



**ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES**

**DESIGN AND DEVELOPMENT OF PUBLIC HEALTH RECORD
COLLECTION SYSTEM USING MMS**

**By:
Andualem Workneh**

**A Project paper submitted to the School of Graduate Studies of Addis
Ababa University in partial fulfillment of the requirements for the
Degree of Master of Science in Computer Science**

June, 2009

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
FACULTY OF INFORMATICS
DEPARTMENT OF COMPUTER SCIENCE

DESIGN AND DEVELOPMENT OF PUBLIC HEALTH RECORD
COLLECTION SYSTEM USING MMS

By: Andualem Workneh

Name and Signature of members of the Examining Board:

NAME	SIGNATURE
1. Dr. Solomon Atnafu, Advisor	_____
2.	_____
3.	_____

Acknowledgment

First and for most I would like to express my gratitude to my advisor, Dr. Solomon Atnafu, for deep concern, constructive comments and suggestion he has given from the beginning to the end of this project.

I would like also to extend my very sincere and special thanks to my mother for providing me all the necessary assistance during my work.

Lastly, my special gratitude and respects goes to my friends, who supplied me with all the necessary information and valuable comments.

Table of content

1	Introduction.....	1
1.1	Overview	1
1.2	Statement of The Problem.....	2
1.3	Objective of The Project	4
1.3.1	General Objective	4
1.3.2	Specific Objective.....	4
1.4	Scope of The Project	4
1.5	Methodology	5
1.6	Application of The Project.....	5
1.7	Outline of The Document.....	6
2	Related Work	7
2.1	Overview	7
2.2	Multimedia Messaging Service.....	7
2.3	Application Of Mobile Messaging In Health Care	9
2.3.1	Medical In-Field Diagnostic Assistant (MIDA).....	10
2.3.2	Click Diagnostic.....	10
2.3.3	Cell-Preven	11
2.3.4	The Dokoza System	12
2.3.5	Episurveyor	12
2.3.6	Mobile Phone For Tele-Dermatology.....	13
2.4	Drawbacks Of The Reviewed Systems	13
3	The Current System	14
4	System Analysis.....	16
4.1	Overview	16
4.2	Functional Requirement	16
4.3	Non-Functional Requirement.....	17
4.4	Model Analysis.....	17
4.4.1	Use Case Model	17

4.4.2	Sequence Diagram	26
4.4.3	Class Diagram	31
5	System Design.....	33
5.1	Overview	33
5.2	Design Goals	33
5.2.1	Performance Criteria.....	33
5.2.2	Dependability Criteria.....	33
5.2.3	Maintenance Criteria.....	34
5.2.4	End User Criteria	34
5.3	System Architecture	34
5.3.1	Subsystem Decomposition.....	35
5.3.2	Hardware/Software Mapping.....	37
5.3.3	Persistent Data Management	38
6	Implementation	41
6.1	Programming Tools.....	41
6.2	The Multimedia Data Collection System (MMDCS)	42
6.3	Evaluation.....	55
7	Conclusions And Recommendation	56
7.1	Conclusion.....	56
7.2	Recommendation.....	57
8	References.....	58

List of Tables

Table 4.1 Actors of the system	18
Table 4.2: Description of ReportCase use case	20
Table 4.3: Description of getAssistance use case	21
Table 4.4: Description of generateReport use case.....	22
Table 4.5: Description of registerUser use case	22
Table 4.6: Description of removeUser use case	23
Table 4.7: Description of ViewreceivedMessage use case.....	24
Table 4.8: Description of GiveAssistance use case.....	24
Table 4.9: Description of getReport use case.....	25

List of Figures

Figure 2.1 Structure of the Multimedia Messaging Service	9
Figure 4.1 use case diagram	19
Figure 4.2 Sequence Diagram for ReportCase use case	26
Figure 4.3 Sequence Diagram for GetAssistance use case	27
Figure 4.4 Sequence Diagram for Generate Report use case.....	28
Figure 4.5 Sequence Diagram for Register user use case	29
Figure 4.6 Sequence Diagram for Remove user use case	29
Figure 4.7 Sequence Diagram for view Received message use case.....	30
Figure 4.8 Sequence Diagram for Give Assistance use case.....	31
Figure 4.9 Class diagram of the system	32
Figure 5.1 Architecture of the proposed system	35
Figure 5.2 Subsystem decomposition and dependence diagram	36
Figure 5.3 Deployment diagram of the system	38
Figure 5.4 Tables and relationship among them	40
Figure 6.1 Login form for the mobile application.....	42
Figure 6.2 List of functionalities in the mobile user's side.....	43
Figure 6.3 Case Reporting main form.....	44
Figure 6.4 Patient Record form	45
Figure 6.5 Epidemic Reporting Form.....	45
Figure 6.6 Assistance Request form.....	46
Figure 6.7 Case Reporting Form	47
Figure 6.8 Patient Record Form	48
Figure 6.9 List of options in Case reporting Form.....	49
Figure 6.10 Case Reporting form with attached Image.	50
Figure 6.11 Assistance Request Form	51
Figure 6.12 List of reported cases Accessed via the Web interface	52
Figure 6.13 Detail Information for the selected reported case	53
Figure 6.14 Report Generated for a particular case	54
Figure 6.15 System Administrator's page.....	54

Abbreviations

EMS	Enhanced Messaging Service
FMoH	Federal Ministry of Health
GPRS	General Packet Radio Service
GSM	Global System of Mobile
HC	Health Center
HEP	Health Extension Program
HEW	Health Extension Worker
HTTP	Hyper Text Transfer Protocol
J2ME	Java 2 Micro Edition
MMS	Multimedia Messaging Service
MMSC	Multimedia Messaging Service center
RHB	Regional Health Bureau
SMS	Short Messaging Service
SMSC	Short Messaging Service Center
URL	Uniform Resource Locator
WAP	Wireless Application Protocol
WHO	Woreda Health Office

Abstract

Mobile technology is playing a great role in communication and service delivery to users. Currently it is capable of providing voice calls, messaging services and more. With the help of messaging services, text, image, audio can be sent from a mobile subscriber to another mobile subscriber or to a third party application.

Messaging services such as SMS and MMS are also applicable in data collection and remote monitoring in different domain. Such applications are developed and used in health data collection and remote patient monitoring. In this project, MMS-based data collection is designed and developed for remote data collection to support the current data collection task of diseases surveillance activity in Ethiopia. In the project, the current workflow and procedure of data collection in disease surveillance and reporting were studied. In the current system, since data collection is done using paper forms, data reporting and analysis takes much time. To overcome this limitation, MMS-based data collection application was designed and a prototype is developed.

Keyword: MMS-based data collection, Disease surveillance, Multimedia Messaging Service

1 INTRODUCTION

1.1 OVERVIEW

Information is a main factor that determines the economic growth of a country. It is one important input for performing different tasks in several sectors including education, health, transportation, etc. As a result, information processing and delivery becomes an important part of an organization's overall operation.

Currently handheld devices like PDA and mobile phone are contributing their parts to fulfill information processing and delivery requirement of an organization. These handheld devices are capable of providing number of services. One of the services is collection and delivery of information from remote site. This service can be used by field workers. It can be done through messaging services like Short Message Service (SMS) and Multimedia Messaging Service (MMS).

SMS was developed as part of Global System for Mobile Communication (GSM) network in 2G mobile system. It is capable of delivering text message of up to 160 characters. Latter in 1990s, Enhanced messaging service (EMS) was proposed by Ericsson to send formatted text messages and ring tones. And at the time 2.5 General Packet Radio Service (GPRS) mobile phone system was introduced, Multimedia messaging services (MMS) were included to add multimedia support for mobile messaging service. MMS is also a part of the current 3G mobile network system. It is a non-real-time multimedia service that allows mobile subscribers to exchange arbitrary types of information in a store-and-forward manner. Multimedia message can consist of text, images, audio or video clips, or any combination of these [7, 8].

Currently there are SMS-based applications used for data collection. These systems are widely used in health care programs in different countries. For instance, mobile phone based data monitoring and

disease management applications were developed in Latin America and Africa [1, 5]. Similarly, SMS-based application was launched by UNICEF Ethiopia to monitor massive food distribution program to supply the high-protein food Plumpy'nut to under-nourished children [4].

In this project, MMS-based data collection system is planned to be designed and developed so that in addition to text message, media types like audio and image can be collected. This application is designed for public health record collection and monitoring that can be used in the health Extension and disease surveillance program of the country.

1.2 STATEMENT OF THE PROBLEM

In Ethiopia, Health Extension Program (HEP) was introduced in 2003 to provide health service at village (kebele) levels of the country. HEP is an innovative community based program aims at creating healthy environment and community by making available essential health services at the grass roots level. To implement the program, two health extension workers (HEW) are assigned in each village (kebele). They conduct house to house visit, educate families, monitor the spread out of communicable and epidemic diseases, and report cases to the next health facility [3]. And during their day to day activity, data collection is the main task to be done.

In the current approach, Health extension workers collect data by using paper or pre-designed form and report it back to the near-by health center or Health post. This will create delay to respond to the reported issue on time. The collected data from the field can also be lost or damaged in the way to the near-by health center. In addition, since the data collection is paper-based, it becomes difficult to analyze the collected data or to retrieve required document from the collection.

To solve these problems, in some countries, SMS-based data collection application is used to collect both quantitative and qualitative data through SMS form. The collected data can then be sent to a central database server. In this approach, fast delivery of data reduces the amount of time required to respond to the reported problem. In addition, the collected data is stored in a database and that makes latter retrieval and processing easy [6]. But using text-based data collection alone has disadvantages like risk of inaccurate data input, misunderstanding or misinterpretation of data, and lack of ability to capture the verbal and non-verbal cues that may also influence the context and interpretation of the message [2, 6]. As a result of these drawbacks, enhanced data collection approach is required.

The proposed approach for field data collection can be done using MMS. With this service, audio, image, and text can be incorporated. By taking picture of object-of-interest or by recording data in audio form, the field worker can collect and send the required data to the central server. One advantage of using MMS is that, it enables the field worker to collect data without typing. As a result, data collection can be done easily with minimum data entry error. In addition, with this new approach, drawbacks listed in using SMS technology such as misinterpretation of content can be solved. Hence, in this project, MMS-based data collection was designed and developed to solve the aforementioned drawbacks.

1.3 OBJECTIVE OF THE PROJECT

1.3.1 GENERAL OBJECTIVE

The main objective of the project is to design and implement a multimedia health data collection system.

1.3.2 SPECIFIC OBJECTIVE

The specific objective includes:

- Conducting literature review to study related systems which are already implemented in different countries.
- Identifying requirement of the system.
- Designing a multimedia health data collection system
- Developing a prototype to demonstrate the practicability of the designed system on the basis of the identified requirement.
- Evaluating the developed prototype against its requirements.

1.4 SCOPE OF THE PROJECT

The system planned to be designed and developed in this project allows the health workers to collect health records and to report incidents to other health professionals while they are in field work. In addition, in the server side, the system is designed to allow users to access the collected data which is stored in the database. But the developed prototype is not tested in actual mobile network since MMS service was not released by the service provider during the project. In addition, the developed prototype is limited to disease surveillance and reporting and it doesn't consider other data collection duties of the health worker.

1.5 METHODOLOGY

In order to design and develop the system,

- Literature review has been conducted to study and analyze the previous efforts in this domain.
- Interview with different parties has been done to find out what data needs to be collected, how the collected data is analyzed and monitored in the health service provision.
- Requirements of a health data collection system have been identified.
- Based on the requirement identified, the system has been designed
- Prototype has been developed and then tested in the identified target environment. During implementation stage, programming languages, simulators and other software tools were selected and used.

For the overall system development life cycle, object-oriented software development approach is used.

1.6 APPLICATION OF THE PROJECT

The result of this project can be used to support the existing data collection mechanism used by health extension works. It enables the workers to collect records in the form of text, image and/or audio and send it to the central server with multimedia database. The collected content can then be accessed through web based interface by interested parties for decision making, monitoring of public health data and thereby improve health management and disease prevention activities. This application can particularly be applied to support disease surveillance and reporting activity. For instance health worker can collect health related data about disease incidents and outbreaks in the area and report it immediately to the next health facility with the help of his/her mobile phone.

1.7 OUTLINE OF THE DOCUMENT

This project report contains seven Chapters including this Chapter. In the next Chapter, reviewed literatures are presented. In Chapter three, the current system and its limitation are presented. In Chapter four and five, requirement analysis and design of the proposed system is presented. In the remaining Chapters, the developed prototype is shown and then conclusions and recommendation is given.

2 RELATED WORK

2.1 OVERVIEW

In public health monitoring program, health record collection and reporting is the main task to be done. Health centers, regional health bureaus, hospitals, and other parties in the health sector need accurate data for making better decision and designing policies and programs based on the health facility requirement of the community. To achieve this objective, health workers and health professionals are assigned in health centers and health posts [3].

Currently paper-based data collection is used. In this case, the health workers fill in the pre-designed form and report it to the nearest health facility. With this approach, the collected data can be analyzed manually or with the help of computer system. Because of this, information delivery and reporting takes much time. But, by making use of mobile messaging service for public health data collection, the health worker can collect data and send it to computer system directly. With this approach, data entry error and time required from data collection to analysis is reduced [22]. In different countries such as South Africa, Uganda, Kenya, mobile based data collection applications are implemented by using messaging services: SMS and MMS [13].

