማንኛውምሰው
4	Dracunculiasis / Guinea Worm ጊኒወርም 	A person who has painful,burning blister OR A ruptured blister with the emergence of one or moreguinea worms. ከፍተኛህመምናየማቃጠልስሜትያለውውሃየቋጠረአብጠትያለውሰውወይም የፈነዳውሃየቋጠረአብጠትሆኖአንድወይምከዚያበላይየጊኒትልከውስጡየሚወጣውቁስልያለውሰው

ተ.ቁ	በሽታ/ሁኔታ Disease/Conditions	የበሽታመግለጫ Case Definition
5	Influenza like Illnesses ጉንፋንመሰልበሽታዎች	Any individual with fever, cough, sore throat, shortness of breath and difficulty of breathing, chest pain;AND/OR Has history of contact during the 7 days prior to the onset of symptoms with sick or dead birds, including chickens. [illegible]
6	Rashes ሽፍታየሚያመጡበሽታዎች 	Any person with fever and vesicular, maculopapular or pustularrashes on any part of the body. [illegible]
7	Neonatal Tetanus የጨቅላህፃናትመንጋጋቆልፍ 	Any newborn with a normal abilityto suck and cry during the first two days of life, and who, between the 3rd and 28th day of age, cannot suck normally, and becomes stiff or has convulsions or both. [illegible] 3-28 [illegible]
8	Rabies የዕብድውሻበሽታ	A person bitten by suspected mad dog or other animal. ማበዱበተጠረጠረውሻወይምሌላእንስሳየተነከሰማንኛውምሰው
9	Hemorrhagic diseases የመድማትበሽታዎች	Any person who has severe illness with fever and bleeding from gums, nose, eye, or skin. [illegible]
II. Weekly Reportableበየሳምንቱሪፖርትየሚደረጉ		
1	Acute Febrile Illness አጣዳፊየትኩሳትበሽታዎች	Any person with fever, severe headache and /or diarrhea ትኩሳትከበድራስምታትእና/ወይምተቅማጥያለውማንኛውምሰው
2	Bloody diarrhea የደምተቅማጥ	Any person with diarrhea and visible blood in the stool ደምየተቀላቀለበትተቅማጥያለውማንኛውምሰው
3	Malaria ˆv	Any person with fever OR fever with headache, back pain, chills, rigor, sweating, muscle pain, nausea and vomiting OR suspected case confirmed by RDT ትኩሳትያለው ወይም [illegible] ወይም [illegible]
4	Meningitis ማጅራትገትር	Any person with fever, severe headache and neck stiffness ትኩሳትከበድራስምታትናየአንገትአለመታጠፍያለውማንኛውምሰው

III. Annexes four INTERVIEW GUIDE QUESTIONS

1. What are the major activities carried out in the epidemic outbreak of the emergency infectious disease?
2. During outbreak who is involved to report and response to make decision
3. What data are captured and how are reports are organized and reports
4. What are the shortcomings of the existing system (paper based) to report emergency infectious disease if any

Declaration

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

Declared by:

Name:_____

Signature:_____

Date:_____

Confirmed by advisor:

Name:_____ Name:_____

Signature:_____ signature:_____

Date:_____ date:_____