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Design a Web-Based Maternal Death Surveillance and Response System for Addis Ababa City Administration Health Bureau, Ethiopia

By SELAMAWIT GOSAYE

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

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ADDIS ABABA UNIVERSITY

SCHOOL OF PUBLIC HEALTH

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M.SC IN HEALTH INFORMATICS

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Dedication

This project is dedicated to my two daughters remaining my ignorance and the patience's they showed during my project study.

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Acronyms

A.A H.B	Addis Ababa Health Bureau
BPMN	Business Process Model and Notation
CBD	Community Based Death
CRVS	Civil Registration and Vital Statistics
DB	Data Base
EDHS	Ethiopia Demographic and Health Surveys
EFMoH	Ethiopia Federal Ministry of Health
EPHI	Ethiopian Public Health Institution
EUC	Essential Use Case
EUI	Essential User Interface
FBD	Facility Based Death
FMoH	Federal Ministry of Health
GC	Gregorian calendar
GTP	Growth and Transformation Plan
HC	Health Center
HSTP	Health Sector Transformation Plan
HTML	Hyper Text Markup Language
ICT	Information Communication Technology
IDSR	Integrated Disease Surveillance and Response
ISO	International Organization for Standardization
K.K	Kolfe Keraniyo
LB	Live Birth
LMICs	Low- and Middle-Income Countries
MDR	Maternal Death Response

MDSR	Maternal Death Surveillance and Response
MDSS	Maternal Death Surveillance System
MMR	Maternal Mortality Ret
MySQL	Structured Query Language
NGO	None Governmental Organization
OO	Object Oriented
PHP	Hypertext Processer
UI	User Interface
UML	Unified Modeling Language
UP	Unified Process
WHO	World Health Organization

Abstract

Maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy. Each maternal death has a story to tell and can provide indications on practical ways of addressing its causes and determinants. Most of these deaths could have been prevented with quality care. Accurate information on how many women died, where they died and why they died is essential, however currently the information is not containing all the necessary data.

The Maternal Death Surveillance and Response done with clear standards provide information that can be used in the development of programs and interventions to improve maternal health. The existing paper based MDSR (Maternal Death Surveillance and Response) system has a problem of delaying of data and information flow from each level, lack of data quality, storage and retrieval of data as needed is difficult. Information Communication Technologies (ICTs) can play in improving information and accountability. The aim of the designed project is to automate the current paper based MDSR system in order to access adequate and timely information on the website from local to national level for Addis Ababa City Administration Health Bauer (health extension worker, Woreda Health Administration, health facilities, Sub-City, Addis Ababa Health Bauer and FMoH).

The designed project was conducted in Addis Ababa and conceptually designing of the web-based Maternal Death Surveillance System for Addis Ababa City Administration Health Bureau. The project used Unified Process methodology with object oriented approach. In order to collect requirements, used a data collection tools (i.e. interview and relevant document review). Analysis and design of the proposed system was performed by using the unified modeling language tools and Microsoft Visio 2013 software. The system prototype is also developed in order to understand the design system. System usability test was done to assess effectiveness, efficiency and satisfaction of the users on the developed prototype.

The newly design web-based Maternal Death Surveillance System can improve business process of the existing system i.e. death recording , death notification, combine data ,record action plan about modifiable factors contributing to deaths and use the information to prevent similar deaths in the future. It solve the challenges of obtaining accurate data, timely report, incompleteness of data, retrieving and storing data based on the need of stakeholders.

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CHAPTER ONE

1. Introduction

1.1 Background

WHO defines maternal death as a death of a woman while pregnant or within 42 days of termination of pregnancy. From any cause associated or aggravated by the pregnancy or its management but not from an accidental. Direct maternal deaths are causing from pregnancy, labor and postnatal complications. Indirect maternal deaths are causing from previously existing diseases, or from diseases that established during pregnancy and that were not due to direct obstetric causes but aggravated by physiological effects of pregnancy [1].

Globally a total of 10.7 million women have died due to maternal causes in the 25 years between 1990 and 2015. The annual number of maternal deaths estimated approximately 303 000 in 2015. Developing countries account for approximately 99% (302, 000) of the global maternal deaths in 2015, with sub-Saharan Africa alone accounting for roughly 66% (201, 000) [2]. According to EFMoH report 2015, maternal death in Ethiopia account 420/100 000 live birth[3].

To eliminate preventable maternal mortality Maternal Death Surveillance and Response (MDSR) was introduced by WHO in 2012 [4]. Ethiopian Federal Ministry of Health (FMoH) adopted MDSR in 2013 in order to reduce maternal mortality and improve the timely notification of maternal deaths [5].

MDSR is a form of continuous surveillance linking the health information system and quality improvement processes from local to national levels. It contains the routine identification, notification, quantification, and determination of causes and avoids ability of all maternal deaths, as well as the use of this information to respond with actions that will prevent future deaths [4].

Sound and reliable information is the foundation of decision-making across all health system building blocks, and is essential for health system policy development and implementation [6]. The healthcare information systems are vital for decision-making and have such functions as; data generation, compilation, analysis and synthesis, and finally communication and use [7]. It is

an interaction between people, process and technology to support operations, management in delivering important information in order to improve the quality of healthcare services. Health information systems have evolved through several different technologies [8].

WHO Stressing that e-Health is the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research [9].

The FMoH recognized the benefits of ICT to support and transform the health sector information system. Ethiopian Health Sector Transformation Plan states that the health sector must invest significant resources to leverage these ICT investments as supportive tools for the effective and efficient delivery of services and to bring critical information to the table for all health system actors [10].

1.2 Statement of the Problem

Women continue to die in the world unnecessarily before, during and after childbirth due to preventable conditions [11]. Studies shows that most of maternal death are preventable. Each death has a story to tell and can provide indications on practical ways of addressing its causes and determinants. Detailed systematic reviews to the cause of maternal death provide evidence of where the main problems in overcoming maternal mortality and morbidity may lie [12-14].

To provide the means, to understand the underlying causes and factors that lead to maternal deaths, to develop solutions and to save lives deploying MDSR is important [15]. The MDSR done with clear standards deliver information that can be used in the development of programs and interventions to improve maternal health [5].

But, study shows the accurate measurement of maternal mortality continues to be a challenge and the optimal resources of collecting accurate data remains unclear. Deaths can be counted in a number of ways, and usually a combination of approaches is necessary [16]. Some of the challenges are irregular and underreporting, lack of consistency across different reports, multiple systems of reporting and poor data quality. Exact information on how many women died, where they died and why they died is essential, however at this time inadequate [11, 15, 17].

Developing countries, including Ethiopia, registration of such as deaths are still mostly paper-based systems and the reporting of these records is often delayed [8]. The existing paper based MDSR system in Addis Ababa City Administration Health Bureau has a problem of delaying of data and information flow from each level, lack of data quality, data storage and retrieval of data as needed is difficult [18].

The use of electronic systems can contribute to significantly reduce delays and providing near real-time reporting, in addition to significantly improving data quality. Some countries have started to understand the potential of leveraging the power of ICT for registering, reporting, and reviewing death both at the facility level and at the community level [8].

The aim of the designed system is to automate the current paper based MDSR system in order to access adequate and timely information. Those digital or automated data and information

processing and communication system enables each stake holders to take timely action and it also help decision support system for policy maker in order to reduced preventable maternal death.

1.3 Objective

1.3.1 General Objective

To design a web-based Maternal Death Surveillance and Response System for Addis Ababa City Administration Health Bureau.

1.3.2 Specific Objective

To achieve the above general objective of the study, the following specific objectives was formulated.

- To assess the existing paper based MDSR system of Addis Ababa City Administration Health Bureau.
- To collect and analyze the functional and non-functional requirement of the MDSR system.
- To design web-based MDSR system for Addis Ababa City Administration Health Bureau.
- To develop prototype of MDSR system.
- To evaluate the developed prototype usability.

1.4 Significance of the Project

The direct beneficiaries of this project

The designed web-based system will improve the Addis Ababa City Administration Health Bureau MDSR system by making information manageable and reusable.

PHEM units at each level the automated web-based system data and information processing enables each stake holders to exchange information timely. It will create fast connection and

communication information system between extension worker, health facilities, Woreda Health Office, Sub-City, AAHB and FMOH.

For health facilities the automated web based MDSR system also decrease the amount of work which is performed on paper can be minimized error with the help of the system. It also strengthens health facility MDSR data quality and builds capacity on data handling, analysis and interpretation.

Indirectly beneficiaries of this project

Improve data quality and information use in MDSR system facilitate evidence based decision making in order to eliminate preventable maternal death. Preventing further maternal death is a social harmony and economic productivity it also reduces costs and burdens to families, communities, and service providers. Prevent maternal death also increase the survival of new born and improve the life of her children's.

For the country the designed system will help to achieve the aim of GTP plan which is reducing maternal mortality to 267 per 100,000 live births in 2020GC.

1.5 Scope and Limitation

The scope of the project is design and develop a prototype web-based MDSR system for Addis Ababa City Administration Health Bureau, Ethiopia. In MDSR system involve different stakeholders at each level. These are the health workers, health facilities, Woreda Health Administration, Sub-City Health Administration, Addis Ababa Health Bureau and FMoH. The scope of the proposed project is design for the purpose of recording, accepting and sending reports or data from website at each level. The designed project was done starting from December 2016 up to June, 2017.

Conceptually the project focused on the designing of a web-based MDSR system and development of the prototype system. Technically the MDSR system analysis and design performed based on Unified Process methodology and limited up to the development of prototype. Because of time limitation and financial constraints it could be difficult to cover whole different life cycles of web based system/software development.

1.6 Organization of the Report

This project report consists of five chapters. Chapter one of this project introduces the report starting from background information, statement of the problem, objective, significance, scope, and limitation of the study. Chapter two contains literature review which is theoretical and empirical reviews. Chapter three is about methodology, which presents study area and period, study design, source of population, data collection tool, method of data analysis, system development prototype, usability testing method, requirement data collection quality assurance, dissemination of results and operational definitions. Chapter four contains analysis and design of the project report while chapter five covered conclusion and recommendation. References, Annexes, and Declarations are also, respectively, included at the end of the report.

CHAPTER TWO

2. Literature Review

Conducting an effective literature review enables one researcher to build a solid theoretical foundation. This can provide a firm groundwork to the selection of the methodology for the study and additionally it also enables researchers to better explain as well as to understand requirements of the project [19]. The literature review part of this project provides theoretical and empirical reviews from different journals, books and electronic sources.

2.1 Health Information System

Information systems are an interrelated mechanisms working together to collect, process, store, and disseminate information to support decision making, coordination, control, analysis, and visualization in an organization. It is combination of hardware, software, and telecommunication network that people build and use to collect, create, and distribute useful data, typically in organizational settings [20].

Health information system is a system that involves data generation, compilation, verification, analyses, synthesis, communication and use. It collect different data from the health sector and other relevant sectors, analyses the data and ensures their overall quality, relevance and timeliness, and converts data into information for health-related decision-making [21].

2.2 Health Information and Communication Technologies

ICTs are defined as tools that facilitate communication and the processing and transmission of information and the sharing of knowledge by electronic means. ICT in healthcare environment has helped healthcare professionals to improve the efficiency and effectiveness of healthcare services [7].In Healthcare information systems recording and realize important information quickly have become a standard practice in many healthcare organizations. HIS is the intersection of between healthcare's business process, and information systems to deliver better healthcare services [22].

There are various emerging tools and technologies in creating and managing HIS [22]. The Internet is beginning to provide the means for making quality measurement more accessible, intelligible, and useful. When using internet the most dramatic change has been and health information is available to the public [23]. Web technology helps computers and people to work better together by giving the contents well-defined meanings [22].

2.2.1 World Wide Web

The World Wide Web commonly known as the web is the largest transformable-information construct the idea was introduced by Tim Burners-Lee in 1989 at first [24]. It is not the same with the internet but is the most noticeable part of the internet that can be defined as a techno-social system to interact humans based on technological networks. The notion of the techno-social system is a system that enhances human cognition, communication, and co-operation; Cognition is the necessary qualification to communicate and the precondition to co-operate. In other words, co-operation needs communication and communication needs cognition [24].

2.3 System Development Methodology

One of the most well-known notions in the area of information systems development is methodology. It is a higher order construct, more comprehensive than method, a meta-method or method of methods, which used to systematically and logically assess the appropriateness of any given method, while method is a way of accomplishing a task in a structured manner [25].

Systems development is essentially a problem solving activity. The two basic groups of methodologies were used, in developing information systems are structural and object oriented approach methodologies [26].

The structural approach and all structural methodologies are characterized by the flow of in advances strictly defined developmental activities successively known a system development life cycle(SDLC) is a structured methodology [27]. It provides a framework of principles, practices, and procedures to guide the systems development process [28].

The other one is object-oriented methodology. It views a system as a bottom-up approach to systems development. It describes the system through a set of business processes and performs as object. It uses a set of diagrams or models to represent various views and functionality of a

system. The OO methodology promises many benefits such as reduction of development time, reduction of time and resources required to maintain existing systems, increase code reuse, and provide a competitive advantage to organizations that use it [27, 29].

The object-oriented (OO) modeling techniques employed on large-scale, mission- critical applications. The modeling techniques described by the UML (Unified Modeling Language). UML prescribes a standard set of diagrams and notations for modeling object- oriented systems. When these models are used along with a particular method of systems development, the OO approach later became known as the Unified process [30, 31].

Unified Process follows an iterative and incremental approach to systems development. The systems development life cycle is viewed as consisting of several increments or phases: inception, elaboration, construction, and transition [32].

Iterative and Incremental

Iterative development is a rework scheduling strategy in which time is set aside to revise and improve parts of the system [33]. Iterative Software Development (ISD) is a software development paradigms that addresses the fundamental problem of the existing system [33]. Incremental development is a staging and scheduling strategy in which various parts of the system are developed at different times or rates and integrated as they are completed [34].

Unified Modeling Language

UML compromises nine diagrams in which to model systems: Use Case diagram for modeling the business processes, sequence diagram for modeling message passing between objects ,collaboration diagram for modeling object interactions , State diagram for modeling the behavior of objects in the system , activity diagram for modeling the behavior of use cases, objects, or operations , class diagram for modeling the static structure of classes in the system ,object diagram for modeling the static structure of objects in the system ,component diagram for modeling components and deployment diagram for modeling distribution of the system [30,35].

Among the above modeling diagram use case modeling diagrams for requirements and system analysis, Class diagrams and sequence diagrams for object-oriented analysis and design and

deployment diagrams for system architecture which will be used for the proposed system discussed as follows.

Use Case Modeling

Use Case modeling is the simplest and most effective technique for modeling system requirements from a user's perspective. Use Cases are used to model how a system or business currently works. It is generally the starting point of object-oriented analysis with UML. The Use Case model consists of actors and use cases. Actors represent users and other systems that interact with the system. Use cases represent the behavior of the system. Use case scenarios that the system goes through in response to stimuli from an actor and each use case is documented by a description of the scenario [30, 36].

Use case diagram building blocks: [36]

System boundary boxes (optional): A rectangle is drawn around the use cases, called the system boundary box, to indicate the scope of system.

An actor is a person, organization, or external system that plays a role in one or more interactions with the system.

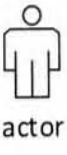

Figure 1 The UML Symbol for an actor

A use case describes a sequence of actions that provide something of measurable value to an actor and is drawn as a horizontal ellipse.

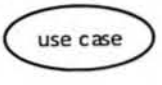

Figure 2 The UML Symbol for Use Case

Include: In one form of interaction, a given use case may include another. Include is a directed relationship between two use cases.

Extend relationship to indicate use cases that are "optional" to the base use case. The relationship indicates that the behavior of the extension use case may be inserted in the extended use case under some conditions.

Generalization: In the third form of relationship among use cases, a generalization/specialization relationship exists. The notation is a solid line ending in a hollow triangle drawn.

Associations: Associations between actors and use cases are indicated in use case diagrams by solid lines.

Class Diagram Modeling

The class diagram is a static model that supports the static view of the evolving system. It shows the classes and the relationships among the classes that remain constant in the system over time [30]. Class diagrams are the backbone of OO modeling and are used to show both what the system will be able to do analysis and how it will be built design. Class diagram formerly called object models, show the classes of the system and their interrelation ships including inheritance, aggregation, and associations [37].

Sequence Diagram

A sequence diagram is an interaction diagram. It is the sequence of messages flowing from one object to another. Interaction among the components of a system is very important from implementation and execution perspective [30]. It describe the flow of messages, events, actions between objects ,show concurrent processes and activations , show time sequences that are not easily depicted in other diagrams and typically used during analysis and design to document and understand the logical flow of the system [38].

Deployment Diagram

UML deployment diagrams describe a high-level organization of the physical nodes and according to a particular execution environment and distribution of software modules [39]. It is a kind of implementation diagram which describes the network of nodes interconnected with communication paths, along with the artifacts allocated to relevant nodes. The nodes represent basically computer and networking hardware [40].

2.4 Maternal Death Surveillance and Response

2.4.1 Maternal Death

Maternal death is overwhelmingly due to a number of interrelated delays which ultimately prevent a pregnant woman accessing the health care she needs. Each delay is closely related to services, goods, facilities and conditions which are important elements of the right to health. Three delays and the right to health: the first delay in seeking appropriate medical help, the second delay in reaching an appropriate facility for reasons of distance, infrastructure and transport and the third delay in receiving adequate care when a facility is reached because there are shortages in staff, or because electricity, water or medical supplies are not available[5].

2.4.2 Surveillance

Surveillance is the process of systematic collection, reach and analysis of data with prompt spreading to those who need to know, for relevant action to be taken. A well-functioning surveillance system provides information for planning, implementation, monitoring and evaluation of public health intervention programmers [41]. A surveillance system is useful if it contributes to the prevention and control of adverse health events, including an improved understanding of the public health implications of such events [42].

2.4.3 MDSR

In September 2011, senior public health professionals and academics from various countries met in Atlanta in the United States of America to discuss ways of improving the measurement of, and response of maternal mortality and they generated a wide range of recommendations, including steps to develop practical guidance of MDSR. The concept get up in the era of the Millennium Development Goals (MDGs) and has become widely established globally, especially since the publication of detailed technical guidance in 2013[4].

MDSR is a form of continuous surveillance linking the health information system and quality improvement processes from local to national levels. There are several steps in maternal death reported and recorded. The cause of death is then noted, other determinants identified, the preventable factors are emphasized and recommendations produced for action [43]. The "R"

(response) focuses on the response action portion of surveillance. MDSR stresses the critical need to respond to every maternal death. Each death provides information that, if acted on, can prevent future deaths. MDSR underlines the link between information and response [15].

2.5 Ethiopia Health Information Systems and MDSR

2.5.1 Ethiopia Health Information Systems

Health Information Systems (HIS) in Ethiopia are run under different authorities [10]. Population level data essential for public health decision-making and generate information and Public health surveillance brings together information from both facilities and communities with a focus mainly on defining problems and providing a timely basis for action this is especially so when responses need to be urgent [10].

According to HSTP guideline use effective information is critical through a range of activities in the health system. It is difficult to promote and sustain quality of primary, secondary and tertiary health care without the availability and effective utilization of micro level medical information [21].

One of the transformation agendas in the current HSTP is the Information Revolution. It refers to an outstanding advancement in the methods and practice of collecting, analyzing, presenting, and disseminating information. Revolutionizing the availability, accessibility, quality, and use of health information for decision-making processes, through the appropriate use of information communication technology at all levels in Ethiopia [10].