2.2 MULTIMEDIA MESSAGING SERVICE

Mobile phone is capable to provide messaging services such as short message service (SMS) and multimedia messaging service (MMS). SMS is a globally accepted wireless service that allows mobile users to send and receive alphanumeric message of up to 160 characters. It delivers messages in a store-and-forward approach to guarantee message delivery to the recipient. The other messaging service is MMS. It is the successor of SMS. It is capable of delivering multimedia contents like audio, image, video clip and

text. Similar to other messaging services like e-mail and SMS, MMS is viewed as a non-real-time message delivery [9].

A typical MMS network consists of MMS client, MMS gateway, MMS sever, SMS center (SMSC), and other third party value added systems. The MMS client is a device through which the user receives or sends multimedia message. It can be a mobile phone or a computer system which is connected with the mobile network. When MMS message is sent to a recipient, what it is actually sent is an MMS notification message which is sent over SMS. For this purpose, the SMSC is taken as part of the MMS network. The MMS notification message consists of header information about the MMS message and a URL pointer from which the actual MMS message can be fetched.

The client device can send and receive MMS message to the gateway by using Wireless Application Protocol (WAP) and Hyper Text Transfer Protocol (HTTP). First the sending client initiates data connection with the MMSC over GPRS network and performs HTTP POST to the messaging center to send the multimedia message. Once the MMSC receives the message, it stores the message and sends notification message to recipient. The notification contains URL to the multimedia message and it is sent via SMS network [23]. The message center is also responsible to switch message between different nodes in the network. That is, it can switch message between two MMS clients or between MMS client and e-mail user. The multimedia message service center (MMSC) is also known as MMS gateway [9].

The other component of the MMS network is the MMS server. It stores the multimedia message permanently. The server provides persistent storage for the message on the network. And from this persistent storage, the stored message can be accessed by other third party applications [9, 10]. The overall structure of the MMS network is shown in Figure 2.1.

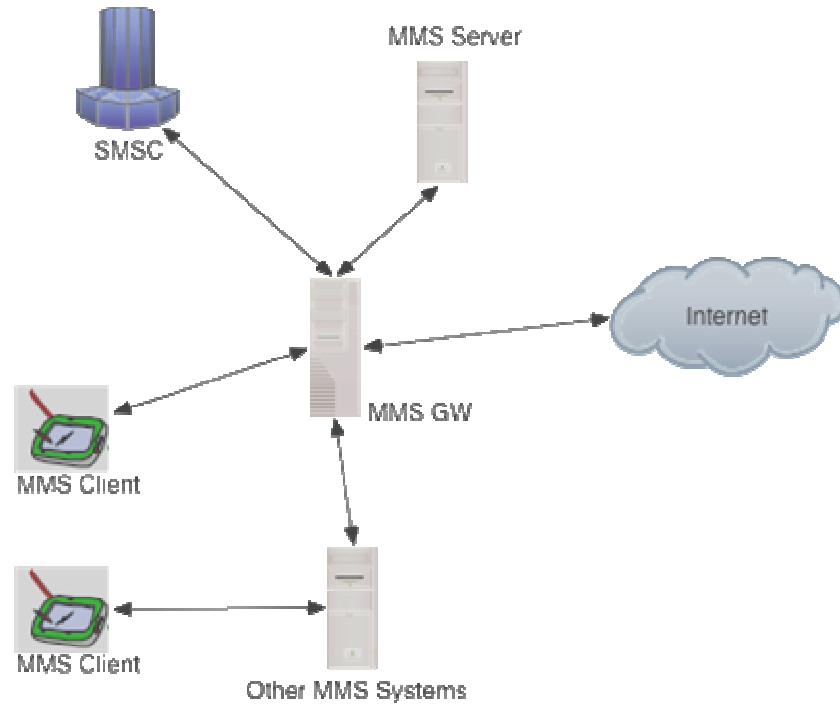


Figure 2.1 Structure of the Multimedia Messaging Service

Interconnection between components of the network is made through different MMS protocols. Communication between MMS clients (phone-to-phone communication) is via MM1 protocol. MM3 protocol is used between other messaging systems like e-mail and MMSC. MM4 protocol is used between two MMSCs and MM7 protocol is used between MMSC and third party applications [11].

2.3 APPLICATION OF MOBILE MESSAGING IN HEALTH CARE

Currently mobile technology is used for better health service provision. A range of mobile based applications were developed. These applications are categorized based on their purpose. These include mobile applications for education and awareness, applications for remote data collection and monitoring, applications for communication and training, applications for remote diagnostic and treatment support and applications for disease and epidemic outbreak tracking. Under data collection application category, there are several mobile phone based applications. These applications were used

for data gathering from remote areas. Such applications have been deployed in many developing countries mainly as a pilot project [13]. Some of these applications are discussed in the following sections.

2.3.1 MEDICAL IN-FIELD DIAGNOSTIC ASSISTANT (MIDA)

MIDA aims to help isolated rural health workers with a free, interactive diagnostic support tool to enhance their work and also to compile health information to assist government and NGO workers. Currently the project is in its first phase of selecting pilot program in the hosting countries. MIDA uses mobile technology to minimize system running cost and to realize mobility. With the help of this system, rural health workers can get assistance from the server by sending free text message with their mobile phone. Reported cases can also be accessed by health professionals in the health center through web interface. In addition the health authorities can be alerted early on to spreading epidemics by accessing data in real-time basis [12].

MIDA utilize a simple user interface through which field workers can submit query as SMS text-message to the central data-hub. The central system can then interpret and process the given query automatically and provide medical diagnostic information back to the field worker. Through the series of SMS message exchange, the field worker can get solutions to the reported problem. The system is also capable of routing the reported information to specialists via email for further consultation [12].

2.3.2 CLICK DIAGNOSTIC

Click diagnostic is a system developed to transform healthcare delivery through mobile telemedicine. It is piloted and deployed in developing countries such as Botswana, Malawi, Egypt, Ghana, and Bangladesh. University of Pennsylvania's Global Health Program and MIT's Innovations in International Health were involved in this project. Click Diagnostic system

enables health-workers to provide advanced medical consultation and to gather health data by connecting to global health servers via mobile phones. It is designed to provide different services such as remote consultation and diagnosis, early diseases detection and warning and public health data-gathering. For instance, with the help of this system, health workers can take pictures of people's eyes or skin and transmit the picture to doctors for diagnosis. For this purpose, mobile phone with multimedia messaging capability is used [17].

2.3.3 CELL-PREVEN

Cell-Preven is a system that combines the phone and internet to create a real-time surveillance system of adverse events. It is tested in Peru as a pilot project. The overall goal of this application was to develop an interactive-computer system using cell phones for real-time data collection and transmission of adverse events. with the help of this application, data can be collected by interviewers from field and the collected data can be sent to an online database where it could be accessed immediately. In addition selected symptoms can be reported to key personnel via e-mail and SMS messages to act on it on time.

This pilot project has demonstrated that it is feasible to develop a public-health surveillance system based on cell phones to collect data in real-time in Peru. Cell phone is chosen in this project because it is affordable by most users and requires limited infrastructure to run in remote areas where internet connectivity and electric power supply is limited. Before Cell-preven is implemented, reports were collected on paper. Because of this, on time delivery and analysis of data can not be achieved. But with the help of this application, health workers can collect data and report adverse events and disease outbreaks from field and the collected data can then be analyzed on time to give immediate response [14].

2.3.4 THE DOKOZA SYSTEM

The Dokoza System is SMS based mobile system designed to fast-track and improve critical services to patients. Initially it was developed for HIV/AIDS and TB patients but extended to include other diseases patients. The project is implemented in South Africa to mainly solve the problem of data-sharing in health sector. The system involves the use of SMS and cell phone technology for information management, transactional exchange and personal communication. The cell phone makes use of an existing mobile technology and normal SMS text message. As a result it does not require special additional software for interacting. Dokoza's back-end system is extensively rule based for intelligent interaction to build the capacity of health workers with little knowledge and experience. The Dokoza system is also integrated with the existing hospital system for data sharing [13].

2.3.5 EPISURVEYOR

EpiSurveyor is developed by non-profitable software provider, DataDyne. Currently the system is tested in Kenya, Uganda, Zambia and other developing countries. It enables public health workers and development professionals to create, share, and deploy health surveys and other forms on mobile devices. The program is free and open software. It is easy to use, and can be downloaded to handheld devices so that workers can use it in the field. It makes data more accessible and strengthens healthcare programs like immunization and disease outbreak reporting. Besides EpiSurveyor makes data analysis faster and provides common data collection platform [15].

2.3.6 MOBILE PHONE FOR TELE-DERMATOLOGY

Tele-dermatology is a subset of telemedicine that incorporates telecommunications technology (information technology) to deliver dermatology service at a distance. In dermatology, examination is primarily based on visual inspection. Because of this, visual information can be passed as digital image for tele-consultation and tele-diagnosis.

For such application, images can be transmitted electronically by using MMS functionality of mobile phones. Currently new generation cellular phones allow taking good quality images and transmitting them directly to other cellular phones via messaging services. Such application is very helpful in the case where there is lack of dermatologists or when the patient is in remote area so that face-to-face communication or consultation is impossible. Several experiments were conducted to test the applicability and quality of mobile-phone-captured images for tele-dermatology application. And the result of this pilot study showed that transmitting images via MMS for tele-dermatology is applicable under certain specified conditions [16].

2.4 DRAWBACKS OF THE REVIEWED SYSTEMS

The reviewed systems are used for mobile based data collection and for disease outbreak tracking. From this review, the following drawbacks were identified.

- The systems use text messaging technology as a main means of communication. And most of them don't yet support multimedia messaging service.
- In addition the systems do not use forms for data entry. Rather free text messaging is used by using the built in messaging interface. As a result of this, guiding information or manual is required to help the data collector on how to collect and report data.

3 THE CURRENT SYSTEM

The health care system organization in Ethiopia is a decentralized system. It consists of The Federal Ministry of Health (FMoH), the Regional health bureaus (RHB), and the woreda health offices (WHO). FMoH and RHB functions more on policy related issues. The woreda health office on the other hand is responsible to manage and coordinate the operations of the primary health care service [18, 19]. On the average, the primary health care unit consists of one health center and five satellite health posts. In each primary health care unit, health workers are assigned to give service to the community [3, 20].

The health extension workers are responsible to conduct house to house visit, educate families, monitor health condition of families, and report cases such as disease outbreaks which is seen in the village. In this case, data collection is the major task which is done regularly so as to track the health status of the community. Currently data collection is done by using paper-based forms. The collected data can then be reported to other stakeholders such as health center, woreda health office, regional health bureau and/or FMoH depending on the type of the case. Other media like phone call can also be used to report incidents which need to be reported immediately.

Analysis on the collected data can then be done either manually or with the help of a computer. Manual data analysis is error prone and time consuming task. To minimize this problem, computer application programs like MS-Excel are used. But this approach requires entering the collected hardcopy data into the computer system manually. As a result, error can be introduced during data-entry.

The main drawback of the current system is in both data collection and data analysis approaches. Since data collection is paper based, data reporting and analysis takes much time. With this data collection and analysis mechanism, health programs such as disease surveillance and reporting are facing great challenges.

In the case of disease surveillance and reporting program, since the program is implemented for early detection and timely response for communicable diseases, it requires efficient data collection and analysis approach. Currently in this program, about nineteen communicable diseases were identified and are under close surveillance. These diseases are kept in two categories. The first category contains communicable diseases that need to be reported immediately when their symptom is seen. In this case, health workers who notice the symptom should report to the nearest health facility or to surveillance focal person. The report should then be delivered at federal level within 24 hours.

The other category contains list of diseases which are under routine surveillance. This category includes all diseases which are in the first category and also other communicable diseases. In this category, the existence of these diseases will be surveyed and reported weekly.

Because of limited communication infrastructure, reporting cases is mainly by paper reports. In this case, reports may take days before they reach the concerned health service provider. And in worst case, disease cases may be left unreported at all. Another problem in the current system is that even though the report reaches on time, analysis may take time since it requires data entry of all forms received.

The current system, since reporting is based on pre-prepared reporting formats, it has no option of reporting images. For some diseases whose symptoms can only be identified by images, the current system has no option.

After observing the problems of reporting in the current system and considering the available technologies, it is our believe that most of these problems can be solved.

4 SYSTEM ANALYSIS

4.1 OVERVIEW

Taking into account the drawbacks of the current data collection system, we have proposed an MMS-based data collection system to support the current system. The proposed system will allow the health extension worker to collect data with the help of mobile phone. This system is designed to support disease surveillance program of the country.

With the help of this proposed system, the health worker can report disease cases from site to the health center by sending multimedia message. The message can then be stored in a database and accessed by other users in the health center. As a result, this system can greatly reduce the amount of time required to report incidents and help to achieve the time constraint set.

The proposed system will have the following functional and non-functional requirements to support health worker in collecting data related to disease surveillance.

4.2 FUNCTIONAL REQUIREMENT

The functional requirement of the system is concerned with the functionality that the system should provide to users. This system is designed to enable users to collect health records related to disease surveillance. It can also provide a means for health workers to request assistance from remote site and get information on how to treat a patient. The functional requirements are listed as follows.

- The system should enable users (the health extension worker) to report cases through multimedia messaging service.
- The system should enable system administrators to generate weekly report based on the collected data
- The system should have a feature to manage group of system users

- The system should allow users to do analysis and query on the stored database based on their requirement.

4.3 NON-FUNCTIONAL REQUIRMENT

The non-functional requirement of the system deals with how well the system provides service to the user. It includes security, reliability and performance issues of the system.

- **Security requirement:** The system should be secured to avoid unauthorized access to the system both in the user side as well as in the server side.
- **Response time:** The system's response time should be applicable for urgent case reporting and should satisfy the minimum time requirement set by the user. For instance the maximum time required to transfer a new case from field to the next health facility is one hour. Therefore the Message and its acknowledgment should be delivered within limited time.
- **Concurrent user support:** The system should support concurrent users to communicate with the system.

4.4 MODEL ANALYSIS

4.4.1 USE CASE MODEL

4.4.1.1 ACTORS

An actor describes any entity that interacts with the system. In this system, the interaction of actors with the system is through either the mobile application which runs in the mobile device or through the web interface which is deployed in the health center. In the proposed system, the following actors were identified. The actors are listed in Table 4.1.

Table 4.1 Actors of the system

Actor	Description
Health worker	Health worker is a personal who is assigned at kebele (village) level to provide health service for the community
Health professional	Health professional is to refer to professionals who give service at the Health center. This includes medical doctors, nurses, and senior staffs in the health center.
Surveillance focal person	Surveillance focal person is an individual who is in charge of monitoring the disease surveillance activity in the woreda.
System administrator	System administrator is a person who maintains and administers the system

4.4.1.2 USE CASES

To better represent the functional requirement of the system, use case model is used. It is used to model the interaction between actors and the system. A use case describes a function provided by the system that yields a visible result to the actors. In the proposed system, the following use cases are identified. Figure 4.1 shows use case diagram of the system.

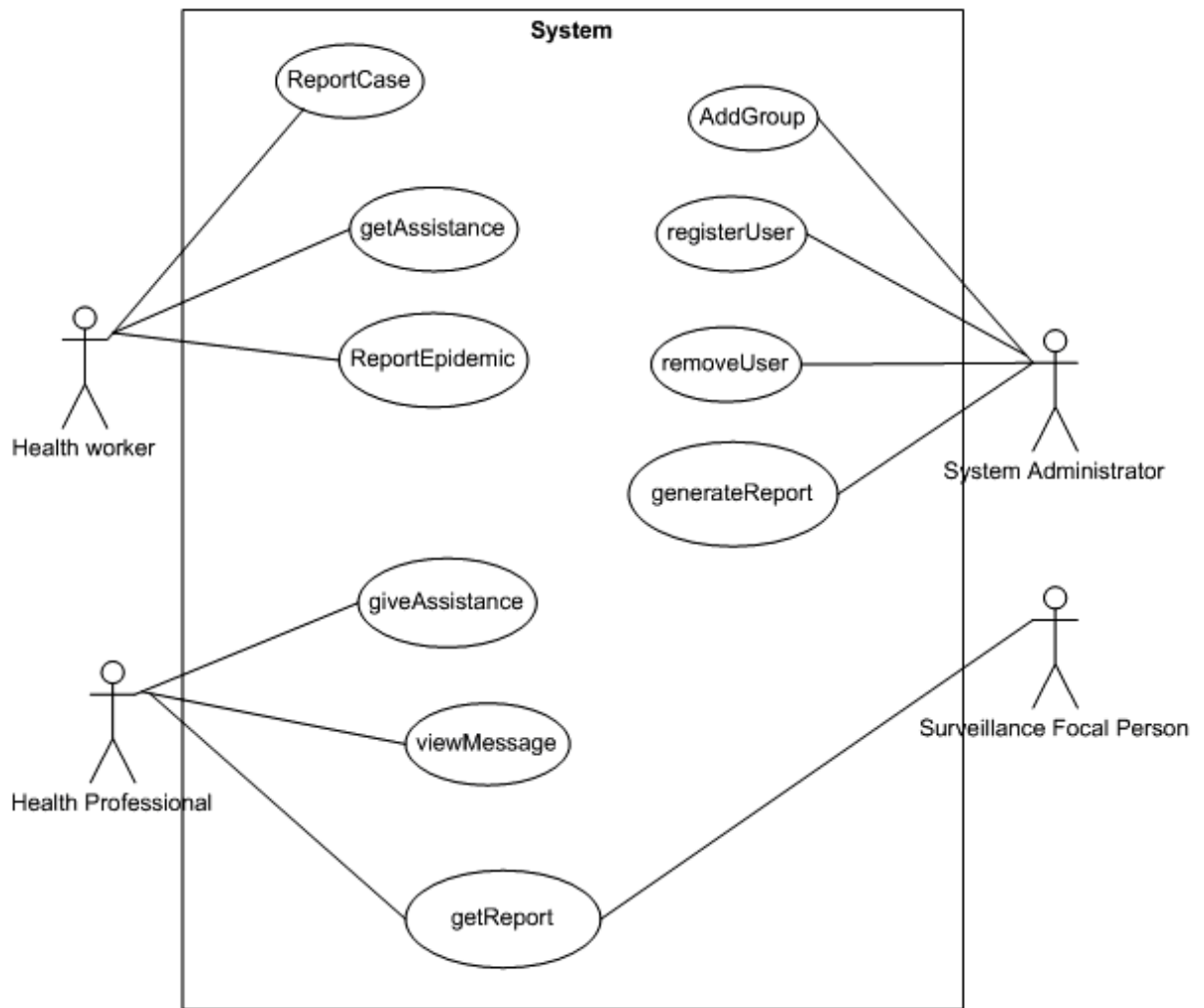


Figure 4.1 use case diagram

Report cases

Table 4.2: Description of ReportCase use case

Use case Name:	ReportCase
Actor:	Health worker
Description:	The health worker reports disease cases
Precondition:	The system must be started and the actor must be logged in
Flow of events	<ol style="list-style-type: none">1. Health worker activates the Report Case functionality from his/her mobile phone.2. Then fills the case reporting form. The form includes date/time at which the case occurs, type of the case, place where it is seen, name of patient and other related information. Image and audio contents can also be attached to the form to give more information about the case. After the form is filled, the health worker sends it to the health center. [Alt-A]3. The sent report is saved in the mobile phone temporarily.4. The surveillance focal person or the health profession in the health center can then accept the report from the web-based application5. Finally the system sends acknowledgment to the health worker who sends the report, when the report is delivered at the central system.
Alternate Flow	The system displays an error message if the filled form
[Alt-A]	is invalid and redisplay the form to the user.
Post condition:	The health worker receives acknowledgment for the reported case.

Get Assistance

Table 4.3: Description of getAssistance use case

Use case Name:	getAssistance
Actor:	Health worker
Description:	getAssistance enable the health worker to get assistance from the health professional on how to treat a particular case.
Precondition:	The system must be started and the actor must be logged in
Flow of events	<ol style="list-style-type: none">1. Health worker activate the get Assistance functionality from his/her mobile phone2. Fill the getAssistance form to report the symptoms and other information about the patient. In this case, to give detail information about the symptom, image and audio content can be attached with the form.3. Send the request to the Health professional at the health center. <p style="text-align: center;">[Alt-A]</p> <ol style="list-style-type: none">4. The health professional can receive the requested assistance from the web-interface and create a response to the request by invoking GiveResponse use case.5. Finally send the response to the health worker.
Alternate Flow	The system displays an error message if the filled form is invalid and redisplay the form to the user.
[Alt-A]	
Post condition:	The health worker gets response for the requested assistance.

Generate Report

Table 4.4: Description of generateReport use case

Use case Name:	generateReport
Actor:	System Administrator
Description:	Used to generate weekly report based on the collected record. This use case allows the System Administrator to generate reports.
Precondition:	The actor must be logged in and there should be stored record in the system
Flow of events	<ol style="list-style-type: none">1. The system administrator activates generate report functionality2. The system administrator specifies the type of the report to be generated and other parameters such as the date. [Alt-A]3. Report will be generated by the system automatically and presented to the system administrator. The report generated includes text, image, and audio content.
Alternate Flow	If the specified parameter is invalid, the system [Alt-A] displays message to the user to correct the error.
Post condition:	Report is generated and displayed to the user

Register new user

Table 4.5: Description of registerUser use case

Use case Name:	registerUser
Actor:	System administrator
Description:	Enable the system administrator to add new user to the system.
Precondition:	The system must be started and the actor must be

	logged in
Flow of events	<ol style="list-style-type: none"> 1. The system administrator activates register new user functionality 2. Fill the new user registration form and then activates registers the new user command [Alt-A] 3. The system displays confirmation to the system administrator
Alternate Flow [Alt-A]	If the filled form is invalid, the system displays error message to the system administrator and redisplay the form
Post condition:	The new user is registered

Remove User

Table 4.6: Description of removeUser use case

Use case Name:	removeUser
Actor:	System administrator
Description:	Enable the system administrator to remove an existing user.
Precondition:	The system must be started and the actor must be logged in
Flow of events	<ol style="list-style-type: none"> 1. The system administrator activates Remove user functionality 2. The system administrator selects the user to be removed from list of users and then activates remove user command. 3. The system displays confirmation to the system administrator.
Post condition:	The user is removed from the system

View Received Message

Table 4.7: Description of ViewreceivedMessage use case

Use case Name: ViewreceivedMessage

Actor: Health professional

Description: It is used to access received case or epidemic reports

Precondition: The system must be started and the actor must be logged in

Flow of events

- 1.** The health professional activates view received message functionality
- 2.** The system displays the received message on the screen. The user can then view the detail content of the message by using view detail link. The detail information includes the reported text, image and audio content.

Post condition: List of received message will be displayed

Give assistance

Table 4.8: Description of GiveAssistance use case

Use case Name: GiveAssistance

Actor: Health professional

Description: Enable the health profession to give assistance to the requested assistance by the health worker

Precondition: The system must be started and the actor must be logged in

Flow of events

- 1.** Activate the giveAssistance functionality of the system
- 2.** Fills the give assistance form to reply for the requested assistance. Assistance information is a multimedia content which includes text, image

and audio.

[Alt-A]

3. Then send the reply message to the health worker

Alternate Flow **[Alt-A]** If there is error in the reply message, the system will inform the user to correct it

Post condition: Reply is sent to the health work who requested assistance.

Get report

Table 4.9: Description of getReport use case

Use case Name: getReport

Actor: Health professional and surveillance focal person

Description: It allows the health professional (surveillance focal person) to get report.

Precondition: The actor must be logged in and there must be generated reports

Flow of events

1. Health professional or the surveillance focal person activates the getReport functionality
2. Specify the date or the week of the report which is required to be accessed and then request the report
3. Then the system displays the report for the specified period. The report includes multimedia content such as image and audio.

Post condition: Report will be displayed to the health professional or to the surveillance focal person

4.4.2 SEQUENCE DIAGRAM

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

4.4.2.3 REPORTCASE

Interaction between objects which are identified from ReportCase use case is shown in figure 4.2. The sequence diagram shows how the health worker report case from her mobile phone. He/She first initiate the use case via the boundary object and can report a case by submitting a filled form.

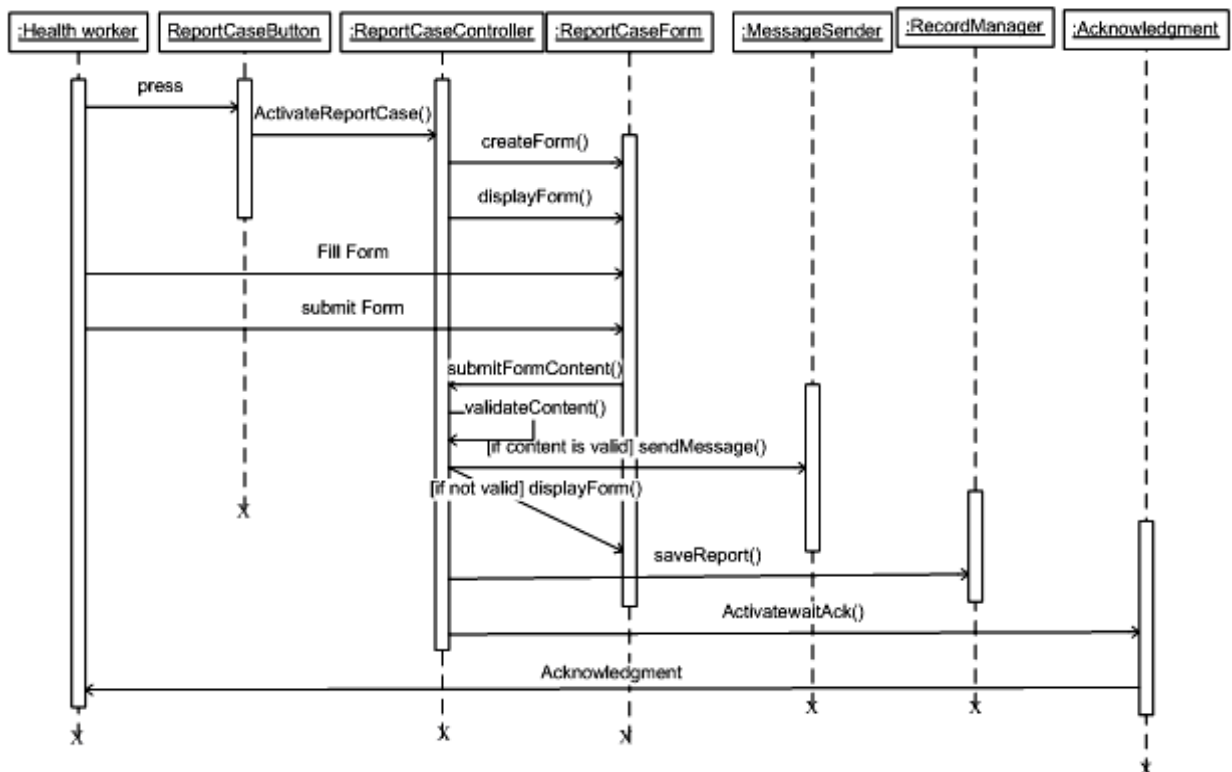


Figure 4.2 Sequence Diagram for ReportCase use case

4.4.2.4 GETASSITANCE

To request assistance, the actor, Health worker, first initiates the use case via boundary object. Once the use case is initiated, he can request assistance by submitting a filled form. The sequence diagram for the getAssitance use case is shown in Figure 4.3.