2.5.2 MDSR in Ethiopia

Ethiopian Federal Ministry of Health (FMOH) adopted MDSR in June 2013. In order to reduce maternal mortality and improve the timely notification of maternal deaths MDSR system national guidelines was introduced [5]. In 2014 the Ethiopian national MDSR system has been active with formal integration into Public Health Emergency Management (PHEM) data collection. Maternal death is one of the 14 immediately reportable conditions in Ethiopia. This reflects reflecting its prioritization at all levels of the health system and the political commitment to working towards preventing the majority of maternal deaths [18].

2.6 Related Work

National Program of Cancer Registries Advancing E-cancer Reporting and Registry Operations (NPCR-AERRO) project done in United State under the title of developing a cancer surveillance informatics structure in the new e-health environment. The aim of the project was to use information technology (IT) in a manner that improves cancer-relate decision-making and ultimately the quality of care that is offered to patients with cancer. The project was designed based on unified process methodology and used up unified modeling language [50].

Another project done in Brazil by a research group under the title of building the national network surveillance system for severe maternal morbidity in Brazil. This internet-based system consists of an electronic platform for data entry and management of data and is designed to support all types of clinical studies in a variety of locations. The system permits autonomy in creating forms, in analyzing and storing data and in stratifying the right of access to be granted to users working in the same study [51].

A project conducted in Ethiopia by Harife Ahmed under the title of a mobile based emergency reporting system for infectious disease surveillance system. The project design a mobile based information system by using object oriented methodology with rapid application development approach. Used unified modeling language techniques; like use case diagram, class diagram and sequence diagram used in order to analyze and designed the system. These project designed for the purpose of accepting and sending reports from mobile devise by using short message system [52].

Another project done in Ethiopia by Hiwot Adane under the title of requirement analysis and system design for voice messages for antenatal and postnatal car services. The project focused under developing of health messages regarding the danger signs that can occur during pregnancy and postpartum period both in mothers and babies follow up reminder messages. For this study designed the investigator was used object oriented system analysis and design methodology with the iterative waterfall model [53].

CHAPER THREE

3 Methodology

3.1 Study Area and Period

The project was conducted from December 2016 to June 2017 in Addis Ababa, Ethiopia. Ethiopia is located in the eastern part of Africa, also known as the Horn of Africa. It borders six countries Eritrea, Djibouti, Somalia, Kenya, South Sudan and the Sudan. The country occupies an area of 1.1 million square kilometers. It is a large landlocked country consisting of nine regional states and two city administrations (Addis Ababa and Dire Dawa). The project study was conducted in Addis Ababa city administration. Addis Ababa was selected because it is the capital city of the country and also where the FMoH is located. The city is consist of ten sub-cities. Each sub-city is also sub divided into Woreda administration.

3.2 Study Design

The project was designed using Unified Process model. This design methodology is chosen because it is a collection of models that emerged in response to the weaknesses of waterfall methodology [31]. It supports the use of an iterative and incremental process model which helps to improve the system step by step in a cyclic way until it satisfies the users. It incorporates object-oriented approach to speed up the analysis, design, and implementation stage [30, 32].

3.3 Source Population

The source of population is all selected institutions which perform MDSR: FMoH, Addis Ababa Health Bureau, Gandi Memorial Hospital, Kolfe Keraniyo Sub-City, Gulele Sub-City, Addis Ketema Sub-City, K.K Woreda 11 Health Administration, and Philipose Health Center. In order to collect requirements for designing MDSR system purposively select directly involved person or experts in order to assess the existing data handling techniques. The purposive sampling method, also called judgment sampling, is the deliberate choice of an informant due to the qualities the informant possesses [54].

The principal investigator select people directly involved in MDSR system. A total of 22 participants were selected. The role of the selected experts in MDSR activities are recording

death, sending and receiving maternal death data, developing an action plan ,combining data and developing report. And gather requirements about the existing information system business process which were: data and process, procedure, people/user, hardware, software and communication/networking [55, 56].

Table. 1 Description of Experts Involved in Requirement Gathering for the Design System.

Organization Type	Department	Respondents' by sex		Total
		Male	Female	
FMoH	MCH	0	1	1
	PHEM	1	0	1
Addis Ababa Health Bureau	PHEM	3	0	3
	MCH	1	0	1
Gandi Memorial Hospital	MCH head	1	0	1
	Finance and IT expert	1	0	1
Gollele Sub City	PHEM officer	1	0	1
Adis Ketema Sub City	PHEM officer	0	1	1
Kolfe Keraniyo Sub City	PHEM officer	0	1	1
	MCH head	1	0	1
Woreda 11 Health administration	PHEM officer	1	0	1
	HEW supervisor	0	2	2
	HEW	0	2	2
Philipos HC	Medical director	1	0	1
	MDSR comity members	2	0	2
	Plan and budget officer	1	0	1
EPHI	PHEM department	1	0	1
Total		15	7	22

3.4 Data Collection Tool

To identify user requirements for the design of maternal death surveillance and response system an interview and document analysis tools were used.

Interview techniques is chosen because

- Can be obtained more information.
- The interviewer can usually control which person(s) will answer the questions.
- Interview method can be made to yield an almost perfect sample of the population [19].

Based on the above fact semi structured interview questioner was developed in order to collect primary data source and it was collected by the principal investigator. The questioner was prepared by revising different model projects which perform previously from different universities.

In addition to that document review was made in order to assess the existing paper based system. The interview sessions were conducted in groups and individually, face-to-face interview in working places. The responses of the respondents were recorded in audio format and taking a short note which was important input for designing a web based MDSR system was used.

Document review made in order to assess the routine data recording, processing and reporting system. Compiled data format, community MDSR format, facility MDSR format, Woerda report format, Sub-City/zone report format and Region report format and FMoH MDSR guidelines were revised as an initial requirement for the system design. Making an interview and document review activity was conducted in average time of 50 min. in each institution.

3.5. Method of Data Analysis

The data collected through interview and document review were summarized by UML modeling at varies phases. For analysis and designing the designed system the following UML diagrams were used: Use case diagram, class diagram and sequence diagram. Under this project designing Microsoft Visio 2013 software was used.

3.6 System Development

In the development of the prototype for this project Joomla 2017 version 3.7 was used. It is an open source Content Management System (CMS), which is used to build websites and online applications [57]. Joomla used HTML as a front end for the construction of the interface and PHP is used as a middle ware to create the different functionalities to the database. MySQL server is used as a back end server to create the tables and save various data on them. WAMP server 3.6 was used as web server and Google chrome browser also used as browser support. The tools that are selected for the designing and development are majorly chosen on the basis their ease of use, availability, supportability of the system environment and researchers prior experience .Almost all of the tools are open sources which does not require any prior payments.

3.7 Prototype Usability Testing Method

ISO standard defines usability as the degree to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [58]. In order to assess the developed prototype system heuristic evaluation method was used. It is a usability analysis method where a number of evaluators are presented with an interface design and asked to comment on it [59]. Self-administer questionnaires was used to understand their preferences about the prototype. This techniques was chosen because it has low cost and it has free from the bias of the investigator [19].

3.8 Requirement Data Collection Quality Assurance

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

3.9 Dissemination of Results

The final report of the project was disseminated to Addis Ababa University, Ethiopian Ministry of health and Addis Ababa City Administration Health Bureau PHEM departments which

involved in the project. The final project will also be distributed through scientific conferences and publications.

3.10 Operational Definitions

Maternal death is the death of a woman while pregnant or within 42 days of the termination of pregnancy.

Maternal death surveillance and response (MDSR) is a component of the health information system, which permits the identification, the notification, the quantification, and the determination of causes and avoid ability of maternal deaths.

People is an element represents the human resources and the security issues that surround them.

Process/ procedures includes formal and informal mechanisms large and small, simple and complex to get things done and provides a vital link to all of the dynamic interconnections.

Technology is an element composed of all of the tools, applications and infrastructure that make processes more efficient.

A system is a collection of components that work together to realize some objectives.

A model is a simplified view of a complex reality and it is a means to creating abstraction

A Diagram is a visual geometric symbolic representation of a software model.

An actor is a person, organization, or external system that plays a role in one or more interactions with the system.

A use case is describes a sequence of actions that provide something of measurable value to an actor and is drawn as a horizontal ellipse.

Effectiveness means the accuracy and completeness with which users achieve specified goals.

Efficiency is the resources expended in relation to the accuracy and completeness with which users achieve goals.

Satisfaction is described as the comfort and acceptability of use.

3.11 Ethical Consideration

Ethical clearance was provided from Addis Ababa University School of Public Health to conduct this project. In addition to these a consent form was given to all of the respondents prior to giving any information for the requirement collection.

CHAPTER FOUR

4. Analysis and Design

Analysis

4.1 Analysis of the system

The analysis part of the project are presented according to the sequence in the questionnaire and are presented according to the following sub-headings: overview of the existing MDSR system and findings of the current MDSR system, would have been discuss. In this project/study, data collected from selected 22 respondents (those health professionals and stakeholders currently evolved in MDSR system) are analyzed and presented. The functional requirement and non-functional requirements, are organized in a meaningful manner to provide the proper functionalities of the system that emerged from the collected data. In addition system modeling analysis and design were presented by object oriented tools UML diagrams.

4.1.1 Overview of the Existing MDSR System

The existing MDSR system currently does most data exchange and information processing using manual paper-based processing. Besides, Addis Ababa Health Bureau was using a standalone registration system deployed by donors (WHO) with the aim of recording, saving and retrieving MDSR data. But, all initial MDSR data was collected manually and record in to excel sheet at regional level.

The existing paper-based MDSR system had two major sources of information which are death from the community and death from the facility. At the community level women death are reported by health extension worker. She report all death of women in the age group of reproductive (15-49) and she report the finding death to the head of the health center within one week.

At facility level maternal death notification was made by head of the labor ward or other ward health professionals who check records from the previous 24 hours and the death reported to the facility medical director within 24 hours by using paper format. Facility maternal death reviewer

collects an identification data by using format from various sources, including family folders, antenatal care records, medical records folders, and interviews with family members and then produce summary reports sheet within one week of death. The maternal death review committee at the health facility reviews the summary reports and produces response actions and submit the summary reports to the next level.

4.1.2 Findings of the Current MDSR System

By the use of the semi structured interview guide questionnaire the following findings were identified. The identified issues are presented in accordance with the different information system components and the main elements of the business model such as processes, people and technology in order to understand the business need and the goal of the system [60].

4.1.2.1 Data Collection and Use of Information in the Current System

Based on the finding of interview and document reviews the existing MDSR system data collection, recording, use of information and the existing problems are discus as follows. As mentioned earlier MDSR system done from community based and facility based. In both system recording data include community base death (notification), facility death notification, death screening, demographic data, exiting problems or disease during pregnancy, obstetric history, facility episode, community factors, cause of death and contributory factors are record manually by using paper form. The collected data from both sources processed by using manual paper format and transfer to the next level to sub city. The sub city combine the data that report from each health facility, develop an action plan and submit to the next level which is regional health office by using paper format. The regional health office record all the collected data from sub city in to excel sheet database and combine the data, develop an action plan and submit to the next level which is to FMoH. FMoH combine all data which is collected from each region develop an action plan and submit to the data to EPHI.

During gathering of requirements, the existing MDSR manual data recording and information processing system identify a lot of gaps and problems. Generally the identified problems are list as follows:

- Incomplete and inaccurate data records are occur

- Loss of filled data from the formats.
- Poor reporting mechanism.
- Delay of data and information flow from each level
- Lack of data storage and communication mechanism.
- Lack of storage and retrieval of data from each level.
- Changing the collected data into computer data base also time consuming in regional level
- Lack of information and process interoperability or feedback mechanism from each level.
- Lack of monitoring and evaluation mechanism.
- Under reporting

4.1.2.2 Report /Communication in the Current System

In the existing MDSR system information flow from the Woreda up to Region Health Bureau made by manual paper form. Under Region Health Bureau the collected data record into standalone computer excel sheet data base .These manual exchanging data have a risk of missing, neglecting and delaying from report period of time are the main limitation that found when gather the requirement. In addition to that there is no mechanism for actual checking of MDSR system functionality that put by standard guide line.

In the existing paper based system it was difficult to generate report from the paper and it takes time to retrieve data even after recording in the database the existing system doesn't generate report automatically.

4.1.2.3 People in the Current System

At each level responsible health professionals are assign for the functionality of the existing MDSR system based on the guide line. According to the finding almost all of have the basic computer skill and also they have an experience of using internet for different purpose. Which is majority of them used social network usage like Facebook, Gmail, and yahoo and Google search engine.

4.1.2.4 Procedure (process) in the Current System

The existing MDSR system follows a national guide line at each level. When maternal death happen in the facility death notification and identification is done by assigned health service provider and data exchanging and recording procedure are the same as to the community based MDSR system .When women death happen in the community health extension workers notified the death by filling paper format and submit to health center. The health center screen the death if it is maternal death, then data collection done by using paper format which include detail history of the deceased, obstetric history, community factor, existing problem, demographic data and cause of death are registered. After that revised the data and generate the summary, develop an action plan and submit the report to the next level which is to sub city. The sub city responsible person combine the data which is come from different health center which is found in that Sub-City PHEM unit, develop an action plan and submit to the next level which is Region Health Bureau PHEM unit . Region Health Bureau responsible officers combine and record the data from the paper into computer database that collected from different sub city and health facility. After recording and combination of the data the region develop an action plan and submit to FMoH. FMoH combine the data, develop an action plan and save the data into national database EPHI.

The existing paper based MDSR recording and reporting procedures formats include:

- MDSR Zonal codes
- Community notification form
- Facility based maternal death notification form
- Death screening form
- Identification form
- Preexisting problems/ medical history form
- Pregnancy/ obstetric characteristics form
- Community factors form
- Facility episode form
- Action plan form
- Reporting form from health center to next level

- Reporting format from Woreda/Sub-City to region
- Reporting format from Region to National Levels

The main drawback of the current procedure which found in requirement gathering is in both data collection and data analysis approaches was since data collection is paper based, data reporting and analysis takes much time. And also entering the collected hardcopy data into the computer system is so difficult with eligibility of hand writing and incompleteness of the recorded data.

4.1.2.5 Technology (Software, Hardware and Network) in the Current System

During gathering of requirements at regional level there is excel software that is donated by WHO which is used to store the data but it doesn't generate report. At Sub-City, Woreda, and at Health Facility level there is no software to support the system.

According to the response given by the respondents at each level there is no problem of lack of computer. At FMoH, at A.A H.B, and at EPHI each PHEM officer had a desktop computer. On the other hand from the three Sub-City which participate for the requirement gathering Gulele and Kolfe Keranyo Sub-City each officers have own desktop computer, whereas Addis Ketema Sub-City one computer used by two officer because of maintenance problem to the old computers. When came to the health facility level in Gandi Memorial Hospital the focal person of the MDSR have a standalone functional computer , in Woreda 11 health administration PHEM unit and health extension supervisors have two functional computers. W/11(Philipos) health center have a total of 50 disc top computer and one laptop computer, among this 26 computer were distributed to each department ,22 new disk top computer were found at store and the rest 3 computer was not functional due to maintenance problem . Almost all of the officers use the computers majorly for storing some documents, to prepare word files, to make excel based report writing and for browsing an internet.

Based on the findings of an interview and observation in FMoH, EPHI, A.A H.B and in two sub city which is Gulele and Addis Ketema Sub-City and Woreda 11 health administration have a broad band and Wi-Fi internet network. Whereas Kolfe Keranio Sub-City. Gandi Memorial

Hospital and Philipos Health Center previously used CDMA and e- video for communication process at this time it was not functional, even though Kolfe Keraniyo Sub-City and Philipos Health Center have a near plan to establish a networked infrastructure.

Modeling

4.2 Business Process Modeling

The business model is the center for conducting business or improving how the business is operated [61, 62].

4.2.1 The Existing MDSR System Business Process Modeling

In maternal death surveillance system as discussed earlier the core business is recording and notifying deaths , recording detail review of why the women day ? Where is the gap? What is the action plan to prevent similar death? Combine data at each level and send data to each responsible stakeholders is the main business of the MDSR. Show Table. 2 MDSR system stakeholders and figure 3 business process model diagram of the existing system respectively.

Table 2 MDSR System Stakeholders

Stakeholders		Description	Goal
Health extension worker		Health extension worker is a person who will identify and notify probable maternal death reports from the community to the respective health center surveillance focal person using the community case definition form for maternal death	To register death notification and to send the notification death.
Health Care Provider		Refers to professionals who give service in health institution (health center or hospital) and also involve in MDSR system. This include, physician, senior midwife, pharmacist , IDSR focal person, medical director etc.	To view death notification which is from the community, to register death notification from the facility, to screening the death is it a maternal death or not, to register death identification, to combine data and to develop an action plan.
Responsible PHEM units at each level	Woreda PHEM unit	It is a unit who is responsible at the Woreda level of MDSR system.	Can view and combine maternal death data at Woreda level, develop action plan, combine the data and send to Sub-City.
	Sub-City PHEM unit	It is a unit who is in charge of in Sub-City MDSR activity and monitor all health facilities and Woreda MDSR activities	Can View and combine all the other information and case summary, record action plan and generate report.
	Region PHEM unit	It is a unit that is in charge of monitoring all health facilities MDSR activities and sub city activities.	Can View all combine data of each sub city the other information and case summary, record action plan and generate report.
	FMoH (National PHEM)	The federal ministry of health is an organization who responsible for controlling and monitoring the overall activities at each level.	Can View all combine data of region, other information and case summary and record an action plan and generate report.
	EPHI PHIM unit	It is a unit in charge of combine the national MDSR data and store in to data warehouse.	Can combine national data and store to data warehouse.
System administrator		System administrator is a person who provides different security access credentials to the system.	Can register all user and send confirmation.
Report viewer		Report viewer is a person/organization interested in viewing the reports generated by the system.	Can view report.