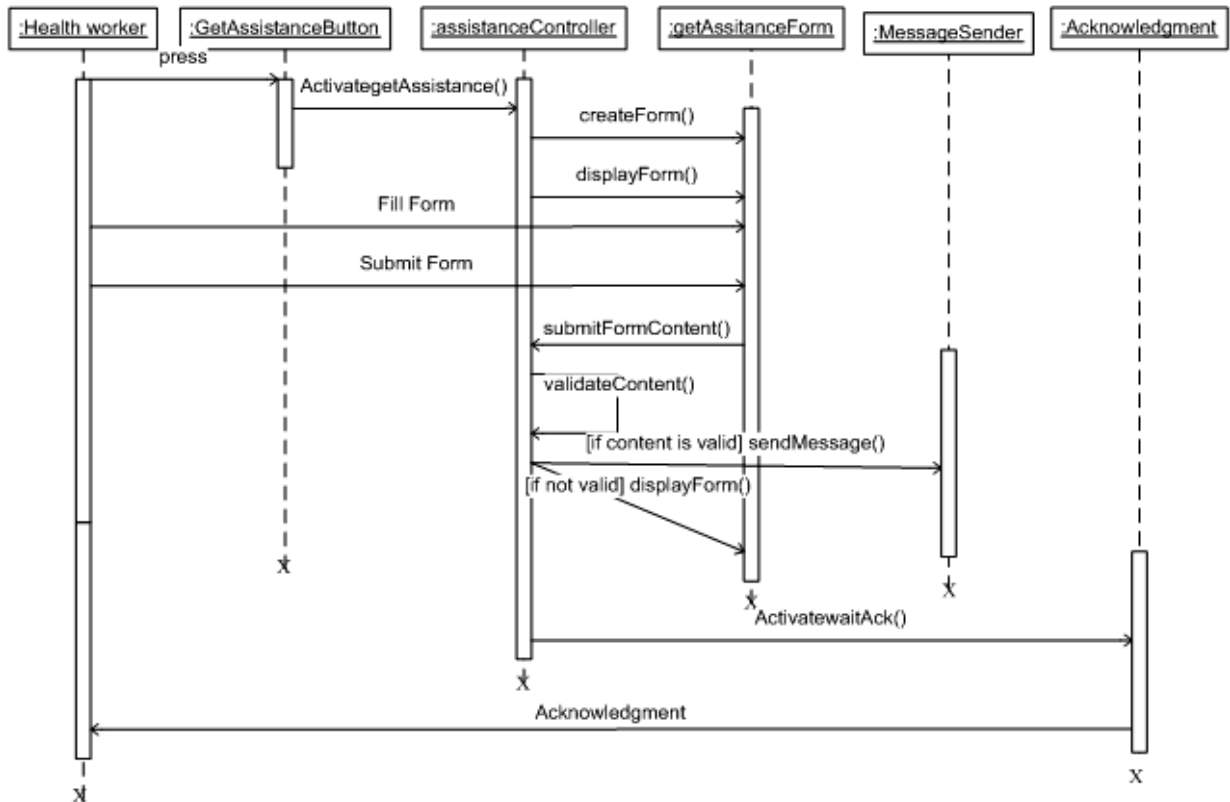


Figure 4.3 Sequence Diagram for GetAssistance use case

4.4.2.5 GENERATE REPORT

This use case is runs in the server side. It enables the system administrator to generate report based on the collected data. The use case is first initiated via a boundary object, GenerateReportButton and the generate report based on the given information. The sequence diagram is shown in Figure 4.4.

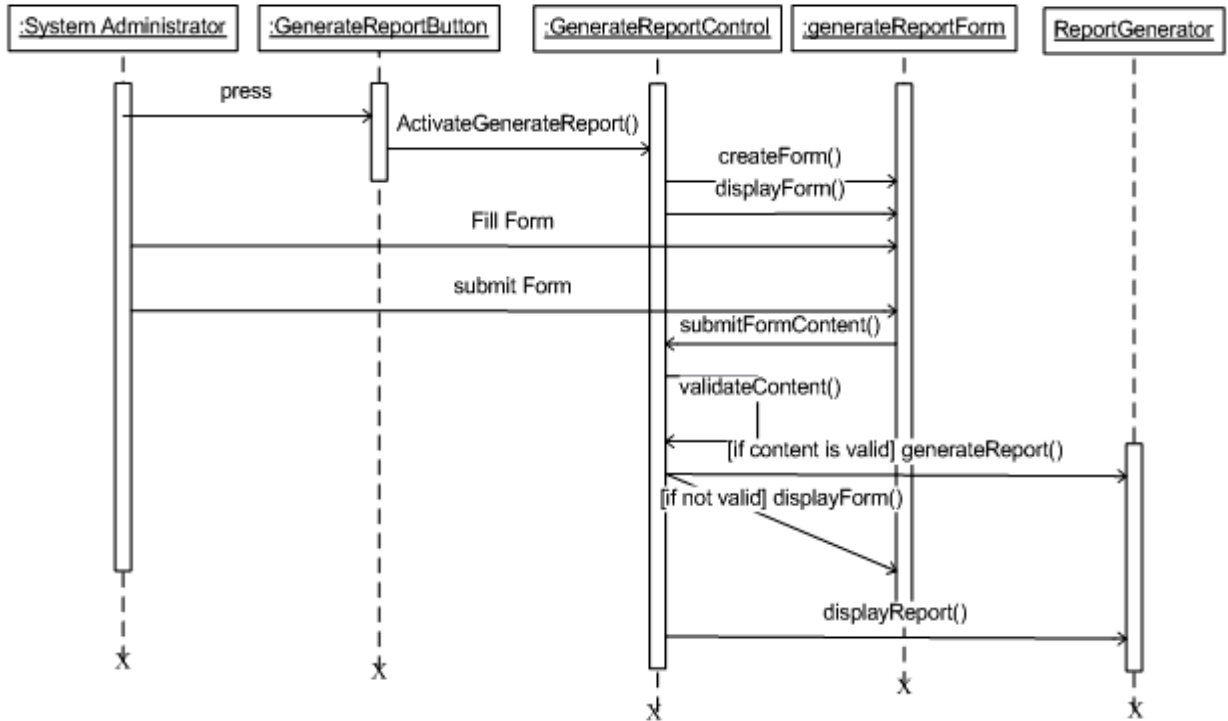


Figure 4.4 Sequence Diagram for Generate Report use case

4.4.2.6 REGISTER USER

Register new user use case is used to register new system users. It runs in the server side of the system. When new user needs to be registered, the system administrator initiates this use case and fills the registration form. If the user information is valid, registration will complete successfully. The sequence diagram of the use case is shown in Figure 4.5.

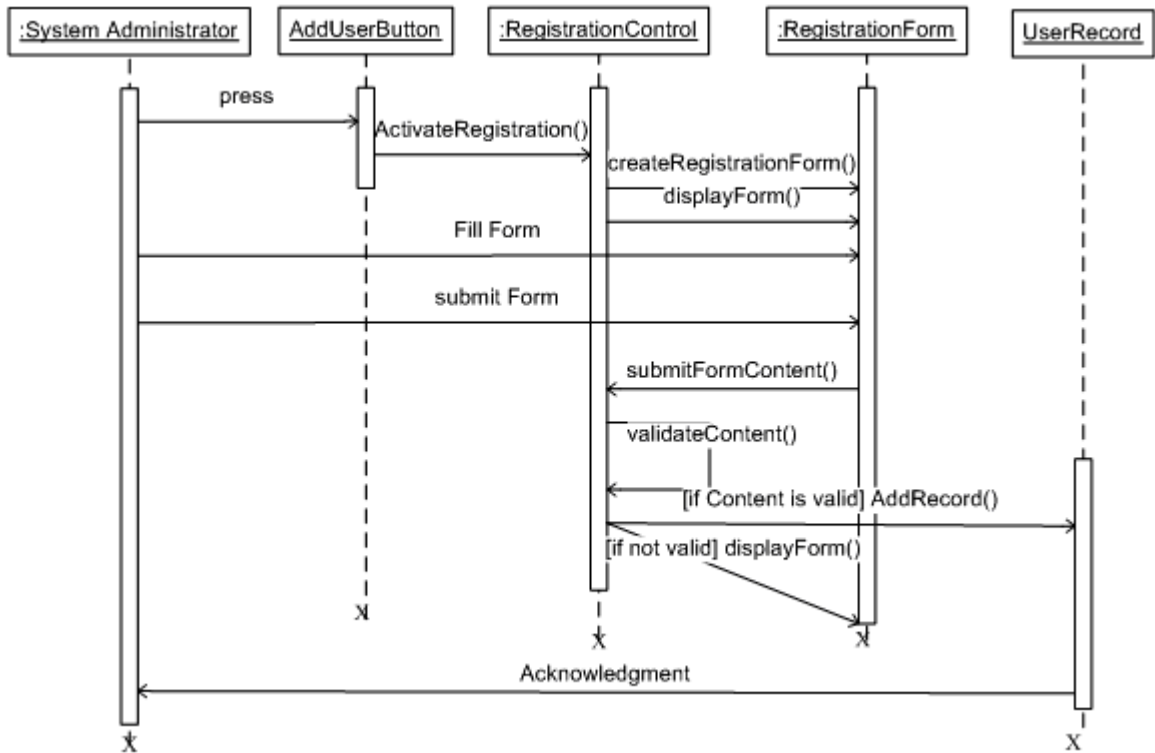


Figure 4.5 Sequence Diagram for Register user use case

4.4.2.7 REMOVE USER

Remove user use case enable system administrator to remove registered user from the system. The sequence diagram is shown in figure 4.6

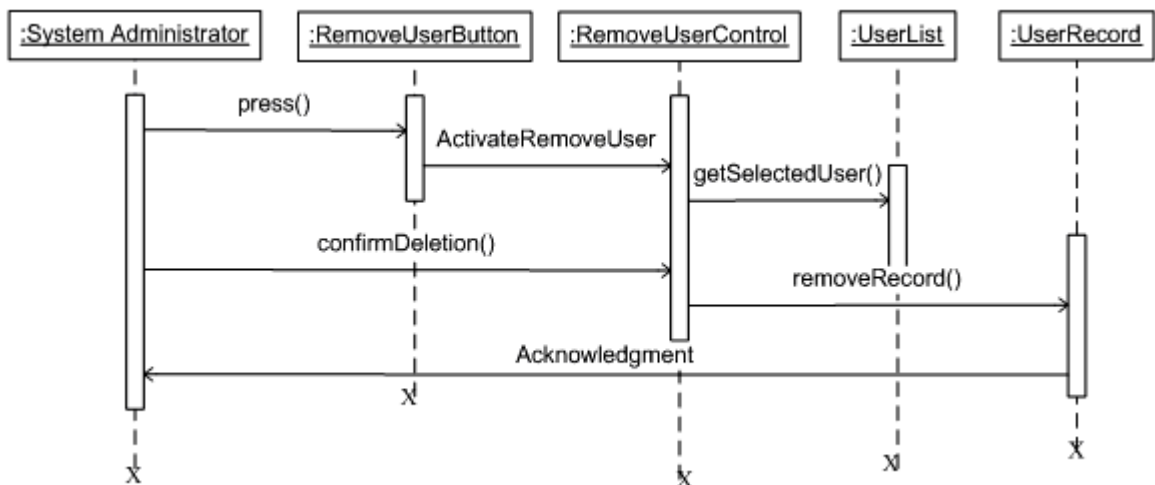


Figure 4.6 Sequence Diagram for Remove user use case

4.4.2.8 VIEW RECEIVED MESSAGE

In the server-side, if the health professional needs to see received messages, he can initiate view received message use case. And the system will display list of received messages together with their detail information. The sequence diagram is shown in figure 4.7

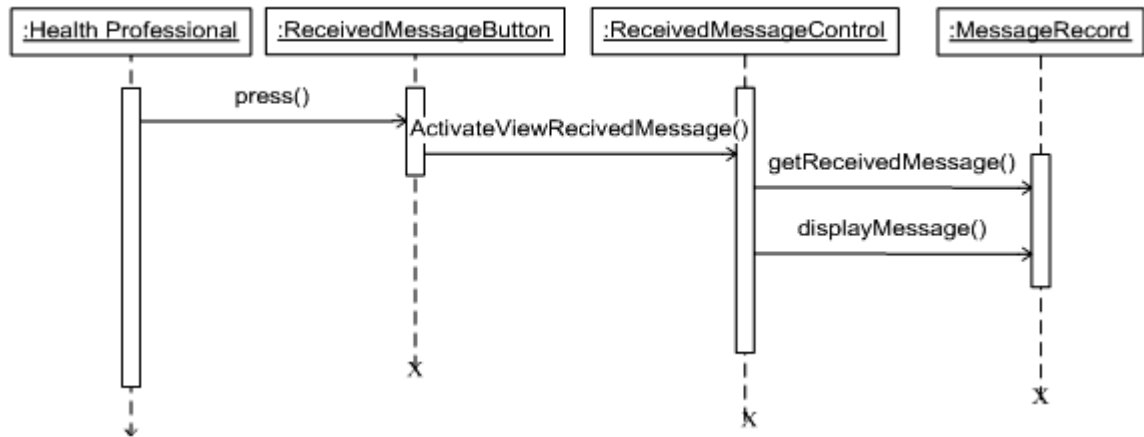


Figure 4.7 Sequence Diagram for view Received message use case

4.4.2.9 GIVE ASSISTANCE

The health professional at the health center can give assistance to the health worker in remote site. To uses this use case, the health professional initiate the use case, fills the give assistance form and send it to the health worker. The sequence diagram is shown in Figure 4.8.

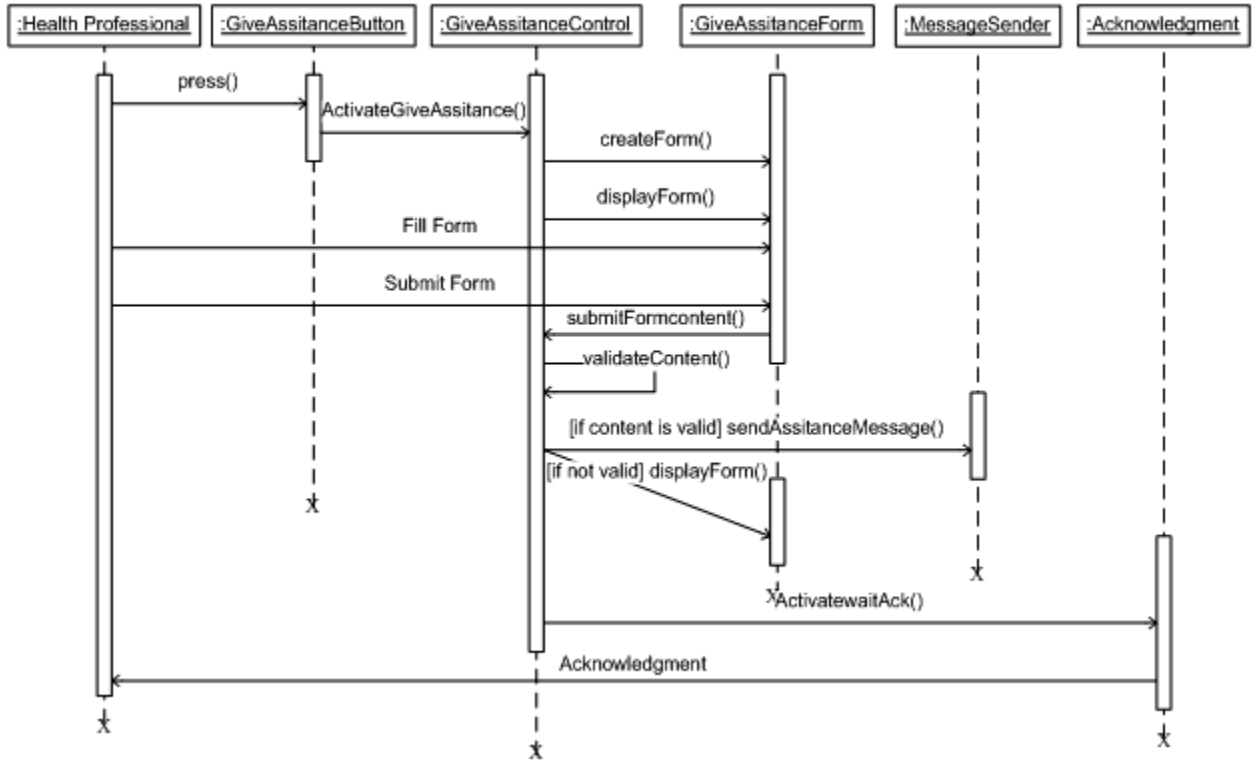


Figure 4.8 Sequence Diagram for Give Assistance use case

4.4.3 CLASS DIAGRAM

Class diagram is used to show association between objects in the system. It describes the system in terms of objects, attributes, operations and their association. The class diagram is shown in Figure 4.9.

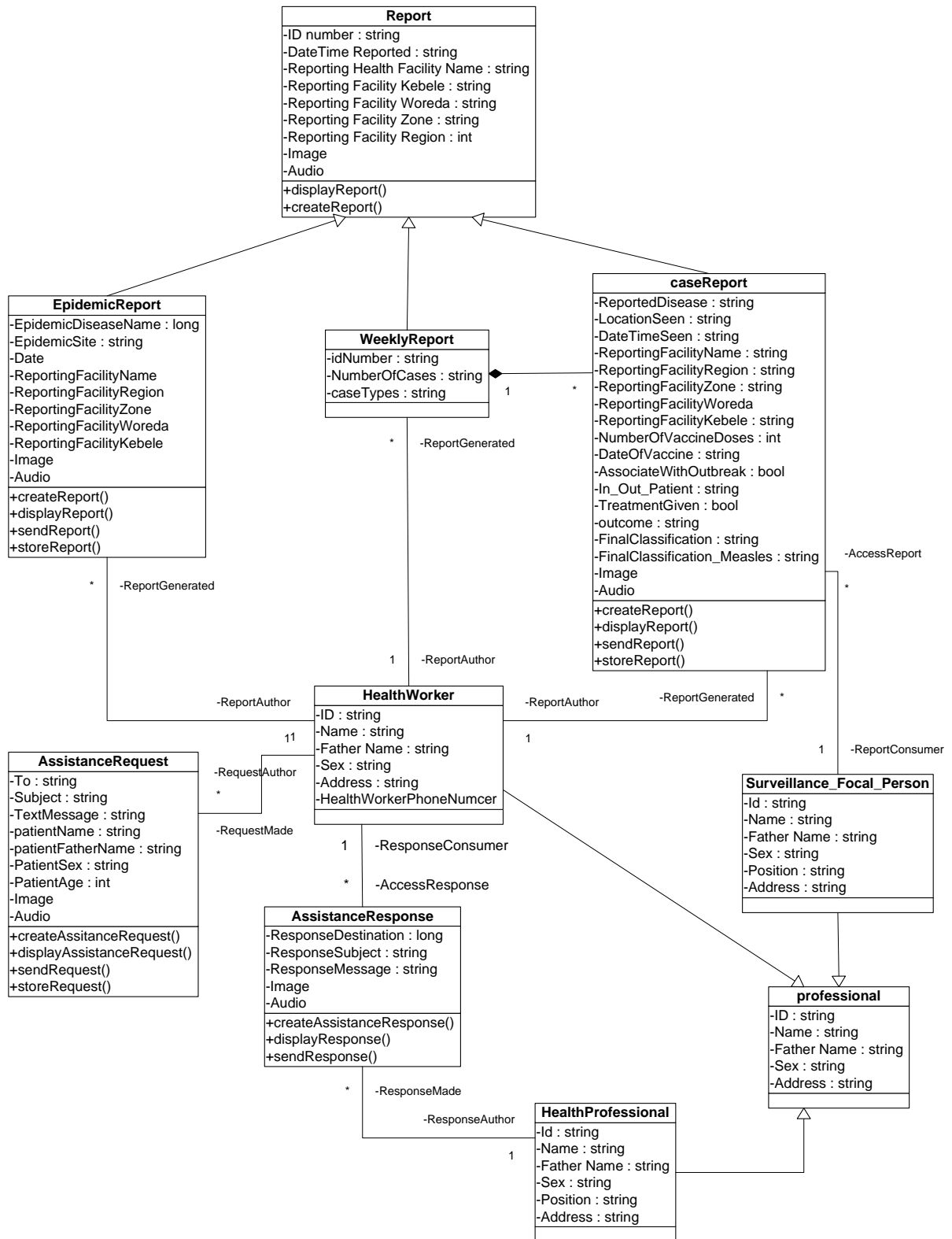


Figure 4.9 Class diagram of the system

5 SYSTEM DESIGN

5.1 OVERVIEW

The system analysis model describes the system from the user's point of view. In the model, the functional and non-functional requirements of the system were identified and the behavior of the system was modeled by the help of sequence diagram. In this section, the internal structure of the system will be discussed. This includes identification of system's design goal and description of system's architecture.

5.2 DESIGN GOALS

Identification of design goal is the first step in system design. It describes the quality of the system that should be satisfied for the final product. Design goal of the system were identified based on the non-functional requirements. The following major criteria were identified

5.2.1 PERFORMANCE CRITERIA

Response time: Sending data and getting acknowledgement should be done within limited amount of time. And in the case of network failure, the client should be informed immediately.

Memory: The user side application runs on mobile device. Because of this, the system should require minimum amount of memory.

Concurrent user support: The system should support multiple users to communicate with the system concurrently.

5.2.2 DEPENDABILITY CRITERIA

Security: At both client-side and server-side of the system, there should be user authentication feature to control access to the system

Reliability: The system should be reliable to guarantee service delivery to the user.

5.2.3 MAINTENANCE CRITERIA

Extensibility: the system should be extensible to incorporate additional functionalities.

Adaptability: The system should be easy to be adapted to other applications.

Readability: The source code should be easy to read and understand.

5.2.4 END USER CRITERIA

Usability: The system should be designed to have an attractive and convenient interface for both less experienced users and system administrators

Utility: the system should be able to support much of the users work

5.3 SYSTEM ARCHITECTURE

In the proposed system, since there is a central database which stores collected data, repository system architecture is used. Other subsystems can access stored data from the central database. In this software architecture, subsystems are relatively independent and interact through the central data repository.

In this system, subsystems will be deployed into two different platforms. The first group of subsystems is deployed in the user's mobile phone. The mobile user can then use the subsystem to send multimedia message via the wireless mobile network. This part of the system enables health workers to collect health related data from site and send it to the nearest health center.

The second group of subsystems runs in a central server system. It consists of a database management system and a web server. This part of the system enables system administrators and other users to get access to the collected data. For instance, the central database server and the web sever can be deployed in a health center so that the collected data can be accessed by health professionals in the center. The structure of the proposed system is shown in Figure 5.1.

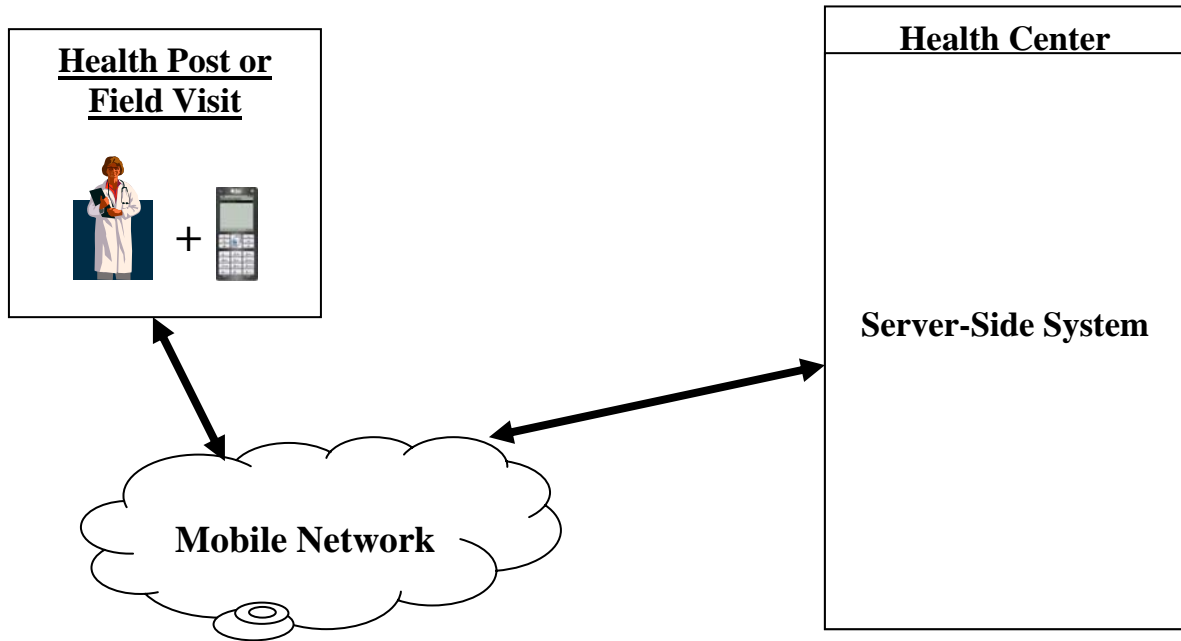


Figure 5.1 Architecture of the proposed system

In the following section, system architecture related concepts such as system decomposition, hardware/software mapping, and persistent data storage management are discussed.