Business process of the existing MDSR system done by using Visio 2013 BPMN basic shape

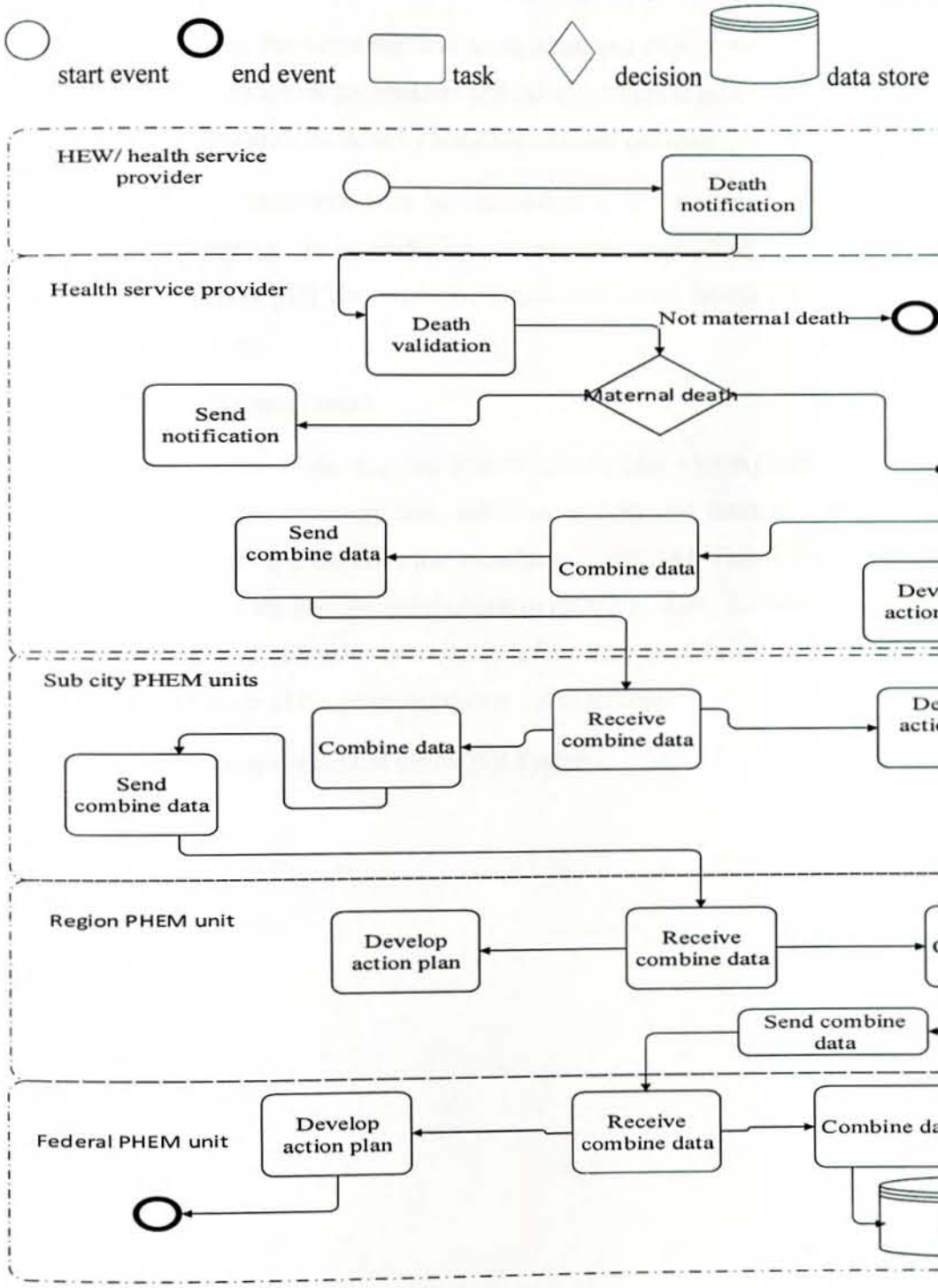

Figure 3 Business Process Modeling of the Existing MDSR System

4.3 Requirement Modelling

This section discussed the functional and none functional requirement of the designed MDSR system. This is done based on stakeholders and existing business process need. In addition to that requirement modeling analysis done by business/essential use case.

A requirement is a feature that must be included in a new system. It may include a way of capturing or processing data, producing information, controlling a business activity, or supporting management [63].The requirements classified under functional requirement and none functional requirements.

4.3.1 Functional Requirement

Functional requirements of the proposed system majorly deal with explaining on what has to be done by identifying the necessary task, action or activity and functionalities that the system should provide to users and the tasks that must be accomplished. This web based MDSR system is designed in order to enables the stakeholders to record, to store, to analyze, to distribute or to create networking and utilize maternal death information at all levels of the organization. The functional requirements of the proposed system list as follows:

Table 3. Functional Requirement of the MDSR System

No	Functional requirement	Use case name
1	The system shall keep record of CBD and FBD basic maternal death information.	Record death notification
2	The system should screening death notification if it is a maternal death or not.	Death Screening
3	The system shall support the management of actor relationships.	Manage user account
4	The system should register detail identification information of the deceased.	Record identification
5	The system should send, maternal death notification to each responsible stake holder.	Send notification
6	The system should remind each responsible stakeholder to submit the combine data according to the schedule dates.	Send alert
7	The system should combine record data.	Combine data
8	The system should send combine maternal death data to the next level.	Send combine data
9	The system should receive combine maternal death data.	Receive/ view combine data
10	The system should register an action plan of each stake holders.	Record action plan
11	The system should allow search into the database, by identification number, by health facility , by Woreda, by Sub-City ,by cause of death etc.	Combine data/generate report
12	The system should generate report.	Generate report

4.3.2 Non-functional Requirement

Non-functional requirements are attributes that either the system or the environment must have. In software system engineering, a software requirement that describes not what the software will do, but how the software will do. Some of these are requirements that many stakeholders drop to, and some are requirements if any end users recognize are needed [64, 65].

Usability refers to the efficiency and user acceptance of online authentication systems [66].The proposed web based MDSR system should be sufficiently easy to allow new users to learn basic operations within one day of use.

Reliability describes the degree to which the system must work for users. Specifications for reliability refer to availability, downtime, time to repair, accuracy, etc. [67]. All MDSR data which record in the system are critical so the proposed systems should have a backup to save the data in addition to that if the electricity interrupted in between a backup generator available until the power return back.

Performance when trying to find certain information all important search and view targets are clearly available [68]. The proposed web based MDSR system should be easily understand able for all users.

Interoperability refers to the ability of one application to exchange data with another. It also incorporate concepts of connectivity, messaging, and interactive portals [69]. The proposed MDSR system portal must be able to easily integrate heterogeneous other medical services implemented on different platforms and with different technologies. The implementation details should be transparent to users of the portal.

Security refers to the ability to provide confidentiality, data integrity, data availability and privilege hierarchy [66]. On the proposed web based system user authentication to multiple applications will be enabled by single sign on technology each stockholders has on privilege to add and update data from the system.

4.3.3 Business Model Use Case / Essential Use Case of MDSR

The business use cases are analyzed to understand how the business should support the business processes [70]. The following figure 4 describes a formal representation of the business process is created using the UML business use case model based on the finding business actors and use cases task. In the diagram HEW is a person who work in community. Health care providers are a person work in health facilities which is in hospital or in health center this include physician, senior midwife, pharmacist, MDSR focal person, IDSR focal person, medical director etc. periodically made surveillance and response when maternal death is happen, develop action plan and send data to the respective PHEM units and notifies that information to the respective offices. PHEM units (Woreda, Sub-city, Region and National level) combine the data develop action plan and send to the next level. The report viewer (person/organization, decision makers and interested stakeholders) analyzed information and used to for decision making in order to reduce and prevent maternal deaths.

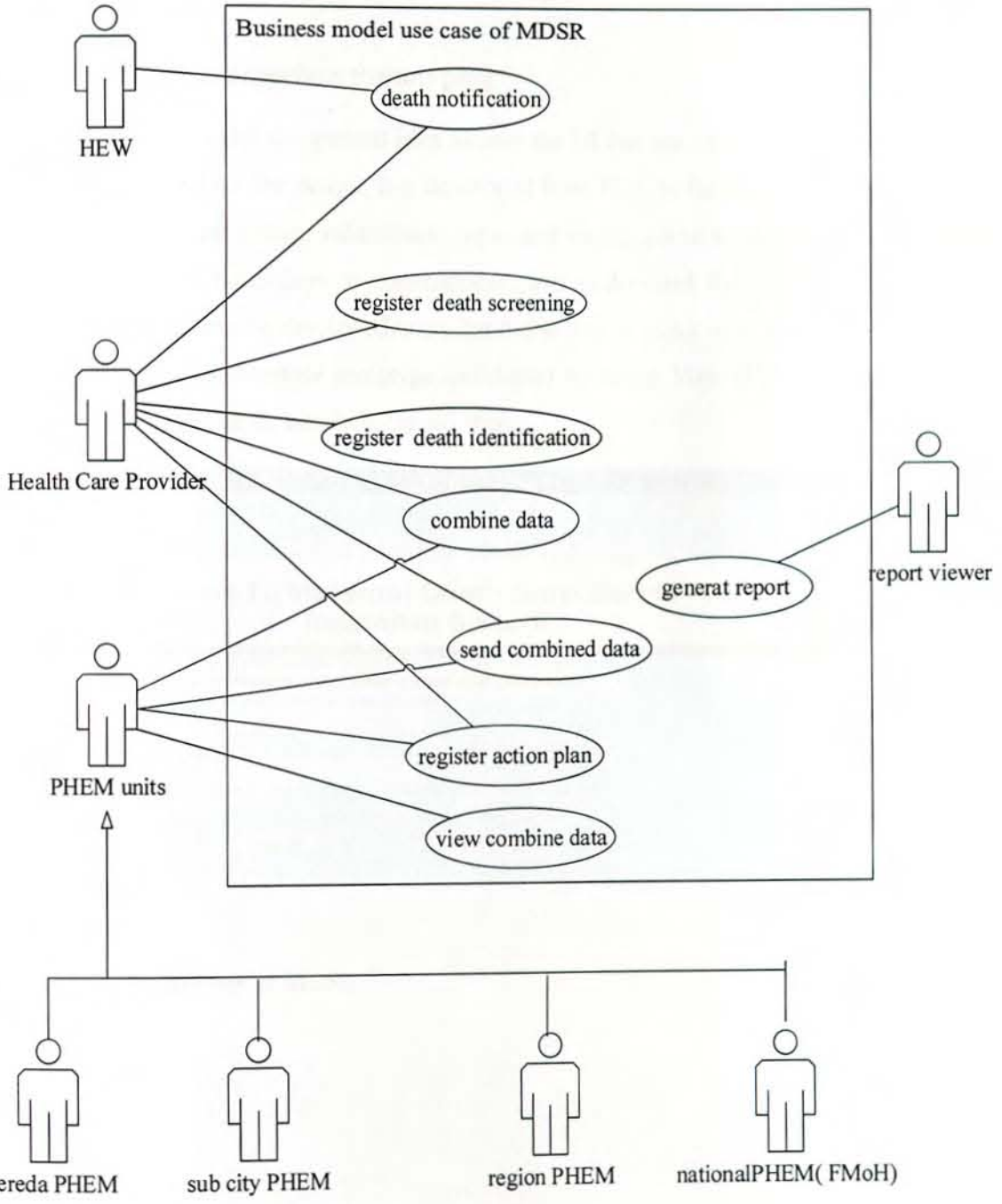

Figure 4 Business Model Use Case of MDSR

4.3.4 Essential User Interface Prototyping

EUI prototyping provides the general idea behind the UI but not its exact details. It focuses on the requirements and not the design. It is developed from EUC or business use case. It supported to illustrate how target system information input and output could work. It uses as an analysis artifact that enables developers to communicate and understand the problem space with the stakeholders [71]. It can be developed using hand drawing or using tools like Visio. The bellows figures show the user interface prototype developed by using Visio2013. The design is made based on business use cases which discussed above.