5.3.1 SUBSYSTEM DECOMPOSITION

In order to make system design and development easy, the system is decomposed into smaller parts called subsystems. In this stage, classes with similar functionality are grouped into a single subsystem. During system decomposition, achieving strong coherence within the subsystem and loose coupling between subsystems were taken into consideration. The major subsystems identified are shown in Figure 5.2.

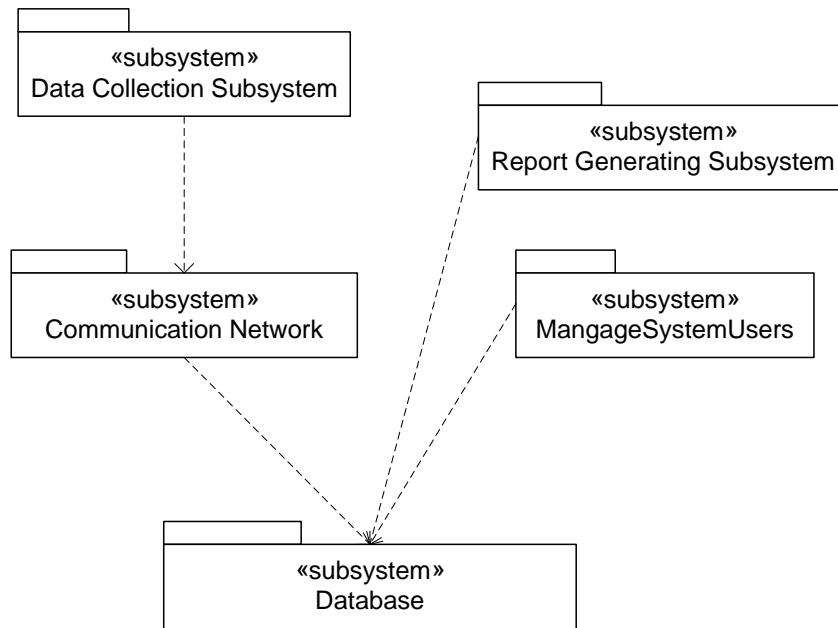


Figure 5.2 Subsystem decomposition and dependence diagram

Description of each subsystem is given as follows:

- **Data collection subsystem:** This subsystem allows the health worker to collect data related to occurrence of diseases from remote. It can be applied for case-based surveillance or for epidemic reporting. In this subsystem, modules for sending and storing collected data are included.
- **Communication Network subsystem:** It is a subsystem which runs in the client-side subsystem. It provides communication facility to send message to server-side subsystems. This subsystem is integrated with the network operator's communication network facility.
- **Report Generating Subsystem:** It is a subsystem which runs in the server side. It is used to generate reports based on the reported cases. The subsystem consists of functionalities to view received messages, generate report from the reported cases.
- **Manage System Users:** There are four groups of users of the system. To manage user related operations such as registering new user,

removing an existing user, and/or changing profile of a user, this subsystem is used. This subsystem runs on the server side.

- **Database subsystem:** It provides persistent data storage mechanism for storing data. All other subsystems interact with this subsystem.

5.3.2 HARDWARE/SOFTWARE MAPPING

In this system, some part of the system runs on user's mobile phone which can be held by a field worker and the other part of the system runs on a central server which is deployed in the health center. To show the relationship among run-time components of the system and the hardware nodes, UML deployment diagram is used.

In the client side, subsystems related to data collection are deployed in the user's mobile phone. In this node, forms for data collection, local data stores for storing data temporarily and message sending module to send collected data to the central server are included.

In the other side, the server-side subsystem runs on a web-based server system. In this node, a database management system is deployed to store collected data permanently. A web server also runs in this system to provide web-based interface to the database. In this case, users can get access to the collected data and reports via the web page designed for this application. The deployment diagram of the system is shown in Figure 5.3.

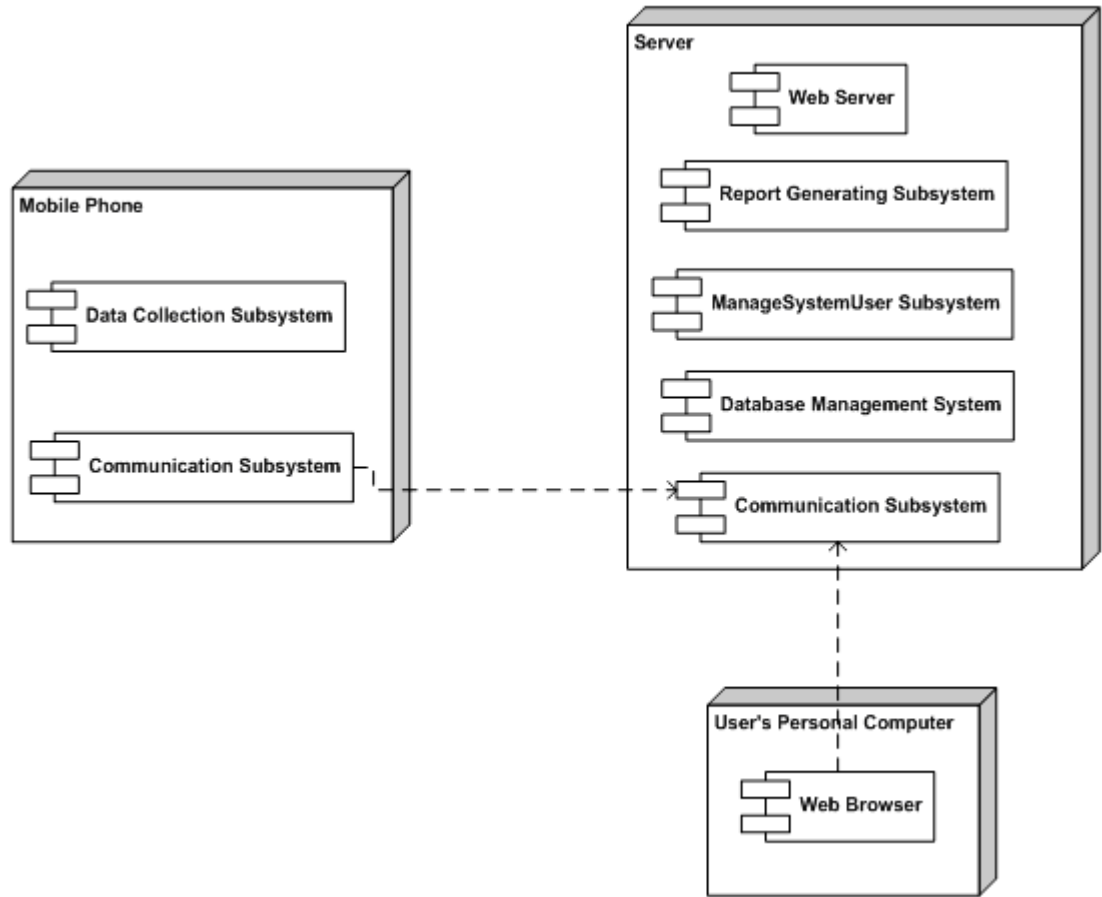


Figure 5.3 Deployment diagram of the system

5.3.3 PERSISTENT DATA MANAGEMENT

To store collected data for later analysis and reporting, persistent data management is required. For this purpose, relational database management system is used in the central system. In addition, for temporary data storage, record management system is used in the mobile phone. The record management system is an application programming interface that is used to store and manipulate data in small computing devices using a J2ME application. It can be used to store collected data in the mobile phone. This enables the data collector to collect and store data in the mobile phone when there is no network connectivity and then send it when network is available. The relational database consists of a single database for storing reported data which is collected from field. The system users' information is also

stored in this database. The relational database developed includes the following tables.

- Table to store Reported case based disease,
- Table to store Reported Epidemic disease,
- Table to store Patient related information,
- Table to store Assistance Request made by the field worker and its corresponding Reply made by the health professional in the health center.
- And Table to store system user's personal data.

In the client system, records were created to store data temporarily in the mobile phone. This includes:

- Record to store collected data about case-based diseases
- Record to store collected data about epidemic diseases
- Record to store assistance request made from the mobile and responses given to the requests from the central system
- Record to store user's name and password. It is used to perform user side authentication instead of sending user name and password to the central machine and get authenticated.

For the relational database which is deployed in the central system, the relationship of tables and their attribute is shown in Figure 5.4.

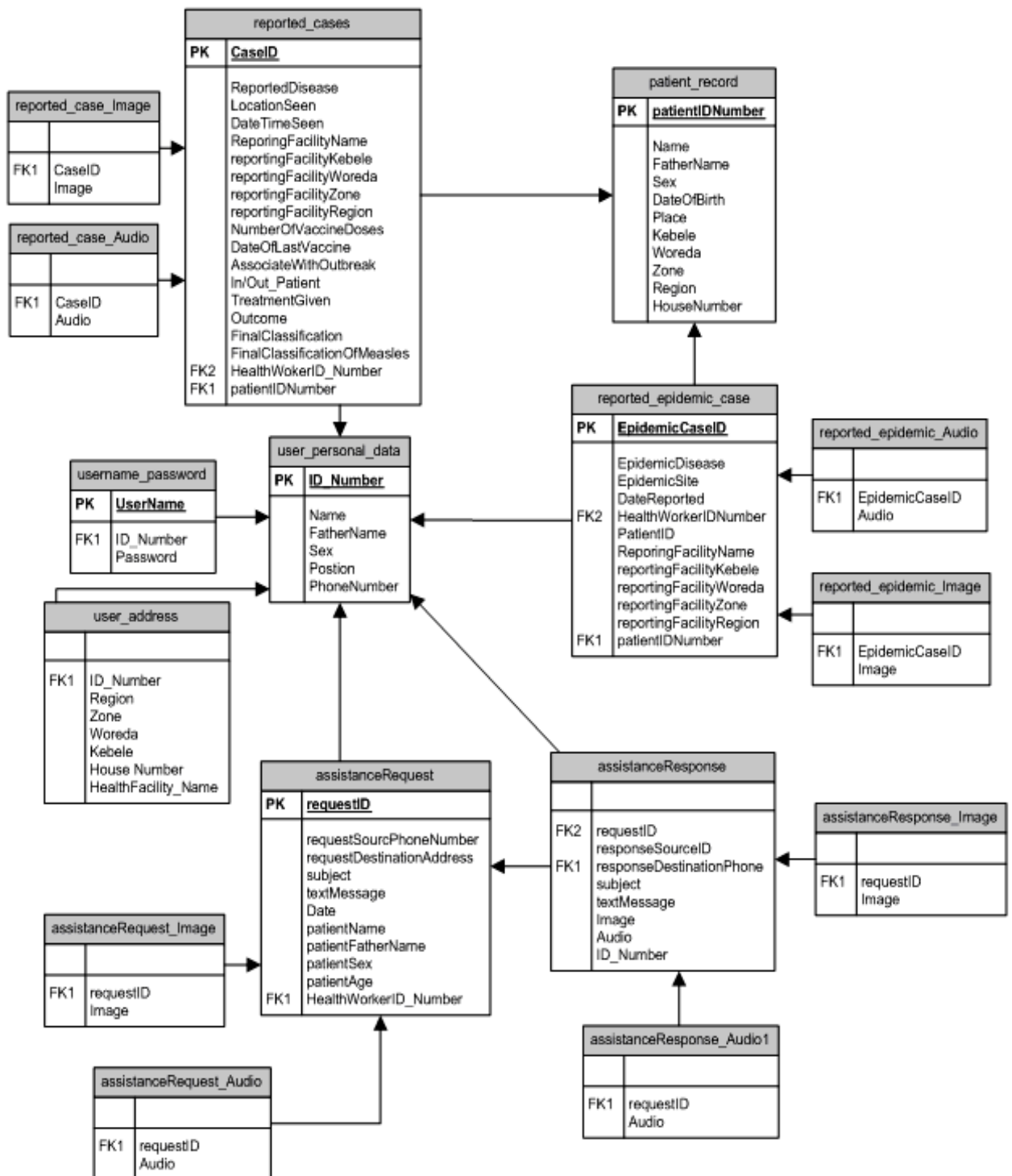


Figure 5.4 Tables and relationship among them

6 IMPLEMENTATION

6.1 PROGRAMMING TOOLS

To develop the prototype for the designed system, the actual mobile multimedia messaging service was planned to be used. But the multimedia messaging service was not released by the telecommunication network operator during the project. Because of this, we have decided to use simulation tools to develop the prototype and test the system.

As a result of the aforementioned communication network limitation, testing the system in actual mobile phones and mobile network were not possible. But, with the help of the selected tools, sending a multimedia message from the phone simulator to the web server is tested. During this time, multipart message consisting of text, image and audio is created in the phone simulator and then the message is sent to the web server via HTTP connection.