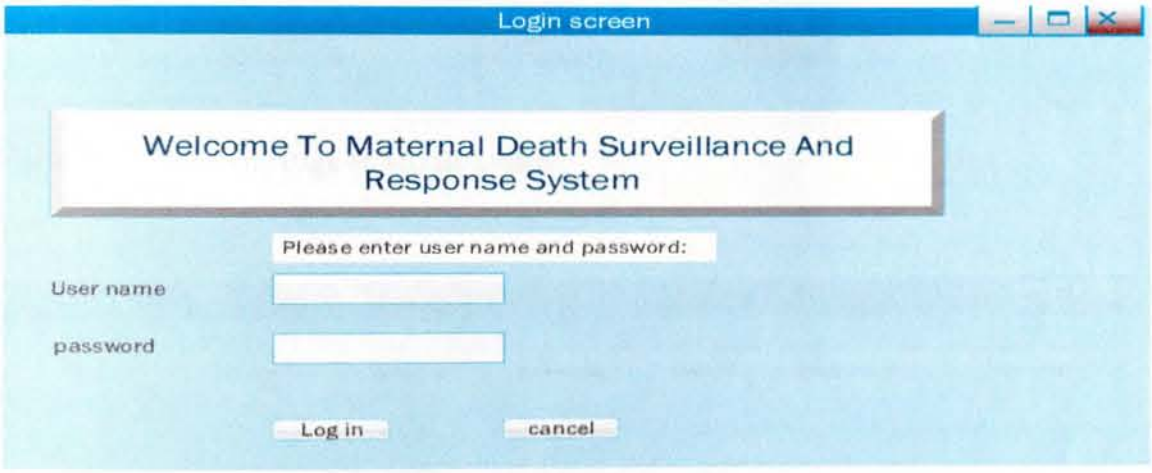

Figure 5 EUI Login Page of MDSR

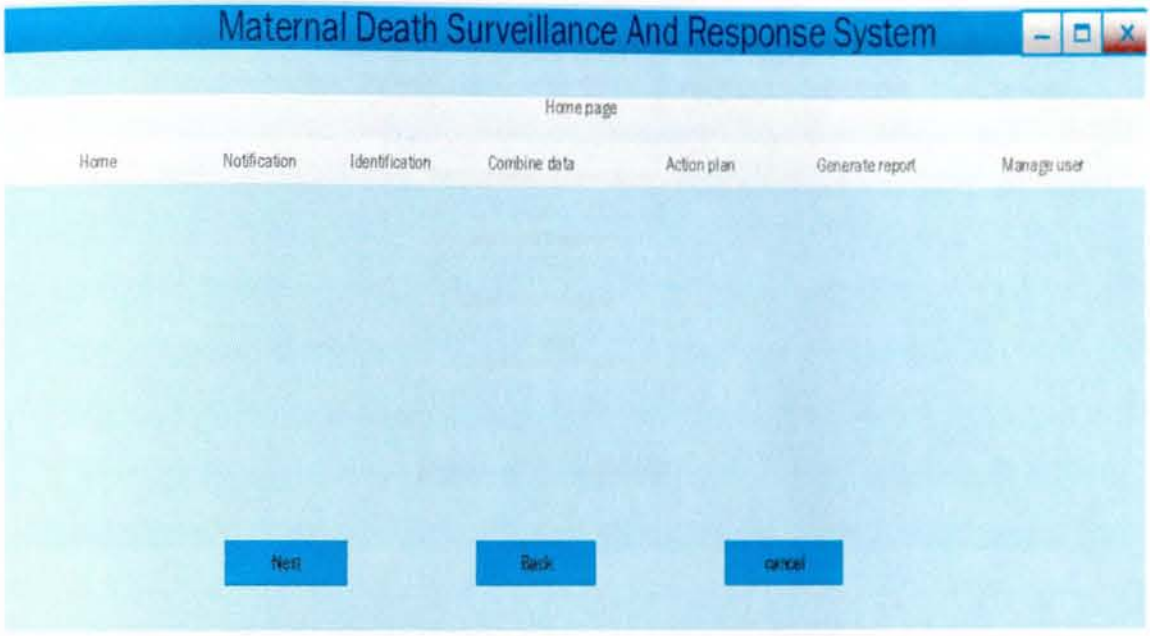

Figure 6 EUI of Home Page of MDSR System

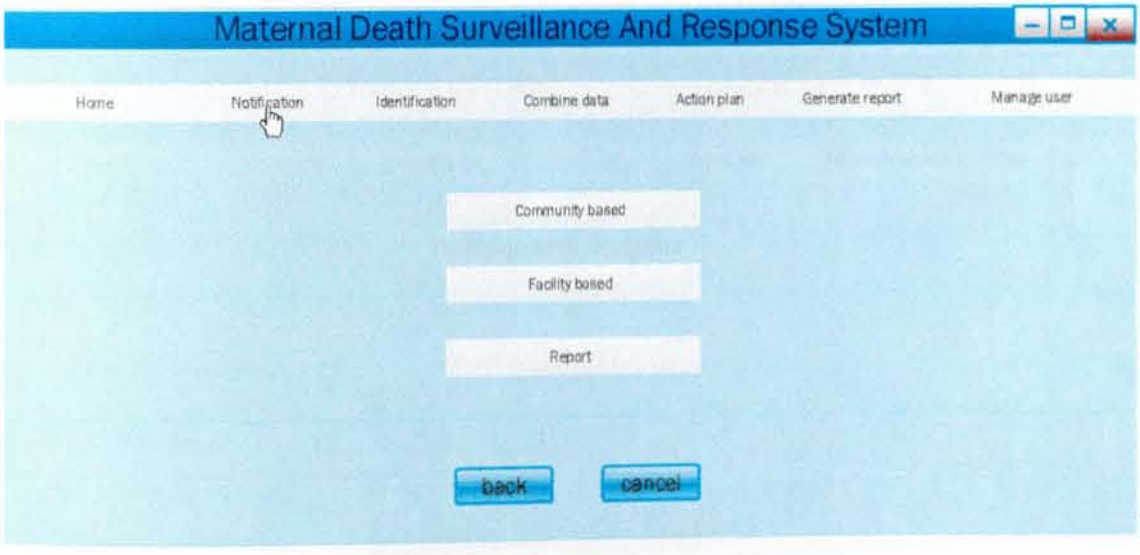

Figure 7 EUI Notification MDSR System

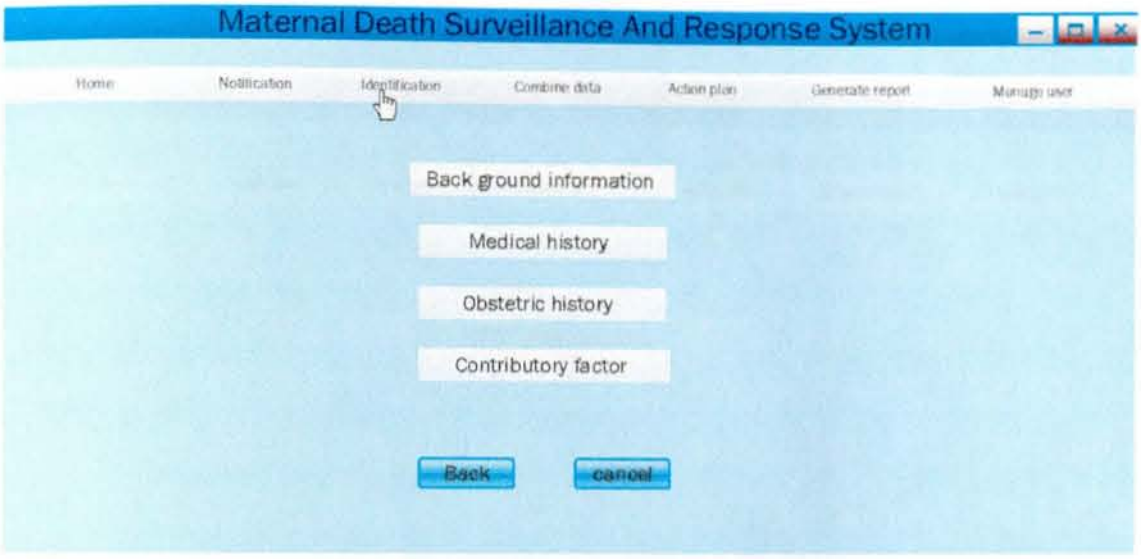

Figure 8 EUI of Identification MDSR System Interface

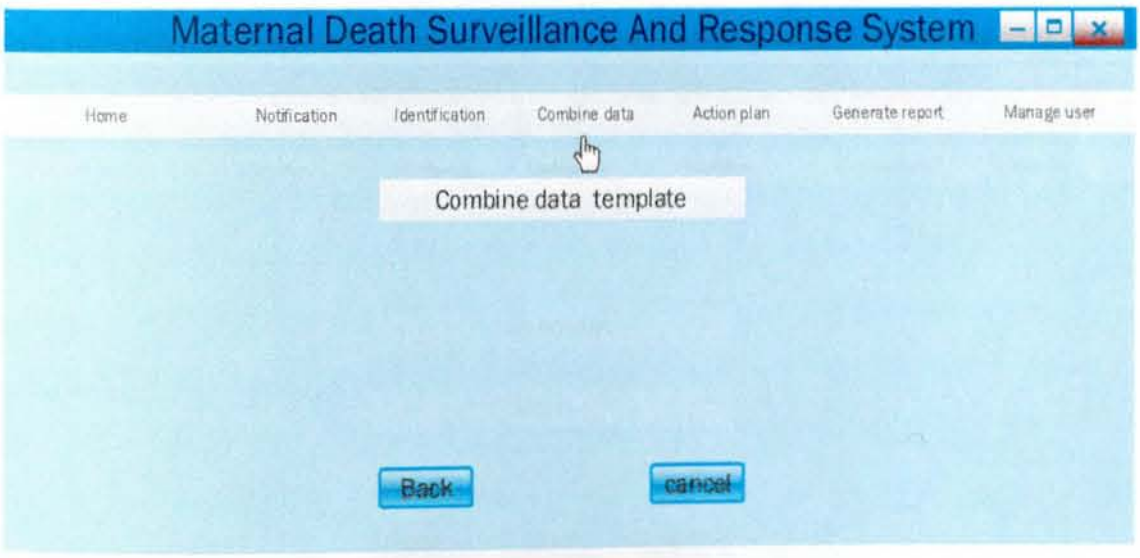

Figure 9 EUI of MDSR System Combine Data Interface

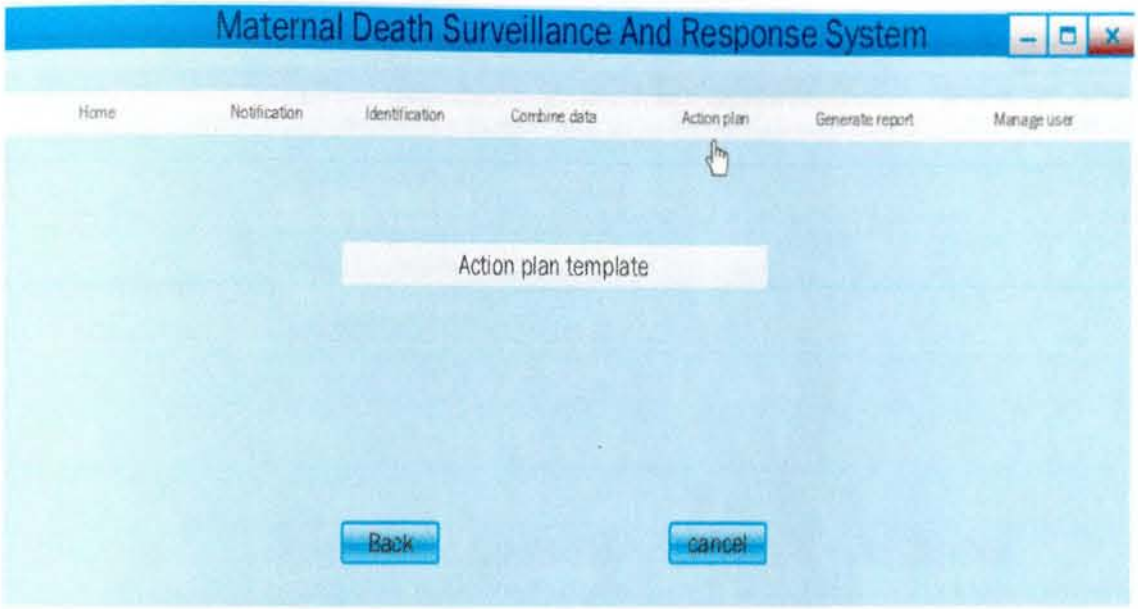

Figure 10 EUI of MDSR Action Plan Registration Interface

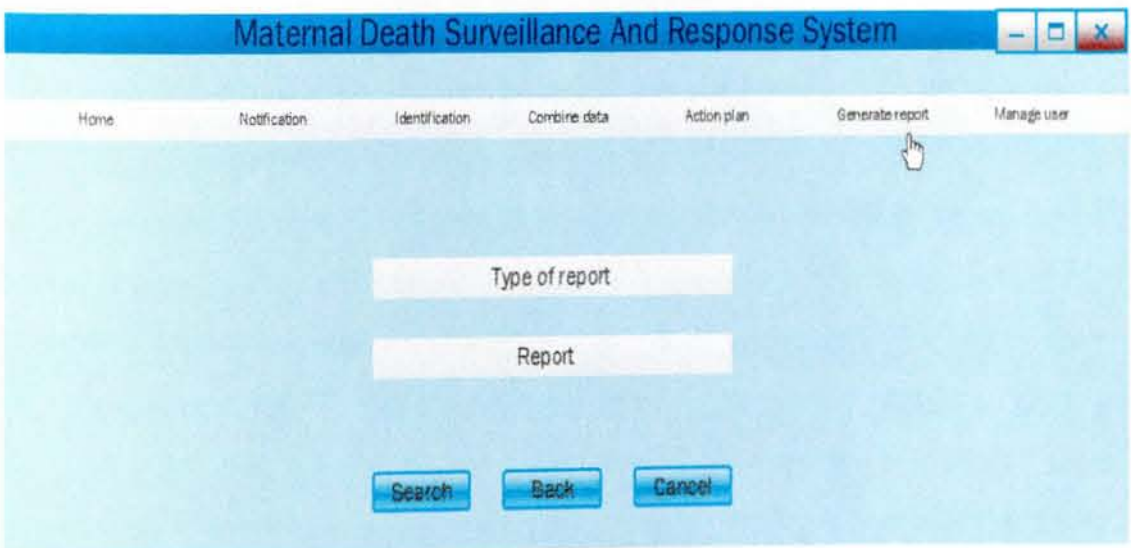

Figure 11 EUI of MDSR System Generate Report Interface

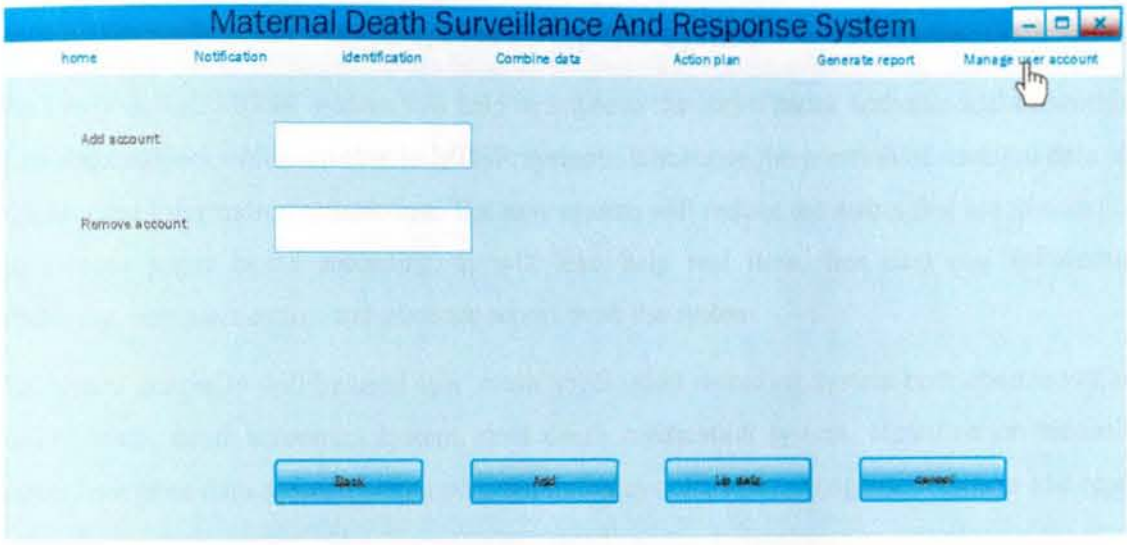

Figure 12 EUI of MDSR System Manage User Account

4.4 System Analysis Modeling

4.4.1 Business Process Modeling of the Proposed System

The newly design MDSR system will help to improve the surveillance activates and networking of all stakeholders which involve in MDSR system. It enhance the creation of standard data sets with secured information transaction. The new system will reduce the errors that are prevalent in the manual paper based recording. It will also help real time, fast data and information processing, communication and generate report from the system.

The system generally will be used as a death notification recording system both community and facility death, death screening system, send death notification system, identification recording system, combine data system, action plan recording system, user management system and report generating system.

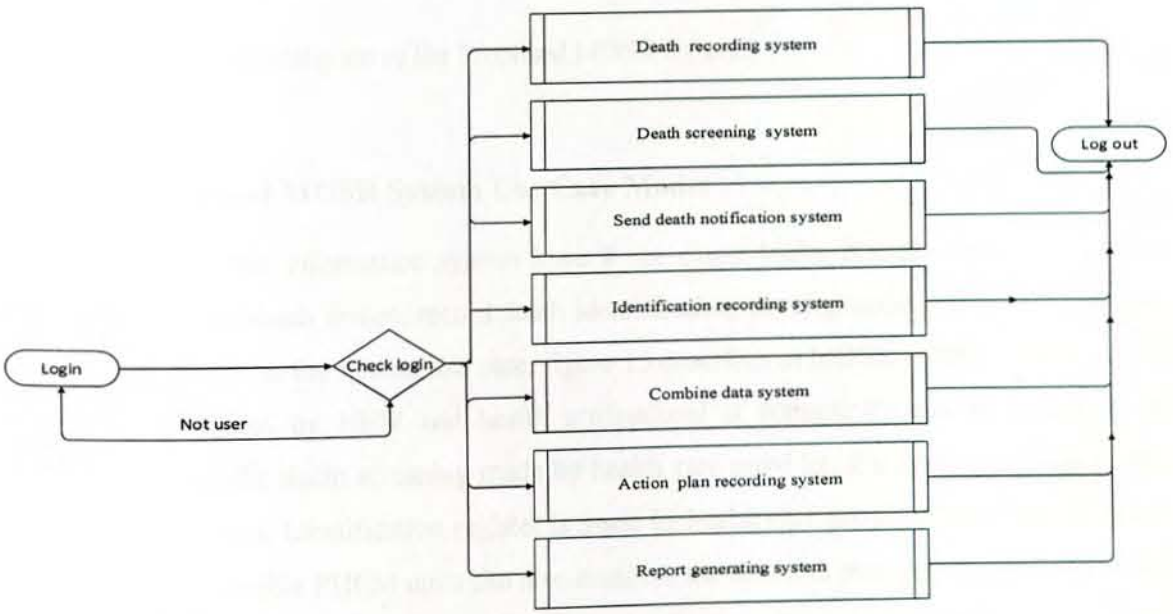

Figure 13 The Proposed MDSR System Business Process Model

4.4.2 The Proposed MDSR System Context Diagram

The context diagram shows the overall business process as just one process and shows the data flows to and from external entities. It help to define the boundaries of the MDSR system to be developed [30].

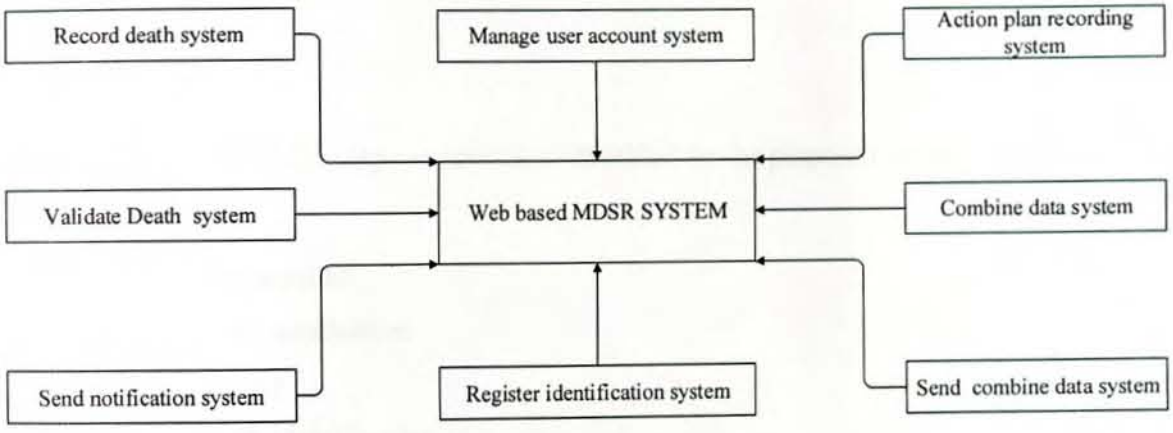

Figure 14 Contextual Diagram of the Proposed MDSR System

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4.4.3 The Proposed MDSR System Use Case Model

The designed MDSR information system have 8 use cases: login, manage user, record death notification, record death screen, record death identification, develop action plan, combine data, and generate report. In the system use case, figure 15 describes in MDSR system maternal death notification is record by HEW and health professional at community and at facility based respectively then, the death screening made by health care provider, the death notification send to each stake holders. Identification register is made by health care provider who work in health facility .The responsible PHEM units can also combine the data that received from a lower-level and send the report to upper level territorial authority (i.e. sub city sends a combine report to the Regional PHEM. Regional PHEM sends a combine report to the National Surveillance

Authority). Each stakeholder record an action plan into the system the system also remind the user in order to send the combine data based on time schedule.

The following actors have identified to interact with the proposed system:

- System admin
- HEW
- Health care provider
- Responsible PHEM units (include Woreda, Sub-City, AAHB and FMoH or national PHEM units.)
- Report viewer

In addition to that the following use cases also identified for the proposed design system:

- Login
- Manage user account
- Register death notification
- Death screening
- Register death identification
- Combine data
- Develop action plan
- Generate report

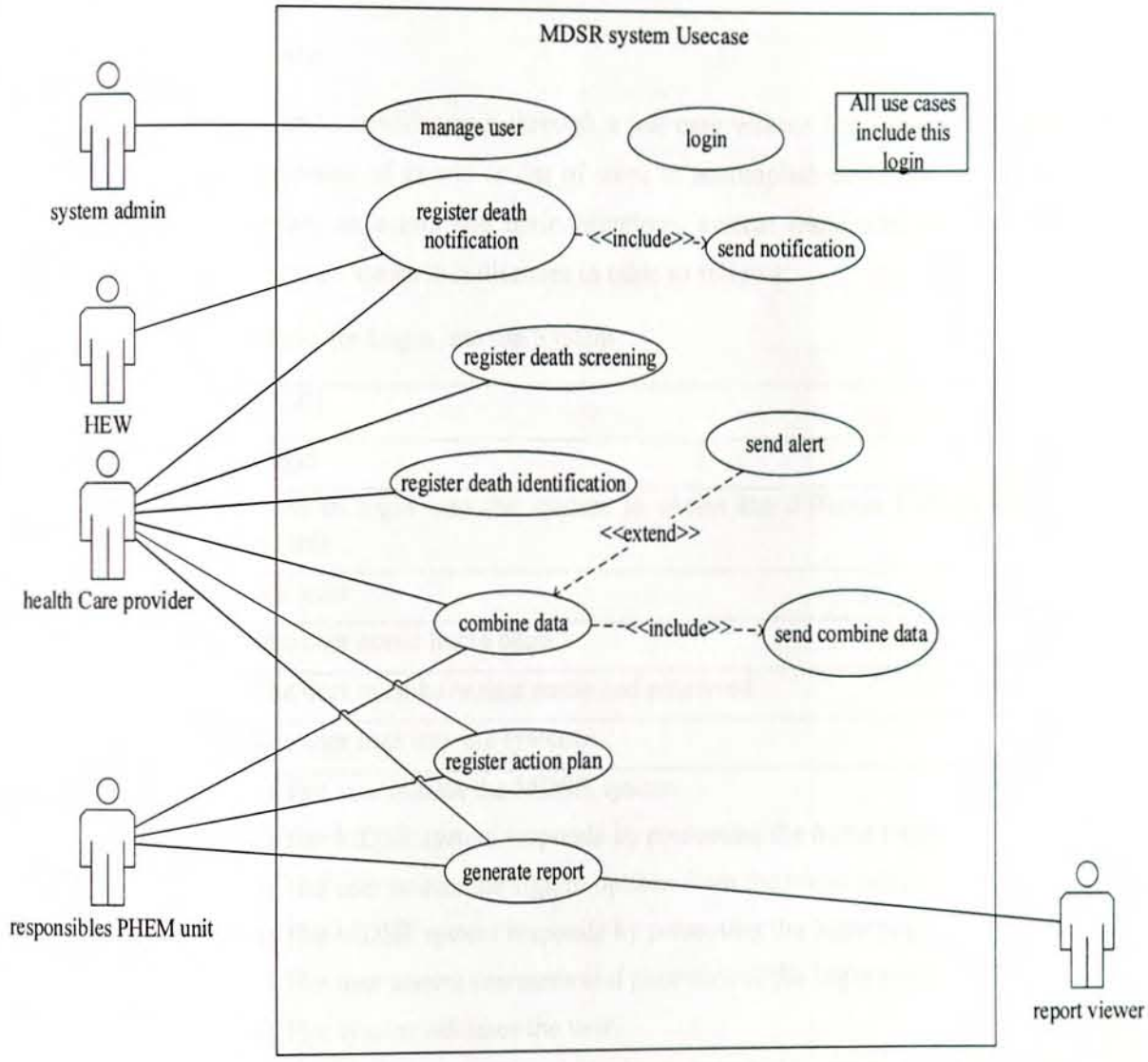

Figure 15 Use Case Diagram of the Proposed System/Web Based MDSR Information System.

4.4.4 Use Case Scenario

Use case scenario is a one particular path through a use case written from the actor's point of view. It describes a sequence of events or list of steps to accomplish each step. It is a simple statement which describes an actors and their intentions, system responsibilities and actions. Each MDSR system use case scenario is discuses in table as follows:

Table 4 Use Case Scenario for Login into the System

Use case ID	UC-01
Use Case Name	Login
Use case Description	Used to login into the system to obtain the different functionalities of the system.
Primary Actor(s)	All user
Trigger	The user opens home page.
Pre-condition	The user must have user name and password.
Post-condition	The user logs into the system.
Basic Scenario	1) The user initiate the MDSR system. 2) The MDSR system responds by presenting the home page. 3) The user selects the sign in options from the home page. 4) The MDSR system responds by presenting the login page. 5) The user inserts username and password in the login page. 6) The system validates the user. 7) The system brings the required interface that is allowed for that user. 8) The use case ends.
Alternative Scenario	5. A. if the username or password is incorrect the system displays an error message "not registered " 5. B. if the user does not use the correct password the system will lock sown after five trial.

Table 5 Use Case Scenario for Managing User Account in MDSR System

Use Case ID	UC-02
Use Case Name	Manage user account
Use case Description	The use case describes how the system administrator activates, inactivates and provides privilege to the users of the system.
Primary Actor(s)	System administrator
Trigger	For the users to access the different services based on their provided privilege.
Pre-condition	1. The system administrator must be logged into the system. 2. The system administrator must be authenticated and authorized by its own assigned privilege. 3. System administrator must be a registered user.
Post-condition	Different user account information are managed.
Basic Scenario	1) The system administrator opens the system administrator home page. 2) The system administrator selects system administration page. 3) The system presents the different users of the system. 4) The system displays a new account creation form. 5) The system administrator check user have a user account from the list of identification numbers. 6) The system administrator fills the required forms. 7) Click submit button to save the data. 8) The system creates account that is the system provides privilege to use the system. 9) The system validates and confirms the inserted data. 10) The use case ends.
Alternative Scenario	6. A) If the system administrator wants to update system user data. B) Selects the identification number of the user. C) The system administrator changes the information of the user. D) The system administrator updates the needed data. E) The system administrator clicks update. F) The data will be saved onto the database. 8. A) If the system administrator wants to deactivate the user.

	B) Click on the identification number of that user. C) The system displays the information of the user. D) The system administrator clicks on the user inactivate button. E) The system will inactivate the user from the database. F) The data will be saved onto the database. 8. If the primary password mismatches with the confirmation password. A) The system notifies the passwords mismatch. B) The system lets the user to reinsert password. 9. If the system administrator skip or miss the necessary information. A.1 The system prompts an error message on the blank space. A.1.1If the information is updated the system display "Updated" message. A.1.2 If the information is not updated the system display "Cancel" message.

Table 6 Use Case Scenario of Death Notification Registration

Use case ID	UC-03
Use Case Name	Register death notification.
Use case Description	Community/facility based maternal death notification and registration system.
Primary Actor(s)	HEW and health care provider.
Trigger	User login to the system in order to register new women's death in reproductive age group (15-49) in the community or maternal death in the facility.
Pre-condition	The user is logged into the system.
Post-condition	The system registered death information in to the database
Basic Scenario	1) The system displays user interface or user home page. 2) The user click community based /facility based registration link from the user main menu. 3) The system displays notification registration form. 4) The user fills death information on the registration form and save the records. 5) The system save the information in to database. 6) The user click submit button. 7) The system send death notification and save the send. 8) Use case ends.
Alternative Scenario	4a. If the women's death is already registered on the system. 4a.1. The system shows messages to stop death notification registration. 4a.2. The user click on the cancel button. 4a.3. The system return to the main menu. 4b. If miss death information the system display "the missed element". 4b.1.The user add the information. 7. If the system fails to send the death notification. 7a. The system prompts "Notification Not sent or error message".

Table 7 Use Case Scenario of Death Screening MDSR System

Use case ID	UC-04
Use Case Name	Death screening.
Use case Description	Health professionals screening the data if it is maternal death or not before going of other procedures.
Primary Actor(s)	Health care provider.
Trigger	Death from the community or from the facility notified by HEW or by health professional.
Pre-condition	1) The health care provider log in into the system. 2) The health care provider must be authenticated and authorized by its own assigned privilege. 3) The notification must be register in the system.
Post-condition	The system screening the death if it was maternal death or not by its criteria.
Basic scenario	1) The system displays screening death from the home page. 2) The health care provider inserts the data in to the system. 3) The system cross check the entered data (age and pregnancy history) from the database. 5) The system return result. 6) The health care provider save the data. 7) The use case ends.
Alternative Scenario	5. A. if the death was a maternal death the system display "Eligible". 5. B. the system proceeds to the next procedure which is register identification. 5. C. If the death was not a maternal death the system display "Ineligible ".

Table 8 Use Case Scenario for Register Death Identification MDSR System

Use case ID	UC-05
Use Case Name	Register death identification information.
Use case Description	This use case describes the detailed information of the deceased about (demographic data, obstetric history, disease condition, contributory factor and delay model).
Primary Actor(s)	Health care provider.
Trigger	The user see death notification do by HEW in case of community based from the system or the user see notification register in case of facility maternal death.
Pre-condition	The user is logging to the system.
Post-condition	Death identification information is available in the data base.
Basic Scenario	1. The system displays user's main menu or user home page. 2. The user selects the death identification information from the user main menu option. 3. The system displays death identification information recording form. 4. The user fills and marks in death identification information form with complete information and click save button. 5. The system save or stored the death identification information on the database. 6. Use case ends.
Alternative Scenario	4a. if error the system display error massage. 4a.1 the user clicks on cancel button. 4a.2 The system return to the main menu.

Table 9 Use Case Scenario for Record Action Plan on MDSR System

Use Case ID	UC-06
Use Case Name	Record Action plan
Use case Description	These use cases describe the recording of an action plan by each stake holder.
Primary Actor(s)	Health professional and responsible PHEM unit at each level (Woreda, Sub-City, Regional and FMoH)
Trigger	The user want to record an action plan.
Pre-condition	The user is logging to the system.
Post-condition	The record action plan is available in the database.
Basic Scenario	1. The system displays user's main menu or user home page. 2. The user selects the action plan record form from the user main menu option. 3. The system displays action plan recording form. 4. The user record an action plan with complete information. 5. The system validate recording of full information. 6. The user click save button. 7. The system save or stored the action plan information on the database. 8. Use case ends.
Alternative Scenario	4) If the recording of an action plan is not completed the system doesn't permit to continue recording. 4. A. The system informs the user that the recording is not completed or there is an error. 4. A.1 The user clicks on cancel button. 4. A.2 The system return to the main menu.

Table 10 Use Case Scenario for Combine Data on MDSR System

Use Case ID	UC-07
Use Case Name	Combine data
Use case Description	This use case describe the combine data.
Primary Actor(s)	Health professionals and responsible PHEM unit (Woreda, Sub-City, Region and National)
Trigger	The user need to combine data.
Pre-condition	1) The user is logging to the system. 2) The data is available in the data base.
Post-condition	The combine data is available in the data base.
Basic Scenario	1) The system displays user's main menu or user home page. 2) The user selects the combine data form from the user main menu option. 3) The system displays combine data recording form. 4) The user give criteria that need to combine from the data base. 5) The system combine the data as user need and save the data. 6) The user click the submit button. 7) The system acknowledged the user when the data is delivered to the next level. 8) Use case ends.
Alternative Scenario	5. If the combine data is not completed the system doesn't permit to continue recording. 5. A. The system informs the user that the recording is not completed or there is an error. 5. A.1 The user clicks on cancel button. 5. A.2 The system return to the main menu. 7. If the filled information the system doesn't continue sending. 7 .A. The system informs the information is not complete. 7. A. 1 The user clicks on cancel button. 7. A. 2 The system return to the main menu.

Table 11 Use Case Scenario for Generate Report MDSR System

Use Case ID	UC-08
Use Case Name	Generate Report
Use case Description	The use case describes the generation of report from the system by the privileged viewers of the report.
Primary Actor(s)	Report viewer, sub city, region, FMoH, health facilities
Trigger	The report viewer request to generate report.
Pre-condition	1) The prerecorded data must be exist on the database. 2) The prerecorded data have a content of report viewer data need. 3) The report viewer must have the security access grant to the type of data he/she can see. 4) The user must be authenticated and authorized by its own assigned privilege. 5) The report viewer must be logged into the system.
Post-condition	1) Report is generated based on the need of the report viewer. 2) The generated report information is saved and stored in the database.
Basic Scenario	1) The report viewer opens the view report home page. 2) The report viewer selects the generate report menu. 3) The system presents the list of available reports types. 4) The report viewer select and submit the report criteria of his/her need. 5) The system presents the description of that report. 6) The report viewer confirms the report if it is what he/she needs. 7) The system generates the selected report. 8) The system displays the selected report on the users screen. 9) The system saves the report onto the database. 10) The report viewer click on print button to print the generated report. 11) The use case ends.
Alternative Scenario	7 A) The system displays the available options of report type. 7 A.1) The report viewer select one or more selecting criteria from the options. 7. A.1.1) if there is no data match with report viewer's request. 7. A.1.2) The system prompts no matching data found.

	8. A.) If the user wants to have the report in different format. 8. A.1) The report viewer click on the export report button. 8. A.2) The system display the format. 8. A.2) The user select the file type of the report.

Designing

4.5 System Designing

Based on the user requirements and the detailed analysis of the existing system, the new system is designed. For designing phase of the proposed system class diagram and sequence diagram was used.

4.5.1 System Sequence Diagram

A sequence diagram is a dynamic model that supports a dynamic view of the evolving systems. It 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 [30]. The following diagrams are show the design MDSR system sequence that an actor how to communicate from the system that based on discussed use case scenario.