To develop the prototype, the following tools and programming languages were used.

- **Java wireless Toolkit:** It is used to develop java-based application for wireless device such as mobile phone. This tool is used to develop the client-side applications such as case and epidemic reporting forms, Assistance request form and the local record store which is stored in the mobile phone. In addition the wireless toolkit provides built-in simulator which supports wireless messaging API (WMA). Multimedia messaging capability is included in Java wireless toolkit version 2.2 and latter versions. And because of this, the built-in simulator is used in the project.
- **Mysql Database Management System:** Mysql server is used to store collected data persistently. It is deployed in the server-side of the system. Mysql server is selected because it is a free and open database management system and it is capable of working with server-side scripting language, php.

- Apache Web Server: It is a web server. It is used to develop dynamic web applications together with scripting languages like php.
- Java 2 Micro Edition programming language: J2ME is Java programming language for smaller device such as mobile phone, PDA, etc. J2ME is used to develop the client side application.
- Php: It is a server-side scripting language. It is used to develop the web interface. It is back ended with Mysql DBMS to retrieve and to store data.

6.2 THE MULTIMEDIA DATA COLLECTION SYSTEM (MMDCS)

Based on the system design, prototype was developed is named as “Multimedia Data Collection System”. The development of MMDCS includes development of user side application which runs on the user’s mobile phone. When the user starts the application, login form is displayed to authenticate himself to the system. The login form is displayed in Figure 6.1.

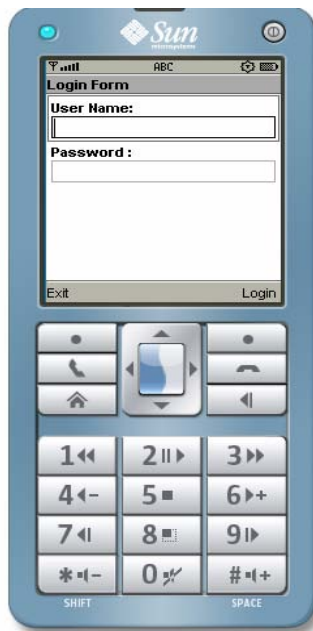


Figure 6.1 Login form for the mobile application
 Once the user is authenticated, the user will be provided with three main options. The options are Case Reporting form, Epidemic Reporting Form, and Assistance Request Form. The screen shot is shown in figure 6.2.



Figure 6.2 List of functionalities in the mobile user's side

Each of the options provides reporting forms for the user. The Case reporting form is used to report case based reports. The content of case reporting form is shown in figure 6.3.

Case Reporting Form	
Reported Disease:	<input type="text"/>
Location Seen	<input type="text"/>
Date/Time Seen:	<input type="text"/>
Reporting Institute	<input type="text"/>
Region	<input type="text"/>
Zone	<input type="text"/>
Woreda	<input type="text"/>
Kebele	<input type="text"/>
Inserted Image Inserted Audio	
More Information	
Number of Vaccine doses received	<input type="text"/>
Date of Last Vaccine	<input type="text"/>
Associated with outbreak	<input type="text"/>
In/Out Patient:	<input type="text"/>
Treatment Given	<input type="text"/>
Outcome	<input type="text"/>
Final Classification of Case	<input type="text"/>
Final Classification of Case of Measles:	<input type="text"/>

Figure 6.3 Case Reporting main form

To collect patient related information, a separate form is designed. This form is used while reporting case-based reports and epidemic reports. The content of Patient record form is shown in figure 6.4.

Patient Record Form	
Name	<input type="text"/>
Father Name	<input type="text"/>
Sex	<input type="text"/>
Date of Birth	<input type="text"/>
Place	<input type="text"/>
Region	<input type="text"/>
Zone	<input type="text"/>
Woreda	<input type="text"/>
Kebele	<input type="text"/>
House Number	<input type="text"/>

Figure 6.4 Patient Record form

To report epidemic cases, a separate form is designed. The content of the epidemic form is shown in figure 6.5.

Epidemic Reporting Form	
Epidemic Disease	<input type="text"/>
Epidemic site	<input type="text"/>
Date Reported	<input type="text"/>
Reporting Institute	<input type="text"/>
Region	<input type="text"/>
Zone	<input type="text"/>
Woreda	<input type="text"/>
Kebele	<input type="text"/>
Inserted Image	
Inserted Audio	

Figure 6.5 Epidemic Reporting Form

In addition Assistance request form is also designed to enable worker to request assistance. The content of the request assistance form is shown in figure 6.6.

Assistance Request Form	
To	<input type="text"/>
Subject	<input type="text"/>
Text Message	<input type="text"/>
Patient Information	
Name	<input type="text"/>
Father Name	<input type="text"/>
Sex	<input type="text"/>
Age	<input type="text"/>
Inserted Image	
Inserted Audio	

Figure 6.6 Assistance Request form

Under the case reporting form option, list of features related to case reporting is displayed. This includes the actual case reporting form, local store to keep list of sent messages and list of saved messages. The screen shot of case reporting form is displayed in figure 6.7.

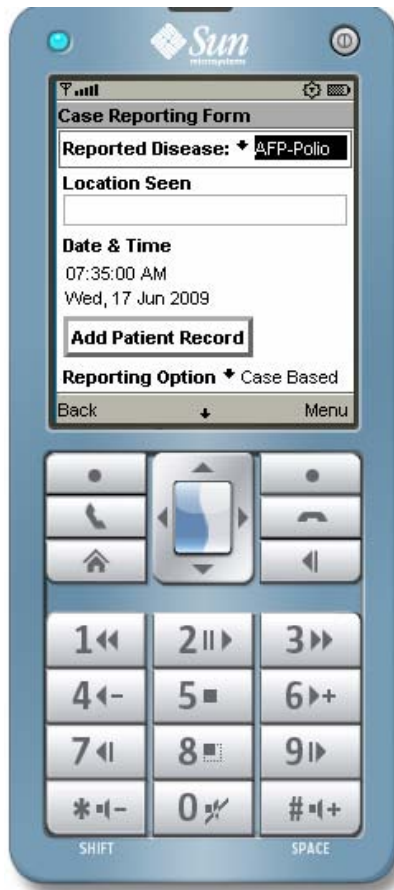


Figure 6.7 Case Reporting Form

The case reporting form includes fields to fill information about disease type, location and time it is seen, reporting option, and address of the reporting facility. Information related to the patient is filled in a separate form. This form can be accessed through 'Add Patient Record' button. With this form patient's name, father name, sex, birth date, add address can be filled. The screen shot of patient record form is shown in figure 6.8.

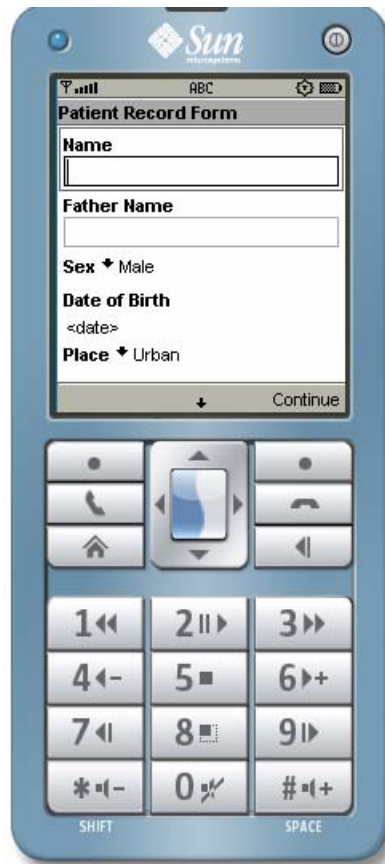


Figure 6.8 Patient Record Form

Once textual information is filled in the forms, image and audio content can be inserted by using 'Insert Image' and 'Insert Audio' options. With 'Insert Image' option, the user can select stored image and insert it into the form. And similarly, with 'Insert Audio' option, the user can select and insert audio file. Figure 6.9 shows the list of options.



Figure 6.9 List of options in Case reporting Form.

If an image is inserted in the report, the image selected will be attached with the filled form. And then when the user sends the report, the content of the form and the image attached will be sent to the server-side system. Form with attached image is shown in figure 6.10



Figure 6.10 Case Reporting form with attached Image.

The other functionality that can be accessed from the mobile application is a form to request to assistance. By using this assistance request form, health worker can send request in the form of textual description and multimedia contents. The screen shot of assistance request form is shown in Figure 6.11.



Figure 6.11 Assistance Request Form

In the server-side of the system, web-based interface is developed to allow users to get access to the reported case. With the help of this web-based interface, health professionals and surveillance focal persons can see the reported case. The screen shot of the server-side web-based interface for the health profession is shown in Figure 6.12

	Reported Disease	Location Seen	Date/Time Reported	Health Worker's Name		Patient Information			View I
				First Name	Last Name	Sex	Age		
Reported Cases	Guinea Worm	addis ababa	Wed Jun 17 07:32:00 UTC 2009	anduaem workenh	abebe	kebede	Male	4	View I
Reported Epidemic Case	AFP-Polio	south omo	Tue Jun 16 08:18:00 UTC 2009	anduaem workenh	kebede	abebe	Male	23	View I
View Assitance Request	Small Pox	jimma	Tue Jun 16 06:36:00 UTC 2009	anduaem workenh	abebe	kebed	Male	2	View I
Edit Profile	Guinea Worm	gambela	Tue Jun 16 06:29:00 UTC 2009	anduaem workenh	Alemu	kebede	Male	2	View I
Log out	AHI	aa	Tue Jun 16 06:11:00 UTC 2009	anduaem workenh	aa	aa	Male	3	View I
	AHI	aa	Tue Jun 16 06:11:00 UTC 2009	anduaem workenh	aa	aa	Male	3	View I
	AFP-Polio	ss	Sat Jun 13 06:19:00 UTC 2009	anduaem workenh	aa	aa	Male	2	View I
	Typhus	south gonder	Fri Jun 12 13:23:00 UTC 2009	anduaem workenh	alemu	Abebe	Female	25	View I
	Meningitis	south gonder	Fri Jun 12 13:23:00 UTC 2009	anduaem workenh	alernmesh	kebed	Female	25	View I
	Measles	south east gambela	Fri Jun 12 13:05:00 UTC 2009	anduaem workenh	Almaze	Kebede	Male	8	View I

Figure 6.12 List of reported cases Accessed via the Web interface

Detail information for a particular reported case can be viewed by using 'view detail' link. It will display the images and the audio file posted by the health worker. Screen shot of the detail page is shown in figure 6.13.



Figure 6.13 Detail Information for the selected reported case

To generate report for a reported case, there is a generate report functionality that can be accessed by the system administrator. He can select a particular case and generate the report for it. The screen shot of a report generated is shown in Figure 6.14.

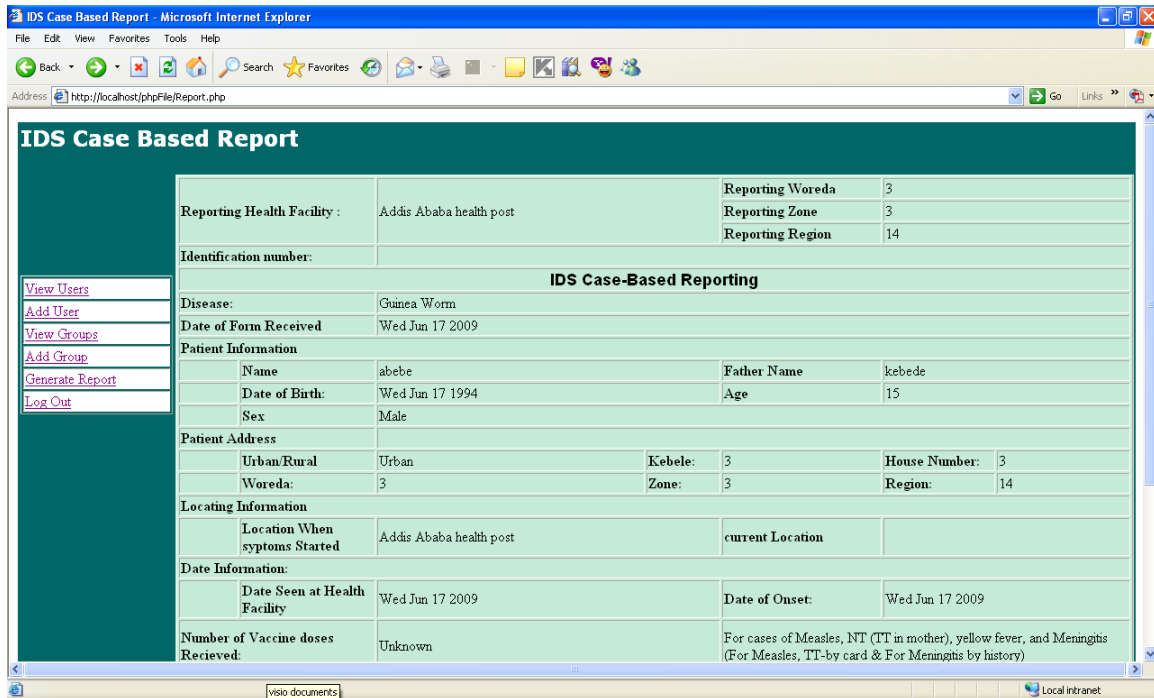


Figure 6.14 Report Generated for a particular case

In addition, the system administrator can also view registered users and register new users. This web-interface is shown in figure 6.15