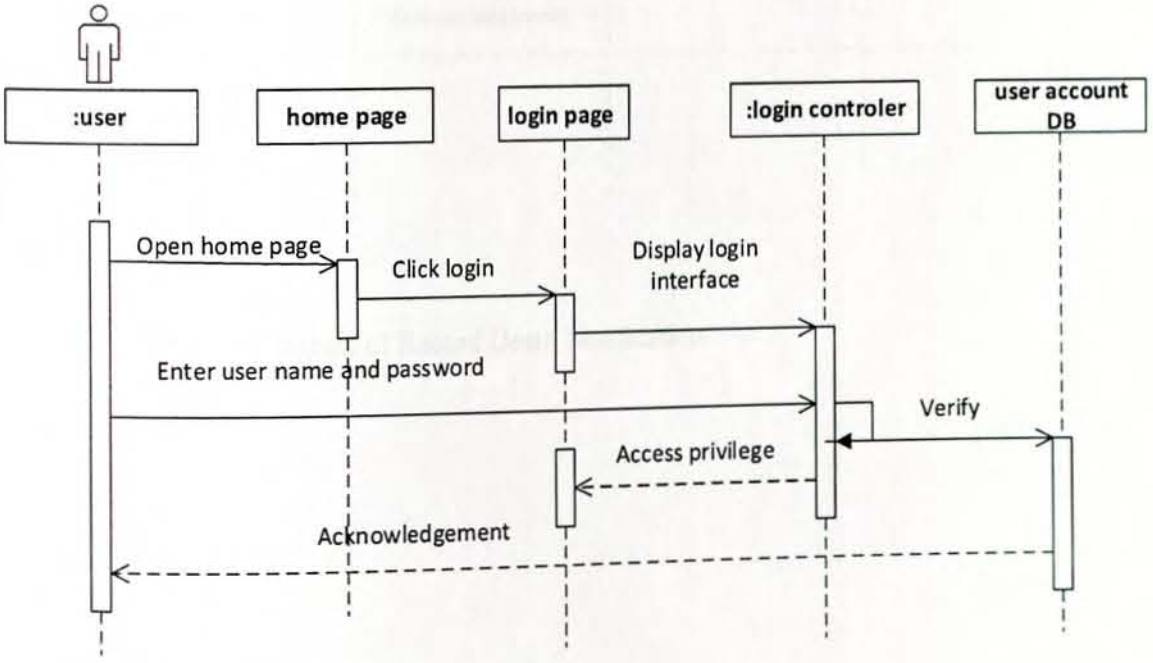

Figure 16 MDSR System Login Sequence Diagram

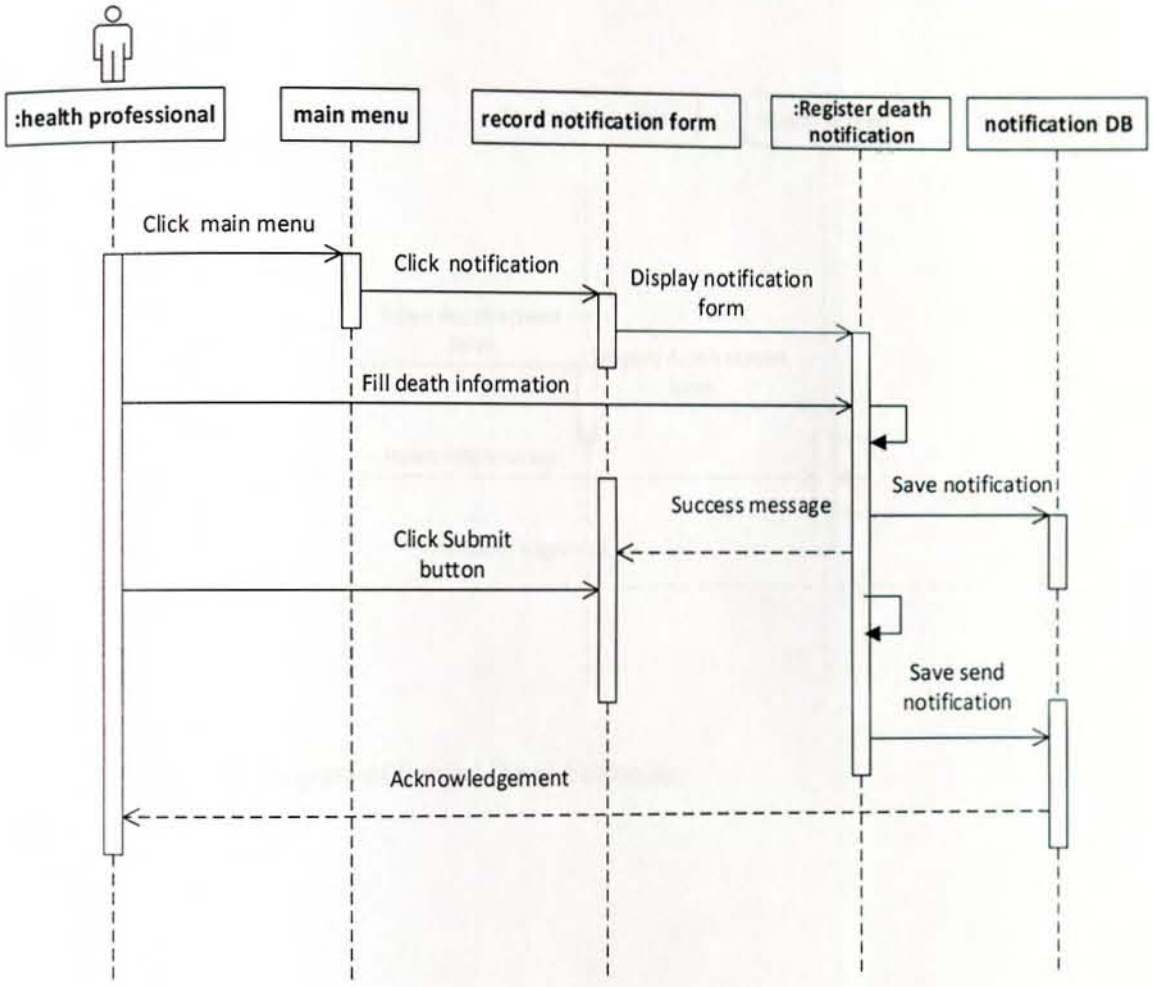

Figure 17 Sequence Diagram of Record Death Notification

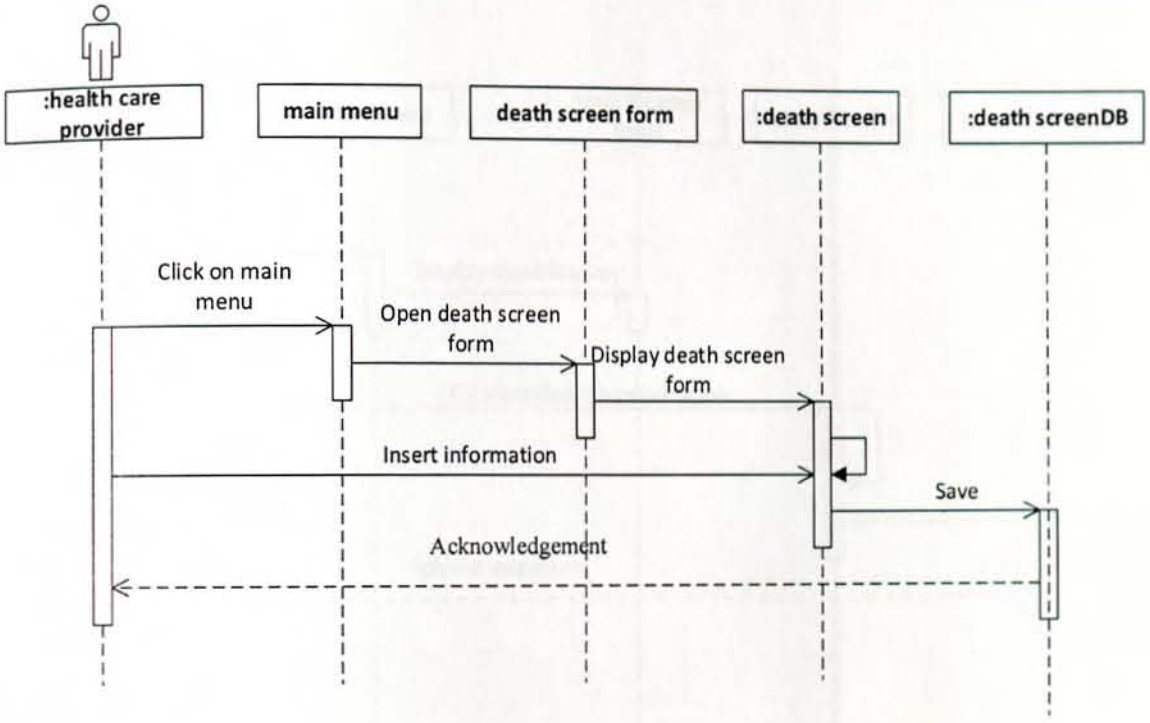

Figure 18 Sequence Diagram of Record Death Screening

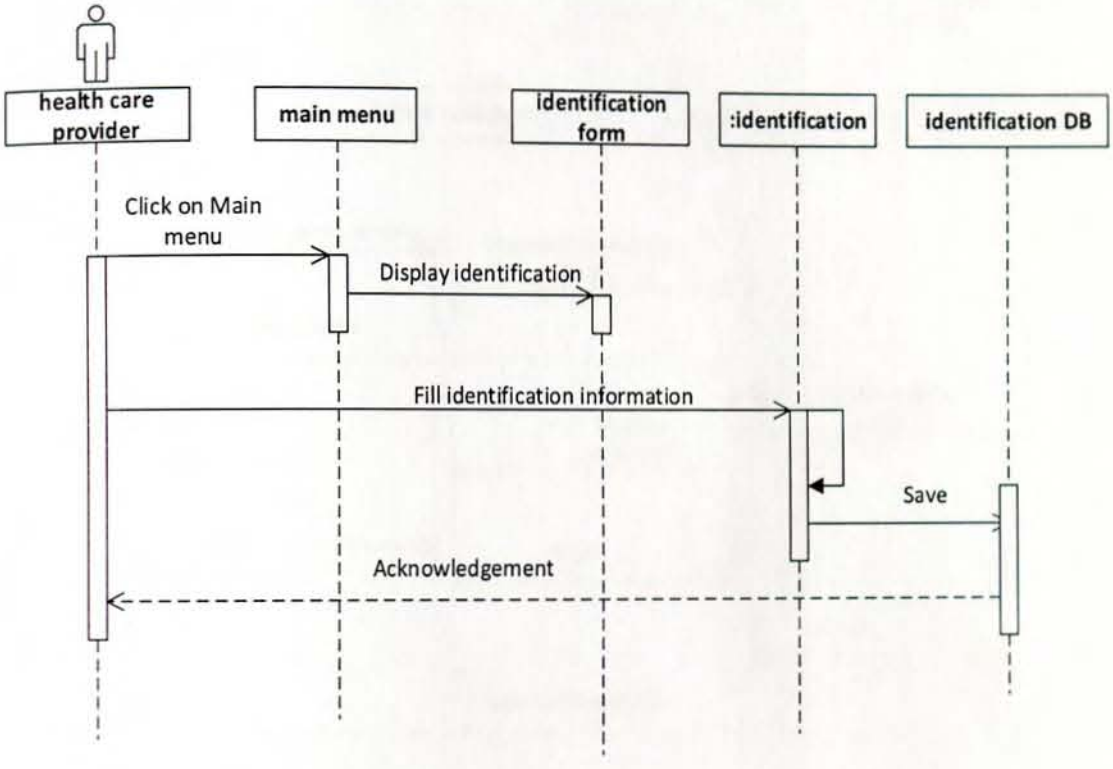

Figure 19 Sequence Diagram of Record Death Identification

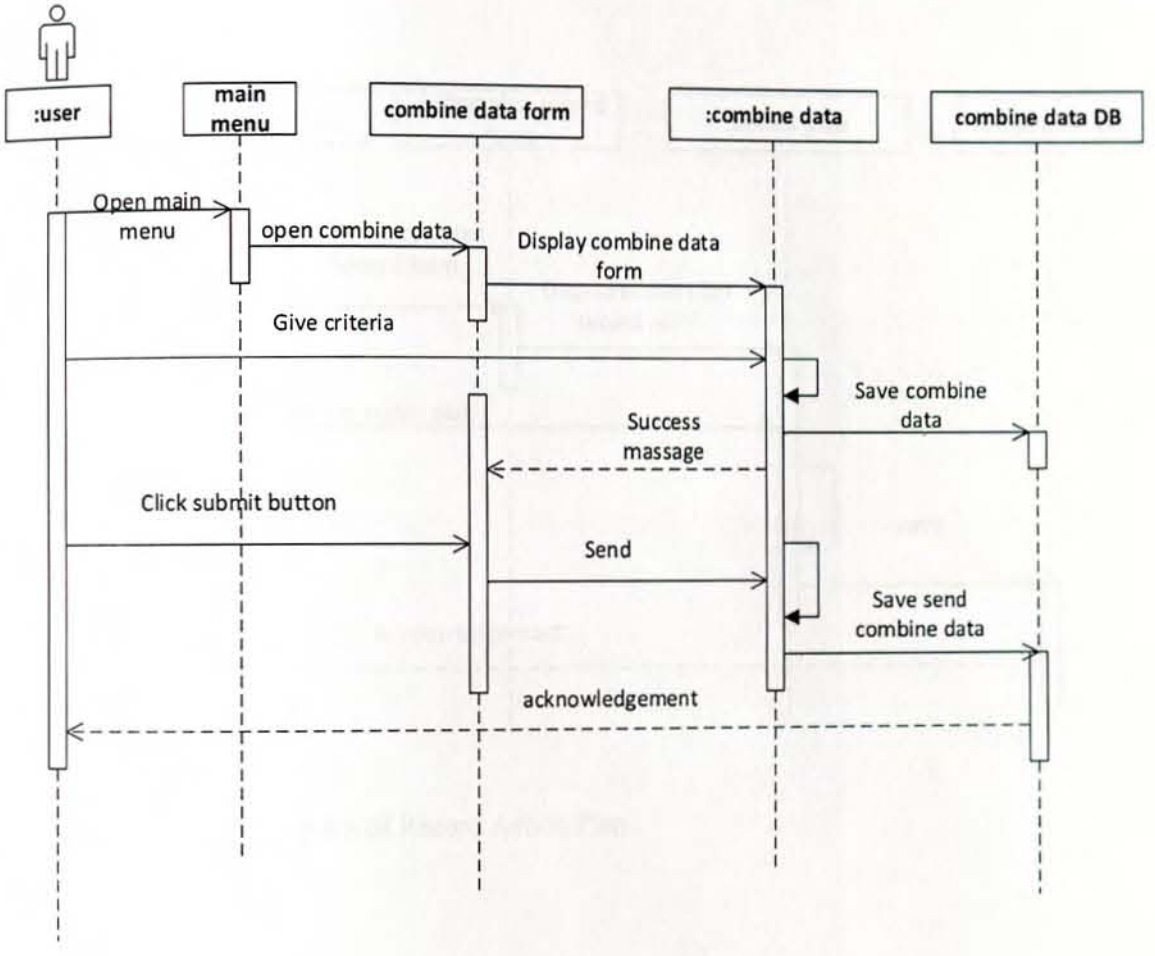

Figure 20 Sequence Diagram of Combine Data

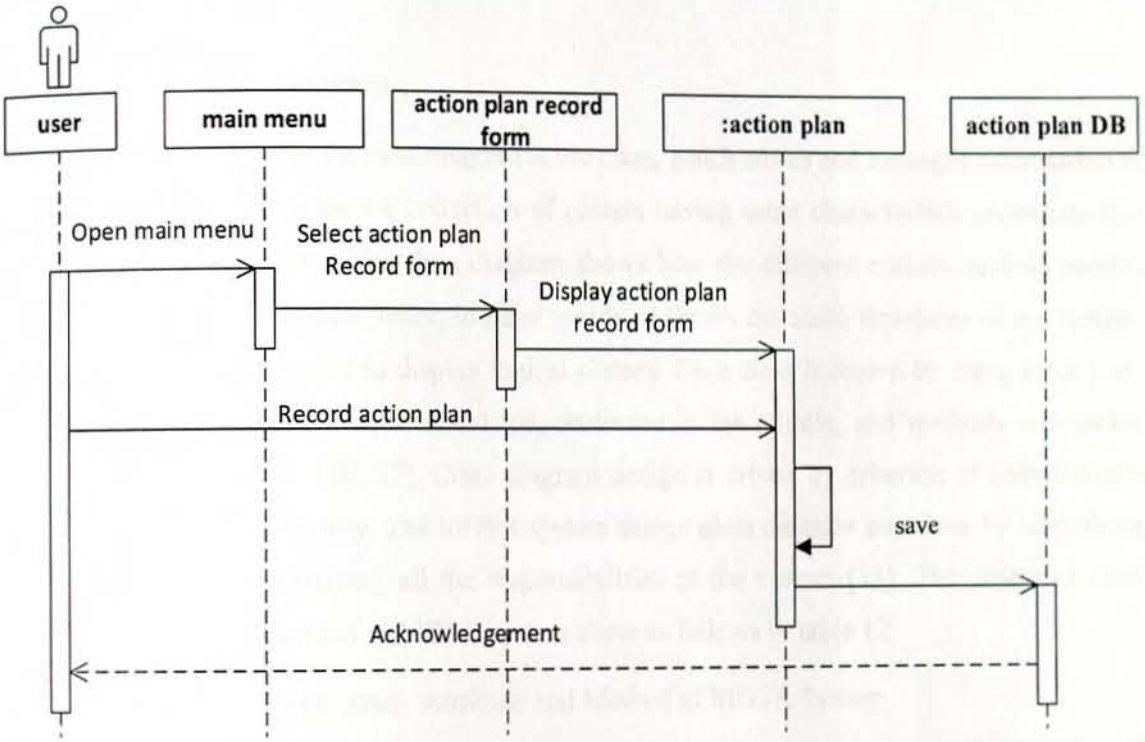

Figure 21 Sequence Diagram of Record Action Plan

4.5.2 Design Class Diagram

The main building block of a class diagram is the class, which stores and manages information in the system. A class represents a collection of objects having same characteristic properties that exhibit common behavior. The class diagram shows how the different entities such as people, things, and data relate to each other; in other words, it shows the static structures of the system. A class diagram can be used to display logical classes. Each class is drawn by using three part-rectangles with the class's name at the top, attributes in the middle, and methods also called operations at the bottom [30, 35]. Class diagram design is driven by criterion of completeness either of data or responsibility. The MDSR system design class diagram was done by identifying all the data and by identifying all the responsibilities of the system [35]. The object of class diagram attribute and method of MDSR system show as follows in table 12

Table 12 Object of Cass Diagram, Attribute and Method of MDSR System

Object	Attribute	Method
Employee	Employee id First name Middle name Last name Date of birth Sex Address Ethnicity	Get address Add Update
Facility Notification	Facility id Facility name Address Qualification of abstractor Facility episode Abstractor involve in management Name of the abstracter	Get notification id Add Update Get facility episode Get address
Facility episode	Facility episode ID MRN of the deceased Date of admission Day of admission Time of admission Main reason of admission Referred case	Add Update

	Summary hospital management	
Community notification	Community ID Community address Community factor Name of deceased Husband name Date of death Informed person Date of notification Name of HEW/HCP	Add Update Get community factor Get address
Community factor	Community factor ID Number of days hours sick Problems before she died Care for problem Where care obtained Mode of transport How long was care given Reason for not sick care How long walk to health facility	Add Update
Death screening	Death screening id Age of woman Sate of pregnancy Place of death Is maternal death Date of validation	Get death screening id Get health service provider Add Update
Death identification	Identification id Identification type Time of death Place of death Place of residence Educational level of deceased Marital status Level of education of husband Occupation of the deceased Occupation of the husband Monthly income Contributory factor Obstetric history Medical history	Add Update Get validation Get address Get health service provider Get facility episode Get community factor
Obstetric history	Obstetric history id Gravidity Parity Number of living children Attended ANC	Get obstetric id Get facility notification Get facility community Add Update

	Place of ANC Number of visits Basic package services State of pregnancy Delivery out come Place of delivery Gestational age Day of alive after termination	
Medical history	Medical history ID Disease Modern treatment Traditional treatment Complication	Add Update
Contributory factor	Contributory factor id Delay one Delay two Delay three	Add Update
Basic service	Basic services id Lab result Vaccination Iron supplement	Add Update
State of pregnancy	State of pregnancy id Ante partum Intra partum Post-partum Post abortion Abortion Ectopic	Add Update
Action plan	Action plan id Date meeting Death preventable Action to betaken Responsible person Time scale Challenge Action completed date	Add Update

Based on the identified objects and attribute in the above table, the design class diagram for MDSR system perform as follows in Figure 22. Employee representing the person associated to the MDSR system and perform: death notification, death screening, death identification and record action plans. Health facilities and communities are a place which the case were identified. The proposed MDSR system design class diagram see below in figure .22

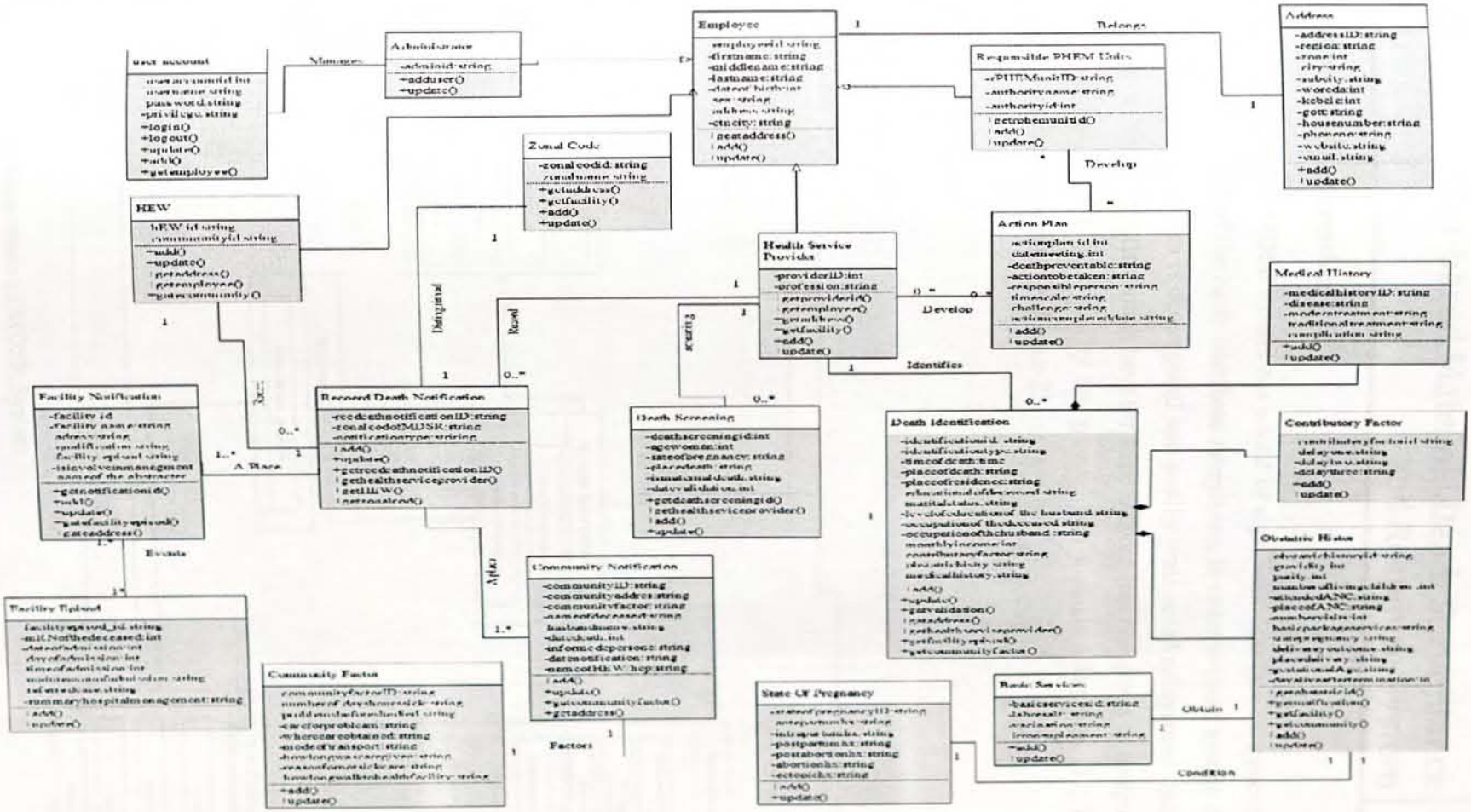

Figure 22 Design Class Diagram of MDSR System

4.5.3 Sub System Description

The designed web based MDSR system has a total of eight basic interface subsystems and five interfaces which are part of the basic interfaces subsystems. In order to make system design and development easy, the system is decomposed into smaller parts called subsystems. Subsystem is categorization of functionalities which have the same purpose into one group or category. In this stage, classes with similar functionality are grouped into a single subsystem [72].The major subsystems identified are shown in Figure 23.

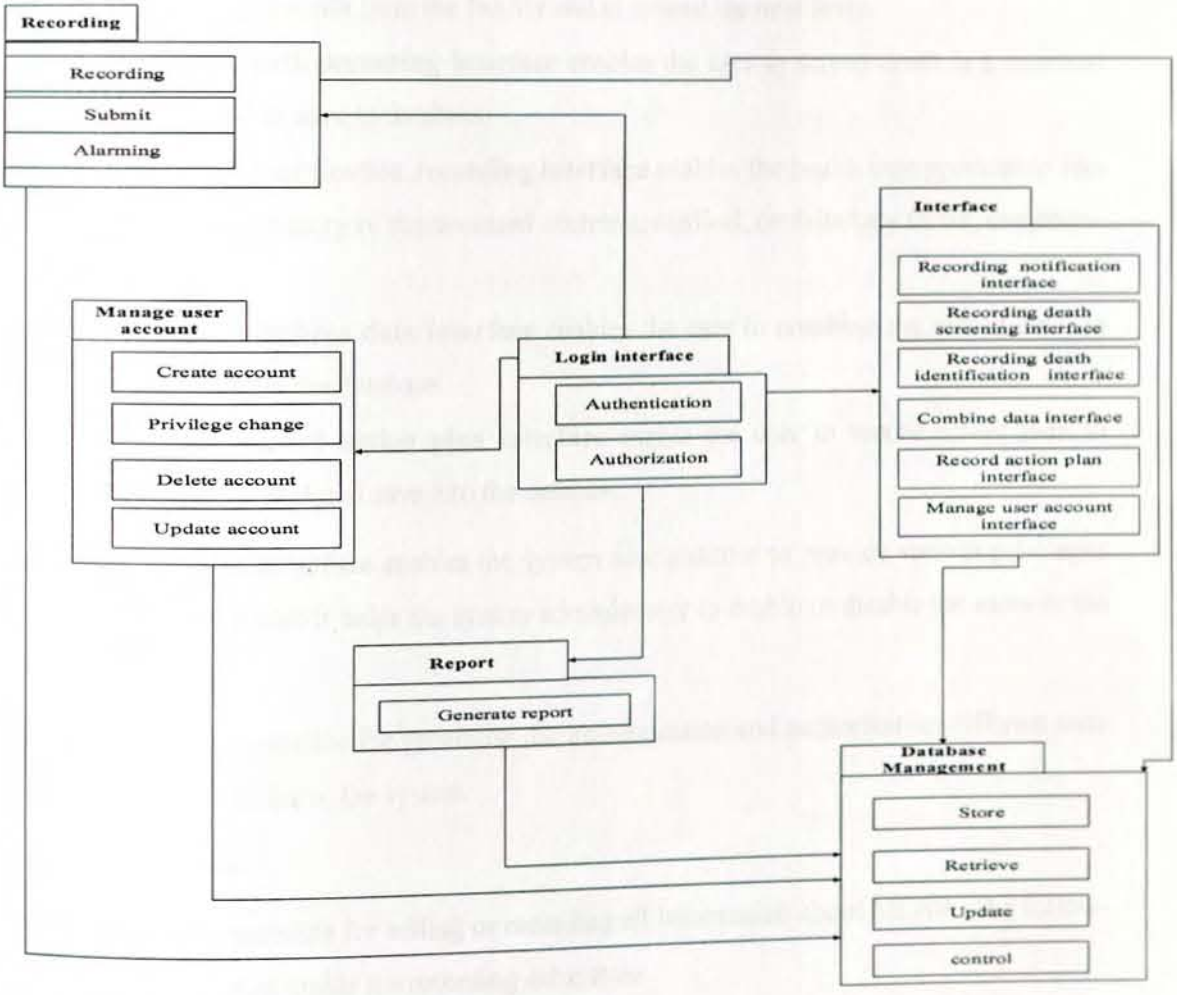

Figure 23 Identified Subsystem of MDSR System

Interface Subsystem

The basic interface and their parts subsystems include:

- **Record death notification interface** enables the user (HEW/health care provider) to record first death notification of maternal death from community/ facility, submit to the next level and save into the database.
- **Record community based death notification interface** enable the HEW to record women's death submit to the next level.
- **Record facility based death notification interface** enables health care provider to record death from the facility and to submit the next level.
- **Death screening interface** enables the user to screen death is a maternal death or not and to save to database.
- **Identification recording interface** enables the health care provider to record the different history of the deceased obstetric, medical, contributory factor, community factor etc.
- **Combine data interface** enables the user to combine the record data, to submit and to save the database.
- **Record action plan interface** enable the user to record action plan to submit the next level and save into the database.

Manage user account interface enables the system administrator to provide various privileges that the user needs and also it helps the system administrator to enable or disable the users in the system.

Login interface is responsible for providing the authentication and authorization different user based on the functionalities in the system.

Recording subsystem

This subsystem is responsible for adding or recording all information about MDSR. The following are the functionalities inside the recording subsystem:

- Recording MDSR data
- Submit to next level
- Alarming the user

Generate report interface enables the user to generate the required report from the system.

Data management sub system

This subsystem is responsible to make a connection with other subsystems and also for storing, retrieving, updating and control all information needed by the system.

4.5.4 Deployment Diagram

Deployment diagram is an architecture-related aspects of information system both software and hardware are visualized with UML using a number of strictly connected diagrams and component [40]. Architecture acts as a common model of a system articulated at a high-level of abstraction. This model plays an important role for implementation of system or it acts as a bridge between what is required and what is implemented. It is no concern with detail, it is abstract in nature and its focus is on the visible properties of software component [73]. See figure 24 the designed MDSR system deployment diagram.

* 3-D box represents a node, either software or hardware. Connections between nodes are represented with a line.

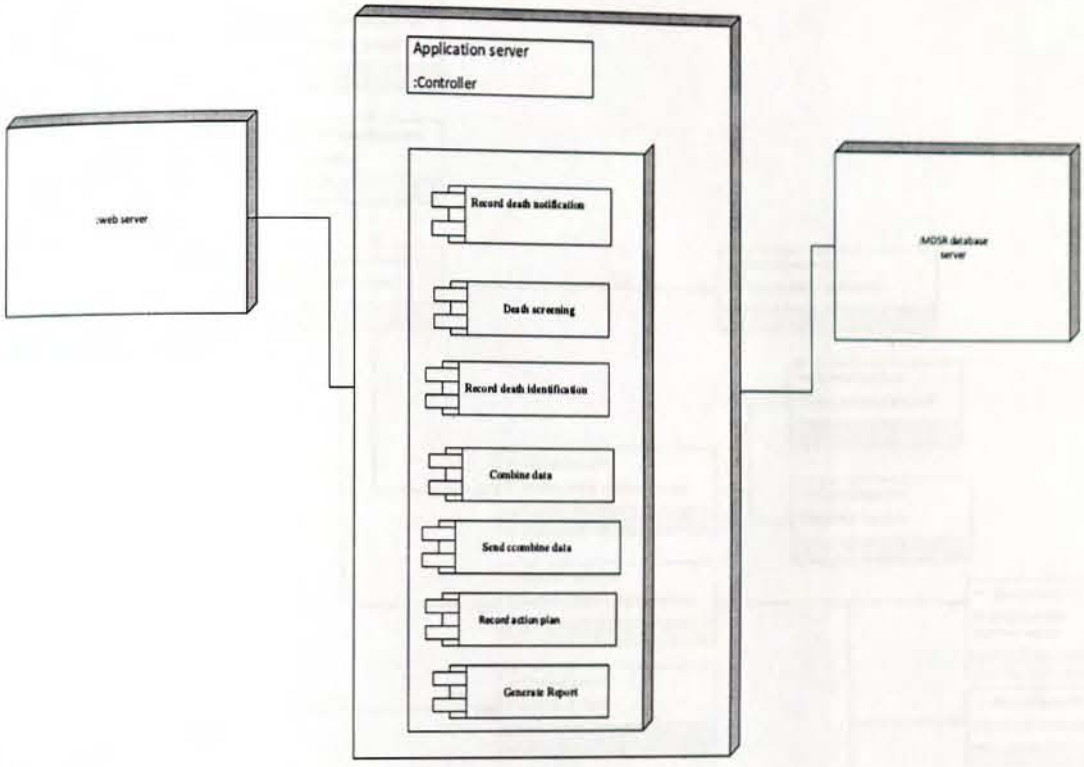

Figure 24 The Proposed web-based MDSR System Deployment Diagram

4.5.5 User Interface Prototype of the Design MDSR System

Prototype is a working model of software with some limited functionality. The prototype does not always hold the exact logic used in the actual software application .It helps to get valuable feedback from the user and it helps to understand about what exactly is expected from the product under development [74].

4.5.5.1 Interface-flow Diagram

Interface-flow diagrams show the relationships between the user interface components, screens and reports, which make up in the application [74]. Figure 25 show that the design MDSR system interface flow diagram an architectural view of how each users in the system is allowed to use and access different functionalities and data entry usage based on their own administrator assigned privilege.

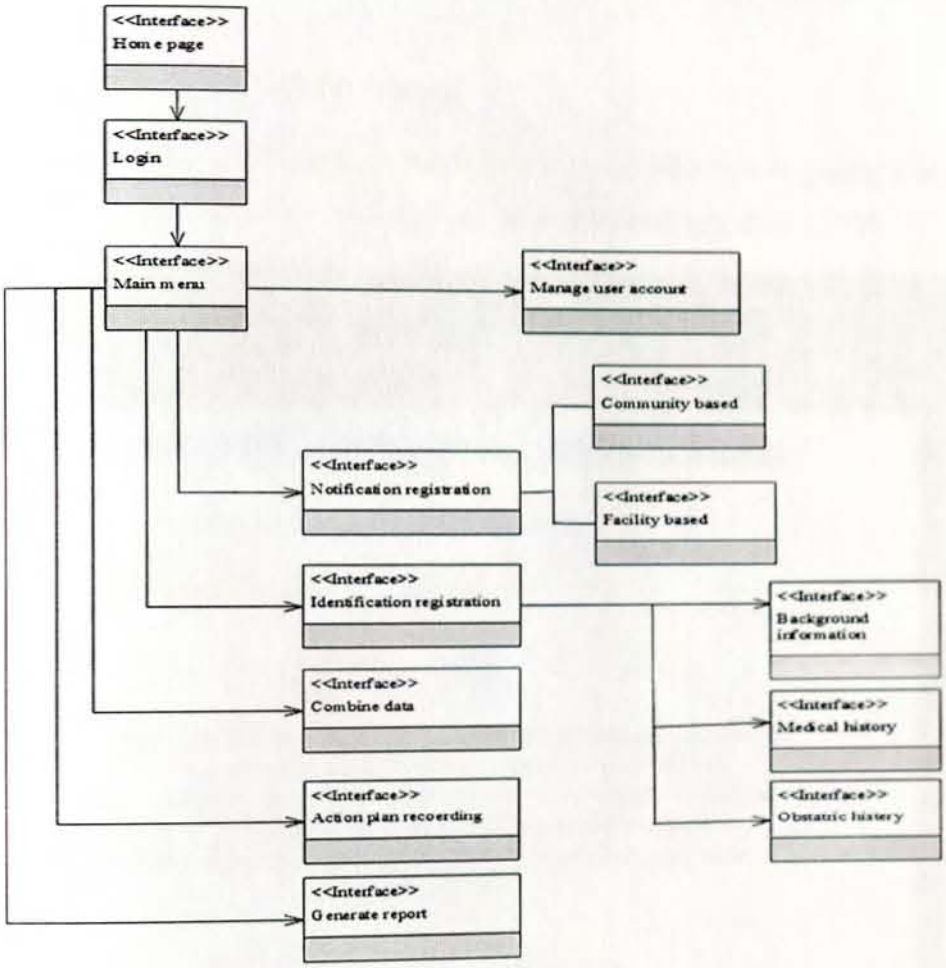

Figure 25. Interface Flow Diagram for a Web-Based MDSR System

4.5.5.2 Prototype of the Design MDSR System

The first user interface the actors of the system will obtain the home page prior to getting access to the different pages and functionalities. This page give general information about MDSR.

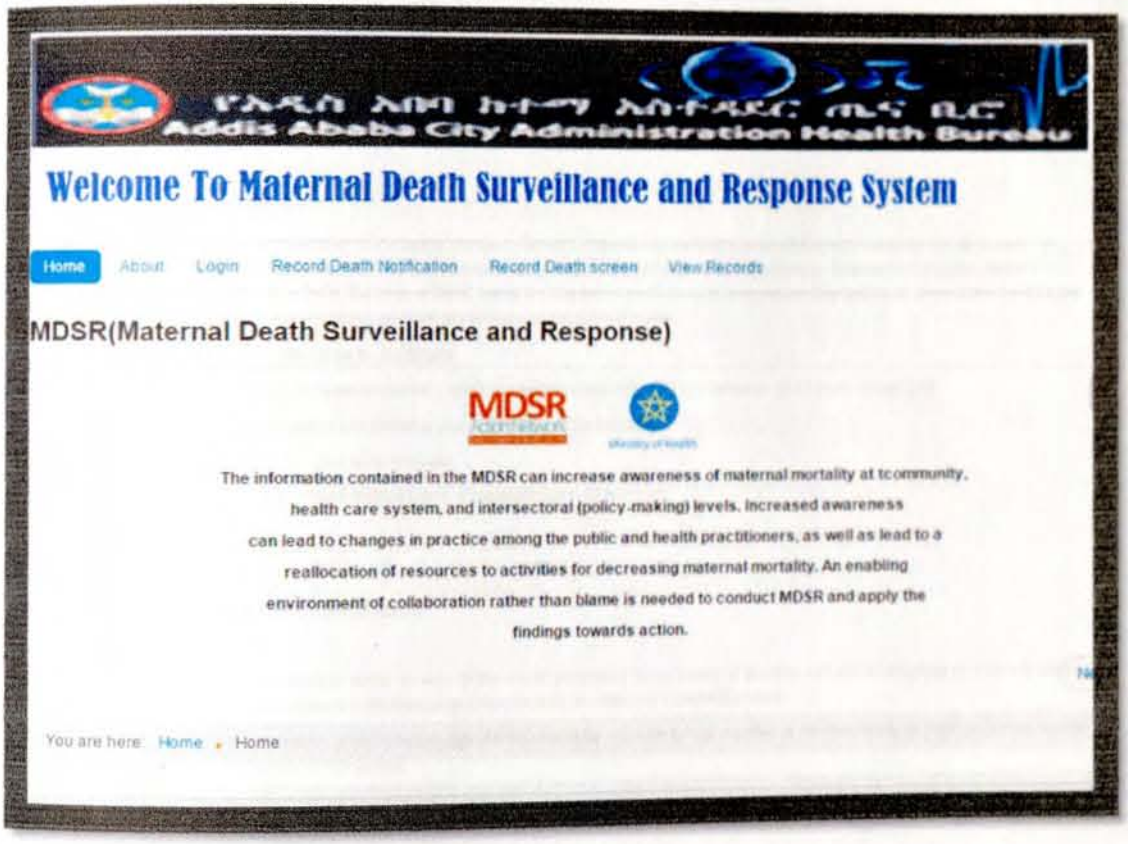

Figure 26 Home Page User Interface of MDSR System

The next interface is "about" the user when click it gate detail information about MDSR

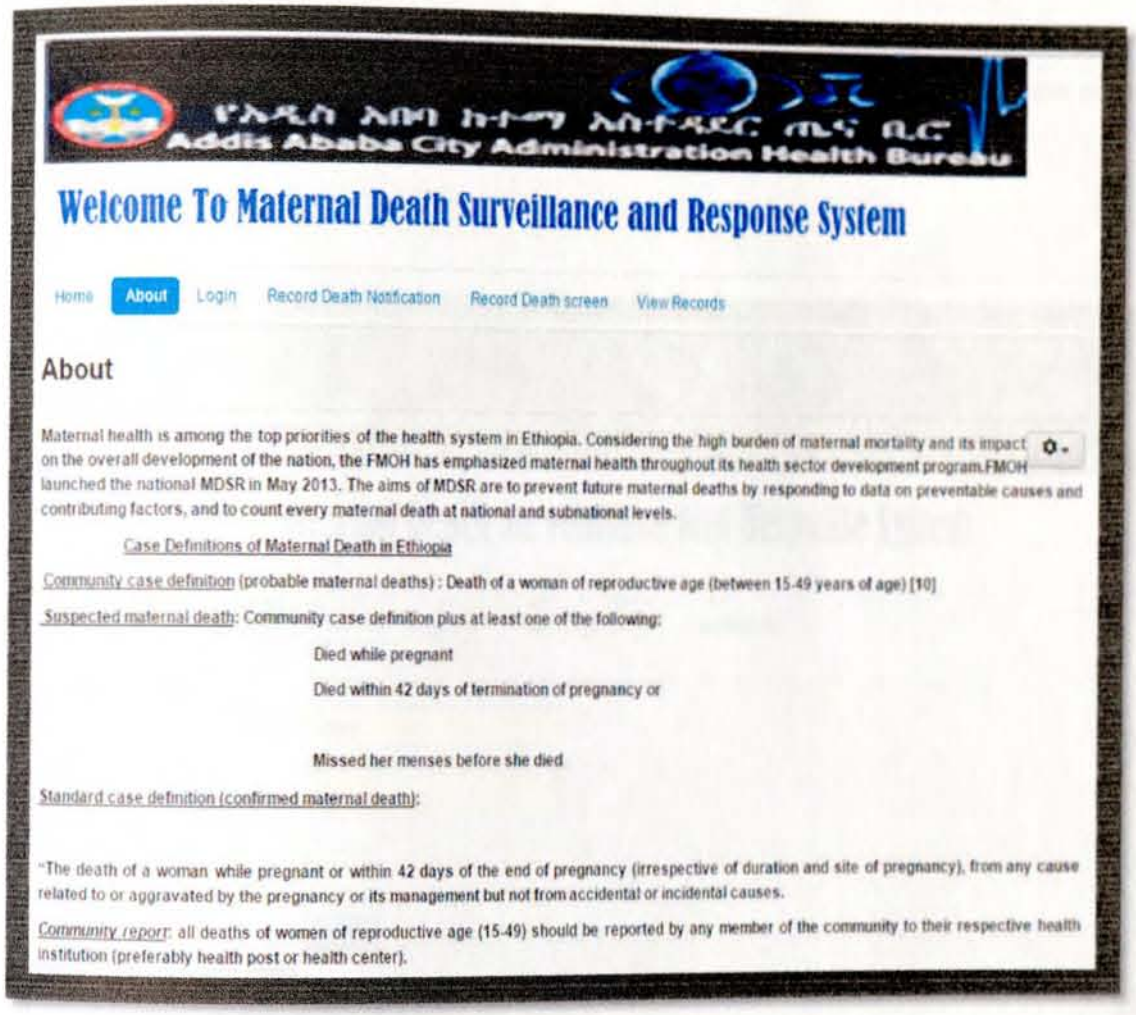

Figure 27 about Page User Interface of MDSR

Login page is the other user interface it is a gate way to the different functionalities of the system. Each user before logs into the system must have the appropriate password and user name and privilege assigned by the administrator of the system.

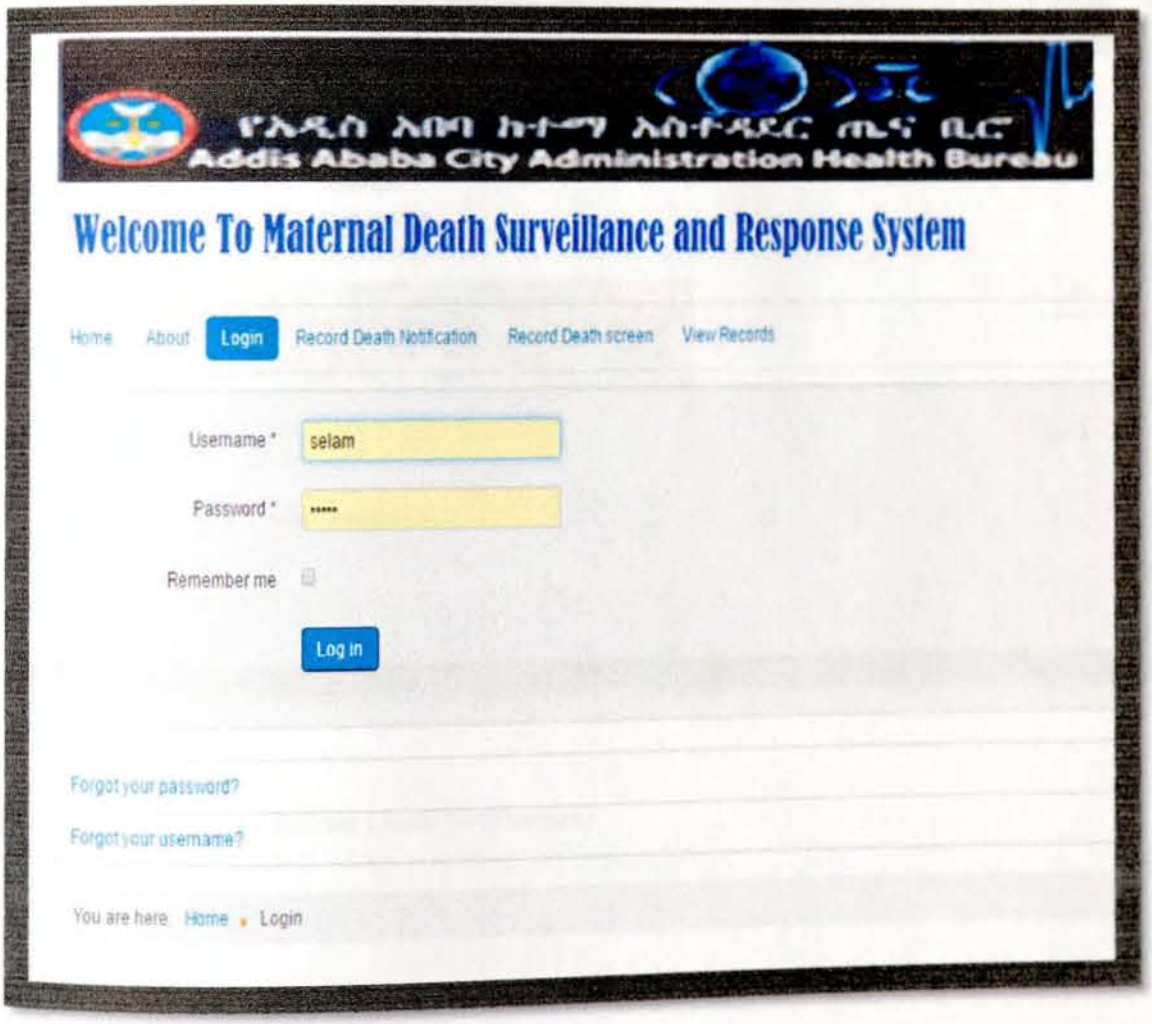

Figure 28 Login Interface of MDSR System

Record death notification interface is user interface found in the main menu and have two sub menu facility death record and community death record.

Figure 29 Interface of Record Death Notification

Facility death recording form is a sub menu found under record death notification select by health care provider in order to record facility maternal death. The record data is save into the database.

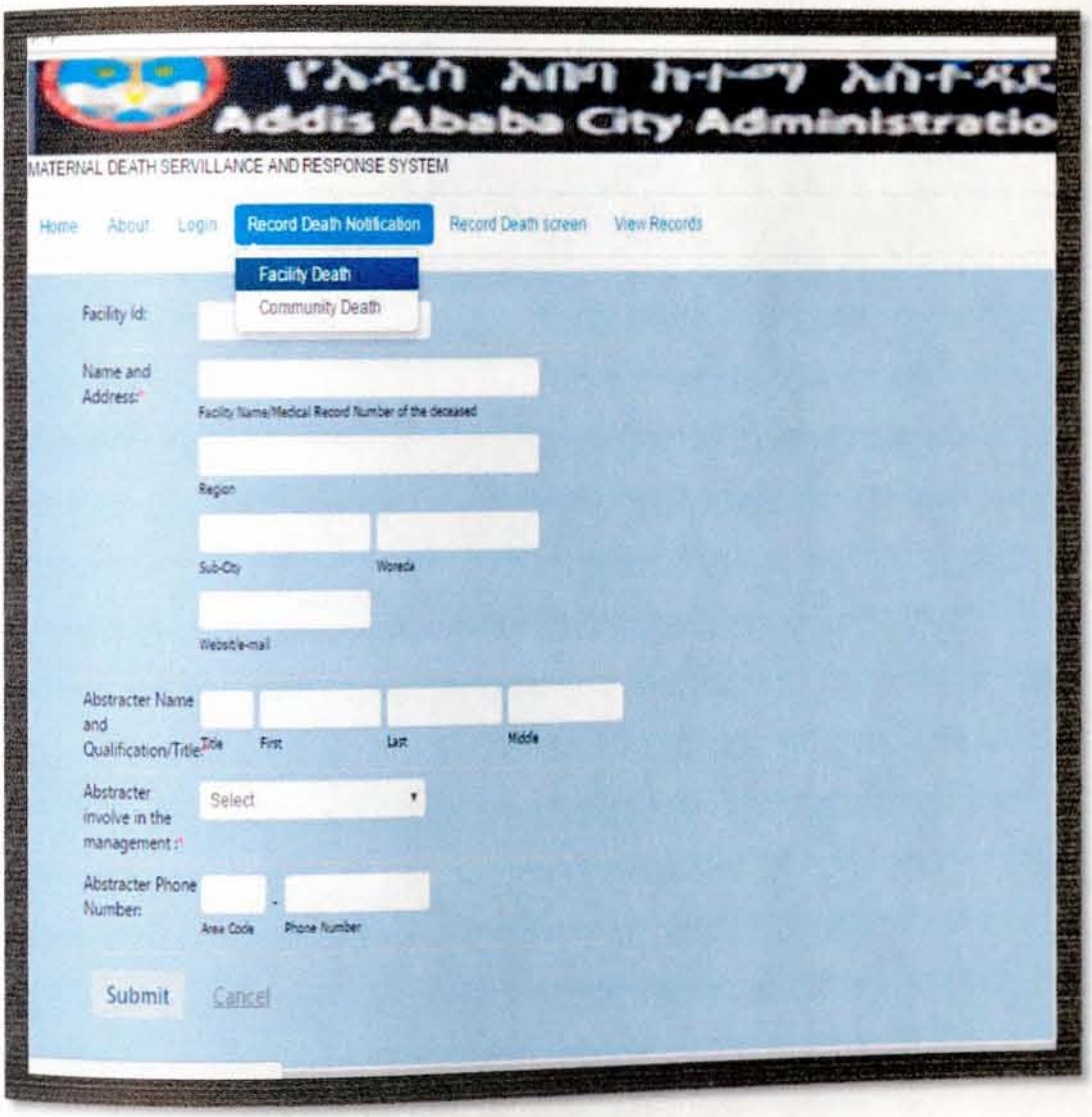

Figure 30 Interface Facility Death Record Form

Community death recording form is a sub menu found under record death notification select by health extension worker in order to record community women's death. The record data is save into the database.