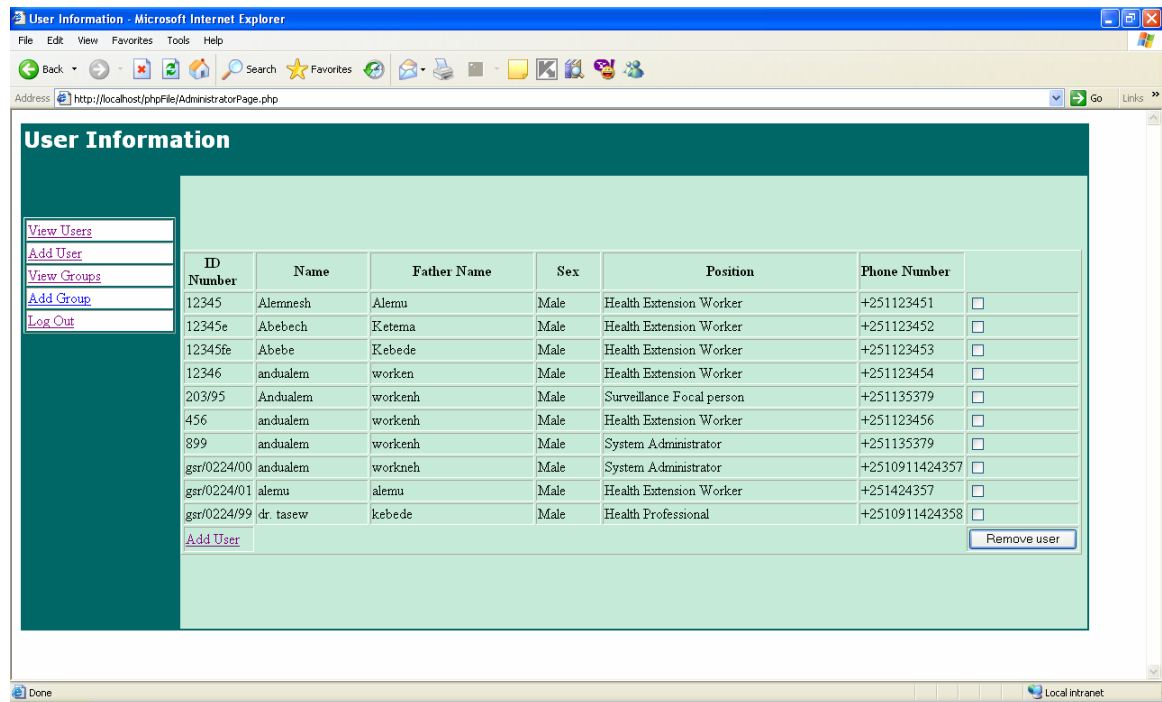


Figure 6.15 System Administrator's page

6.3 EVALUATION

System evaluation is done to compare the functionality of the system with the requirements which are identified during analysis. While evaluating the system the following functionalities were considered.

- Functionalities that are used by the health worker to report cases, and to request assistance and
- Functionalities that run in the server side to store the reported case and generate report from the collected data.

During evaluation, messages were sent from the client interface to the server and checked whether the messages are delivered to the server side properly. The message used for evaluation includes text, image and audio. And in the server side, the contents were stored in a database as required and accessed via the web interface.

With this capability of the developed prototype, the proposed system can be applied in health data collection application and particularly in disease surveillance and reporting.

7 CONCLUSIONS AND RECOMMENDATION

7.1 CONCLUSION

In the current system, manual data collection is done to collect health related data. In this approach, workers will use paper forms to collect and report disease outbreaks and to monitor health status of the community. Using manual data collection has many disadvantages and one of the disadvantages is its inability to report cases on time. Because of this, reports may take days before they are delivered to their destination. To solve this problem, mobile based data collection is proposed. In this case mobile's messaging services like SMS and MMS are used to conduct remote data collection. This mobile based data collection has great advantage to conduct data collection in areas where there is limited communication infrastructure. In this project, the current data collection and reporting system in health service provision was investigated to find problem area. From this investigation, diseases surveillance and reporting were identified to be one of the critical parts of health service provision which needs efficient communication and reporting mechanism. The existing data collection approach and reporting flow was studied to identify requirement for the proposed system. Considering the functional and non-functional requirements identified, an MMS-based data collection system was designed and a prototype is developed to show the applicability of MMS for data collection in disease surveillance and reporting. The prototype development includes developing a java based reporting form in the mobile phone and developing a web interface which runs in the server system to easily access the collected data. The system enables workers to collect data from field and report it to the central system which is deployed in the health center.

7.2 RECOMMENDATION

To improve the proposed system, the following points can be considered.

- The system can be integrated with other communication facilities such as woredaNet. With the help of these infrastructures, report made by a health worker in a particular kebele can be accessed at the federal level health facilities within short period of time. As a result of this, timely delivery of reports can be achieved.
- The system can be extended to consider other data collection tasks in the health service. This includes extending the system to consider other health programs such as HIV/AIDS patient monitoring, immunization program monitoring, etc.

8 REFERENCES

1. Antonino Giuffrida, Shireen El-Wahab, and Rafael Anta. Mobile Health The Potential Of Mobile Telephony To Bring Health Care To The Majority. Project Report from Inter-American Development Bank. February 2009
2. Gurol-Urganci I, de Jongh T, Vodopivec-Jamsek V, Car J, Atun R. Mobile phone messaging for communicating results of medical investigations (Protocol). Cochrane Database of Systematic Reviews 2008, Issue 4. Art. No.: CD007456. DOI: 10.1002/14651858.CD007456.
3. Habtamu Argaw. The Health Extension Program (HEP) of Ethiopia. September 2007
4. Katrin Verclas. Prevention of Famine with a Mobile <http://mobileactive.org/preventing-famine-mobile> . December -2008 . (Visited in 04-March-2009)
5. Rapid SMS: Monitoring & Data Collection. User's Manual. June 2008, Uganda
6. RapidSMS Review. http://mobileactive.org/wiki/RapidSMS_Review. October 2008 (visited in 06-February-2009)
7. Sevanto, J., Nokia Telecommunication. Multimedia Messaging Service for GPRS and UMTS. Wireless Communications and Networking Conference, 1999, WCNC. 1999 IEEE. 1999
8. Wikipedia . Multimedia Messaging Service. http://en.wikipedia.org/wiki/Multimedia_Messaging_service.html . Wikipedia, the free encyclopedia (Visited in 14-Feb-2009)
9. Majid Ghaderi and Srinivasan Keshav. Multimedia Messaging Service: System Description and Performance Analysis. School of Computer. Science, Waterloo University, Ont., Canada; Wireless Internet, 2005. Proceedings. First International Conference . Publication Date: 10-14 July 2005 On page(s): 198-205
10. Mbuni: Open Source MMS Gateway, User Guide <http://mbuni.org/userguide.html> (visited in 06-February 2009)
11. Open Mobile Alliance. MMS Architecture. Candidate version 1.3. January 2008

12. What is MIDA?. <http://www.mida-intl.org/MIDA/MIDA.html> (visited in 10-February 2009)
13. Vital Wave Consulting. mHealth for Development: The Opportunity of Mobile Technology for Healthcare in the Developing World. Washington, D.C. and Berkshire, UK: UN Foundation-Vodafone Foundation Partnership, 2009
14. Walter H. Curioso, Bryant T. Karras, Pablo E. Campos et.al. Design and Implementation of Cell-PREVEN: A Real-Time Surveillance System for Adverse Events Using Cell Phones in Peru. AMIA 2005 Symposium Proceedings Page – 176. September 2005
15. Vishwanath Anantraman, MMBSS, MS Tarjei Mikkelsen et.al. Handheld computers for rural healthcare: Experiences from research concept to global operations. October 2002
16. Garehatty Rudrappa Kanthraj, Teledermatology: It's Role in Dermatotomy. Journal of Cutaneous and Aesthetic Surgery - Jul-Dec 2008, Volume 1, Issue 2
17. Click diagnostic. <http://www.clickdiagnostics.com/ourserVICES.html#08> (visited in 26-February 2009)
18. Health Background. From Ministry of Health website http://moh.gov.et/index.php?option=com_content&view=article&id=79&Itemid=263 (visited in 25-May 2009)
19. Ministry of Health (FDRE). Health Sector Strategic Plan (HSDP-III) 2005/6-2009/10. Addis Ababa
20. Ministry of Health (FDRE). HMIS/M&E procedures manual. Service delivery reporting formats and instructions. January 2008
21. Mikko Petteri Kiiski. A Model for a Multimedia Messaging Service Gateway. Finland, February-2003.
22. Anant Shah. Public Health and Mobile Technology. The Yale Journal of Public Health .July -2007
23. How MMS Works. <http://www.nowsms.com/howmmsworks.htm> (visited in 25-May 2009)

Annex A:

Interview Questions

The following were interview questions that were prepared to identifying requirement of the system and to analyze the system.

1. What is the responsibility of health workers (HWs)?
2. What type of health service is provided by health workers? What is the extent of the service provided?
E.g. Is it only limited to providing First Aid service?
3. Is data collection required in the process of health service provision?
4. Who is responsible for data collection? HW? The Community? Both the health worker and the community? Or is there any other party?
5. What data is required to be collected in the process of health service provision
 - A. Health record of each individual?
 - B. Other?
6. How data is collected?
 - A. Is there any designed form for data collection?
 - B. Is there any guideline?
7. To whom the collected data is delivered or reported?
 - A. What is the organizational structure?
Health post, health center, district hospital, zonal hospital, specialized hospitals
 - B. What is there relationship and coordination?
8. Where is the collected data stored?
9. How is the collected data used or analyzed in the current system?
10. Where does the health extension worker report some incidents like disease outbreaks, serious patient cases, etc?
 - A. Is there any formal procedure to report such events?

11. Is there any challenge or problem that is resulted from the current data collection approach?
12. Is there any planned approach or system to improve the current system?
 - A. EpiSurveyor program
13. Are there any program/project linked in this activity?
 - A. HealthNet and woredaNet

Annex B:

The current case reporting form is shown below.

REPORTING HEALTH FACILITY:					REPORTING WOREDA/ZONE: REGION				
IDENTIFICATION NUMBER:									
IDS Case-based Reporting Format									
From Health Facility/Health Worker to Woreda/Zone Health offices/Department									
Cholera	Dracunculiasis	Neonatal Tetanus	Measles	Meningitis	Plague	Viral Hemorrhagic Fever	Yellow Fever	Others/ Specify	
Date of form received at the national level					/	/	(Day/Month/Year)		
Name of Patient:									
Date of Birth (DOB):			/	/	(Day/Month/Year)		Age (if DOB unknown):		
					Year	Month (if < 12)	Day (NNT only)		
Sex:	M= Male F=Female								
Patient Address:	Urban			Rural					
Kebele:						House number:			
Woreda:		Zone:				Region:			
Locating Information:	Location When Symptom Started				Current Location				
	if applicable or if the patient is neonate or child, please write full name of the mother and father of the patient								
Date Seen at Health facility	Date Health facility Notified woreda/Zone				Date of onset				
Number of Vaccine doses received:	9=unknown								
For Cases of Measles, NT(TT in mother), yellow fever, and Meningitis (For Measles, TT, YF-by card and for Meningitis by history)									
Date of last Vaccination:	/ /								
(Measles, Neonatal Tetanus (TT in mother), Yellow fever, and Meningitis only)									
Blank variable #1 of the case:									
Association with outbreak	1 = Yes		2 = No						
In/Out patient	1 = Inpatient				2 = outpatient				
Treatment given	1 = Yes (specify)_____ 2 = No								
Outcome	1 = Alive			2 = Dead			3 = unknown		
Final Classification of case	1 = Confirmed		2 = Probable		3 = Discarded		4 = Suspect		
Final classification for Measles	1 = Laboratory confirmed		2 = confirmed by Epidemiological linkage		3 = clinical compatible		4 = Discard	5 = suspect	
Person Completing the form: Name					Signature:				
Date form sent to woreda/zone:					/	/	(Day/Month/Year)		

Annex C:

The current Epidemic reporting form is shown below.

Epidemic Disease Report Form

Reporting Institution: _____ Region: _____
 Zone: _____ Woreda: _____ Date of Reporting: _____

CASES

Epidemic disease	Epidemic Site	Site Population	Date of Onset	< 1		1 – 4		5 – 14		15 – 44		45+		Total		
				M	F	M	F	M	F	M	F	M	F	M	F	M & F

DEATHS

Zone population: _____ woreda population _____ Kilil Population _____

Main Determinant of the Epidemic _____

Lab Test done Yes or No if yes specify _____

Control measure undertaken _____

Name & Signature _____

Declaration

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

Declared by:

Name: _____

Signature: _____

Date: _____

Confirmed by advisor:

Name: _____

Signature: _____

Date: _____

Place and date of submission: Addis Ababa, June 2009