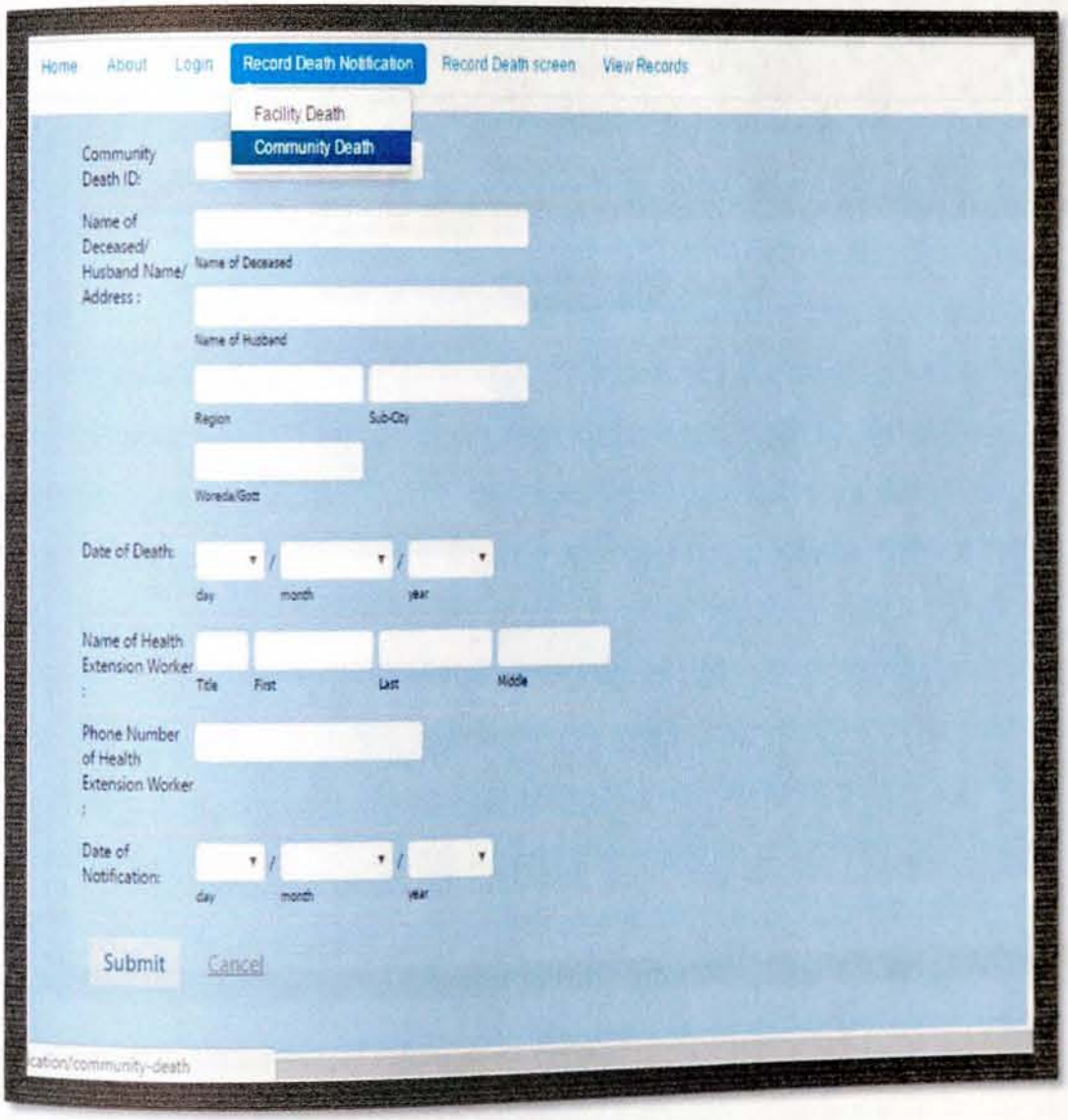

Figure 31 Interface Record Community Death Form

Interface record death screen form used in order to validate the death is a maternal death or not. This interface is used by health care provider finally the record data save to database.

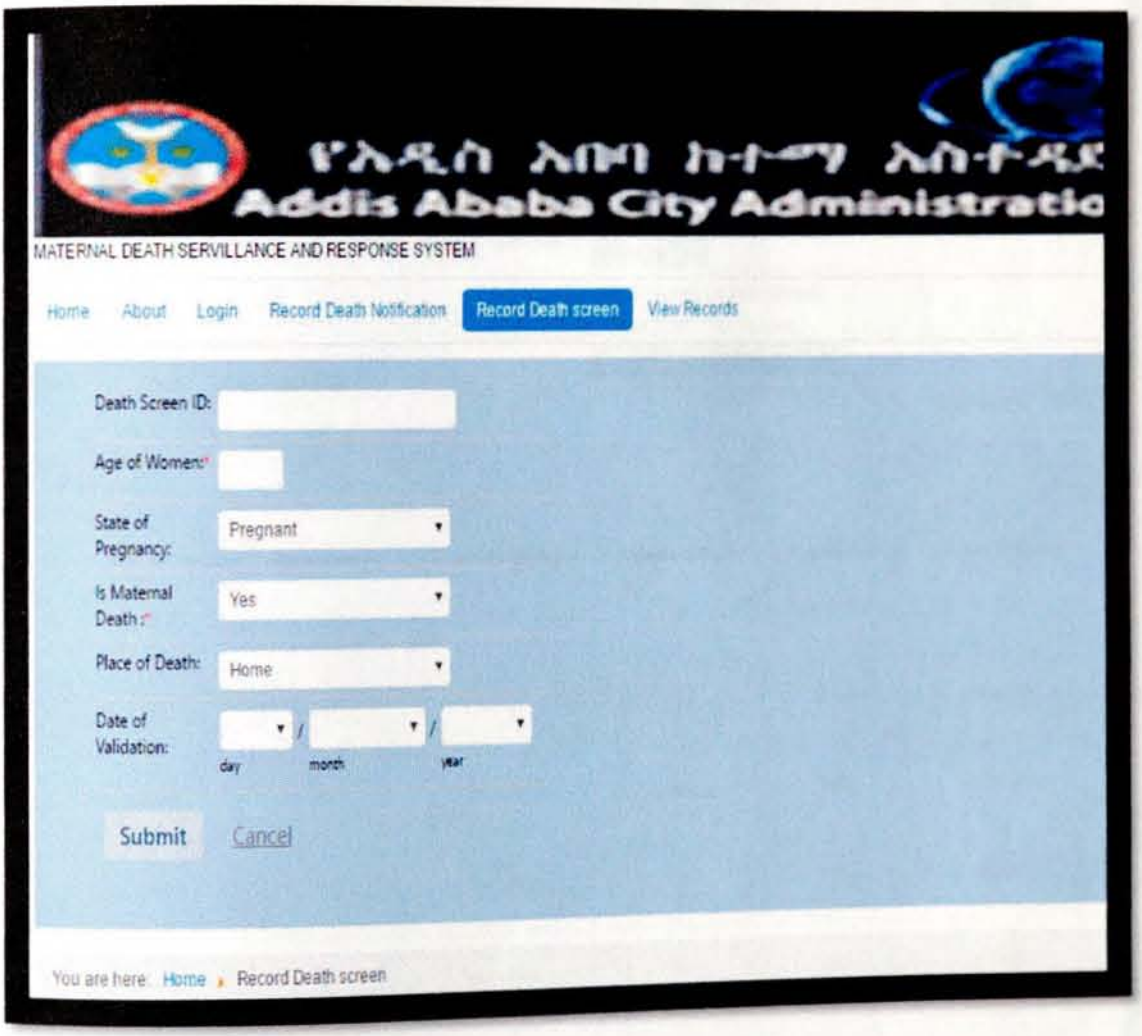

Figure 32 Interface Record Death Screen Form

Interface view records found in the main menu and have different sub menus. It used when the user need to see the save data for different purpose.

Figure 33 Interface View Records

4.5.6 User Interface Evaluation

ISO 9241-11 explains the benefits of measuring usability in terms of effectiveness, efficiency and satisfaction of user toward the system [58]. Heuristic Usability Evaluation Methods (UEMs) are a set of methods used to evaluate human interaction with a product; they are aimed at identifying issues or areas of improvement in this interaction in order to increase usability [59].

Based on heuristic evaluation inspection method experts select directly involve in the MDSR system are HEW, health care provider, responsible PHEM unit stakeholders at each level of the system are include in usability testing . Based on this testing method that asks usability practitioners and other stakeholders to evaluate a user interface based on a set of different principles and based on FMoH national guide line.

For this particular project user test was done for the developed prototype. Test the system by demonstrate experts which means they putting input and then they see the result which is used to measures the easiness of use as well as the degree of comfort and satisfaction of users. 10 users participated in the testing process and are presented with eleven different questions that the investigator believes will address the user requirement. Using Likert scale evaluation methods in Likert scale, the respondent is asked to respond to each of the statements in terms of several degrees, usually five degrees [19].

Table 13 User Interface Evaluation of Web-based MDSR System

(Self-administer question adopt and modified from *John Brooke john.brooke@redhatch.co.uk)*

NO	Rate your agreement with the following statements (Place a X in the appropriate column)	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
1	I found the system necessarily simple to do and communicate clearly.				2	8
2	I thought the system is easy to open and access the option menu.				3	7
3	I thought the system was easy to use.				3	7
4	I think that no need of a technical support to use this system.			1	5	4
5	The system display the required information in recording death notification.				2	8
6	I thought there was reliability in this system which means consistency from the user requirement.			2	4	4
7	All the system input fields buttons locations are consistent.				5	5
8	The system response time while saving and viewing is acceptable.				2	8
9	I found the system attractive to use.			1	6	3
10	I think the system improve data quality and reporting system.				5	5
11	It was clear to access the saves entered data properly.				2	8
	Average present			4%	35%	61%

Based on the finding of the result of the user evaluation test questions presented to the respondents, 61% and 35% of the respondents give their response strongly agree and agree respectively towards the interface consistency ,effectiveness and attractiveness. Which means that 96% of the participants in the evaluation and testing has shown positive attitude and response (either agreed or strongly agreed to) for the prototype.

CHAPTER FIVE

5. Conclusion and Recommendations

5.1 Conclusion

The project was conducted to design and develop a prototype web based MDSR system for Addis Ababa City Administration Health Bureau. The existing MDSR system is a paper based one. According to the gathered information by using interview and document review, the existing paper based manual system have a lot of gabs in their functionality. Most of the problems are manifested regarding the quality of the data that recorded and reported to the next level. That is loss of filled data from the formats, incompleteness, and difficulty in retrieval, report long time spent to reach the next level, difficulty in processing report or combination of data. For designing and developing prototype web based MDSR system UP methodology was used.

After gathering of information the system business modelling analysis was performed. The first thing that performed was list out the current business processes stakeholders', roles, and responsibilities and show it by diagram.

Requirement modelling was done based on the understanding of business process need. In this level identifying functional and none functional requirements were done that help to understand problem and its application area. These functional requirements included the recording death notification, screening death, recording identification, reporting, combine data and record action plan were identified. Beside the functional requirements, the non-functional requirements which are required to keep the system: running like security, scalability, interoperability and performance requirements were also identified. Requirement analysis was done by essential use case modelling and essential interface designing.

Based on the analyses of the requirements, system analysis modeling and system design of the MDSR system was accomplished. System analysis modeling was started by the proposed MDSR system business process modeling. And then shows the overall business process as just one process by context modeling diagram. Analysis and design of the system used up object oriented

approach. In order to model the analysis and design of the proposed system, unified modeling language (UML) tools was used. From the different types of the UML tools use case, class diagram sequence diagrams was used. In order to implement the system UML deployment diagram was done to show system architecture.

Finally prototype develop to get valuable feedback from the user. And then interface usability was tested to assess effectiveness, efficiency and satisfaction of the users on the developed prototype.

5.2 Recommendations

This research project made to design a web-based MDSR system in order to improve the current paper based system. Based on the finding the following recommendations had better be taken in consideration to Addis Ababa City Administration Health Bureau managing bodies and other stakeholders to solve the existing paper based system problems.

Addis Ababa Health Bureau

I recommended that AAHB to support sub city and health facility in order to implement the system .Also put in plan to allocate budget in order to full fill the necessary infrastructure, hardware, software and human resource.

To provide technical support and follow-up for system automation to each sub city.

To evaluate the impact of automating the MDSR system.

Sub-City Health Administration, Woreda Health Administration and Health facilities

I recommended that to provide the necessary sport in order to implement the web-based system.
I recommended that to allocate budget to full fill that necessary infrastructure, hardware and software.

I recommended that to provide technical support and follow-up in order to implement the system.

To researchers/students

I recommended that the researchers/students to continue the project and work on the development and implementation of the system

I recommended that the researchers/students to continue the project and work on the remaining parts of the system.

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Annexes 1 Question for Requirement Collection

Interview guide question was developed based on business process components which are: data, process, procedure, people/user, hardware, software and communication/networking. The questioner was prepared by revising different model projects which perform previously from different universities.

ADDIS ABEBA UNIVERSITY

SCHOOL OF INFORMATION SCIENCE AND SCHOOL OF PUBLIC HEALTH

MSC IN HEALTH INFORMATICS PROGRAM

In Formation Sheet and Informed Consent for Interview Guide Questions

My name is SELAMAWIT GOSAYE I am post graduate student of health informatics program in Addis Ababa University. I am doing a research project on designing of web-based maternal death surveillance and response systems for Addis Ababa City Administration Health Bureau. The following interview is designed in agreement to strengthen the information need of the project on how to design, implement and achieving the organizational mission and goals. Thus you are kindly requested to provide genuine and correct answers for the questions posed by the principal investigator.

The information you provide is confidential and will be used only for the purpose of this study. Sir/madam, if you have anything, you want to be clarified it is possible to ask the investigator/the interviewer. Your full cooperation and participation until the completion of the interview is very necessary and crucial for the completion of the assessment. I kindly ask you to provide your genuine willingness. Besides, you have the right to turn down if you are not voluntary to participate on the interview, thus you can fill/mark the NO box

If you are voluntary or not mark 'X' on your opinion YES_____ NO _____

THANK YOU FOR YOUR PARTICIPATION!

Interview guide questions for Designing of Web-based MDSR Information System.

Hint

* Data is row facts about event.

* Information is meaningful collection of facts or data.

1. Data and process/Functionality

1. What types of information is processed in the current system?
2. What data are included in each type of information processed?
3. How are maternal data collected and stored?
4. How are data retained for any period of time?
5. What are the problems with the current existing forms?
6. How do you retrieve maternal information in the current system?
7. How do you record data during processing of MDSR in the current system?
8. Is there a standard format to collect the data? Yes _____ No_____
9. How is the MDSR process started/initiated?
10. What are the current problems on data processing?
11. What types of errors most occur in recording and processing?
12. What are the appropriate reactions to possible problem?

2. Users/people

13. What categories of users exist in MDSR system?
14. How is maternal information accessing privilege provided for the professional?
15. Who is responsible for MDSR record, combine and report data?

3. Management /procedure

16. Do you have a guideline to help or to assist the different MDSR system user?

17. What type of data are recorded? And what are the procedures followed in recording.

18. How are problems associated with MDSR information or data recording handled?

4. Software and Hardware

19. Do you have any software used to prepare the reports? Which software?

20. Is there a planned approach to automate the current system?

21. Do you have computer network for sharing information?

22. Do you have computer? How many?

23. For what purpose do you use them?

Chick list for document review

S. no	List of Documents	Yes	No
1	Are there standard documents		
2	Is there guidelines		
3	Is there job aids		
4	Is there brochures		
5	Is there protocols		
6	Is there literatures		
7	Is there registration book		

Annex 2 User Interface Evaluation

User interface evaluation of Web based MDSR system. The questionnaire was modified after being adopted from *John Brooke john.brooke@redhatch.co.uk*

Addis Ababa University School of Health Informatics and School of Public Health

Rate your agreement with the following statements (Place an X in the appropriate column)

1 I found the system necessarily simple to do and communicate clearly.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. I thought the system is easy to open and access the option menu.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. I thought the system was easy to use.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. I think that no need of a technical support to use this system.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. The system display the required information in recording death notification.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. I thought there was reliability in this system which means consistency from the user requirement.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. All the system input fields buttons locations are consistent.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

8. The system response time while saving and viewing is acceptable.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

9. I found the system attractive to use.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

10. I think that the system improve data quality and reporting system.

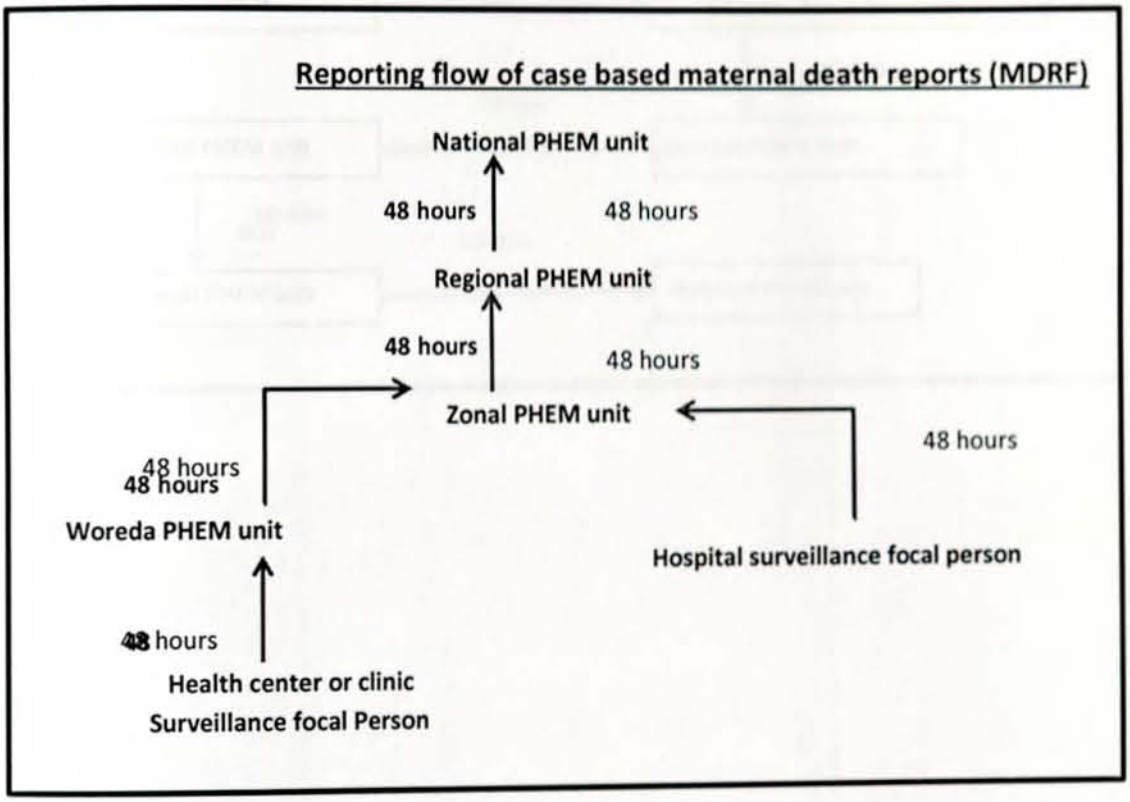
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

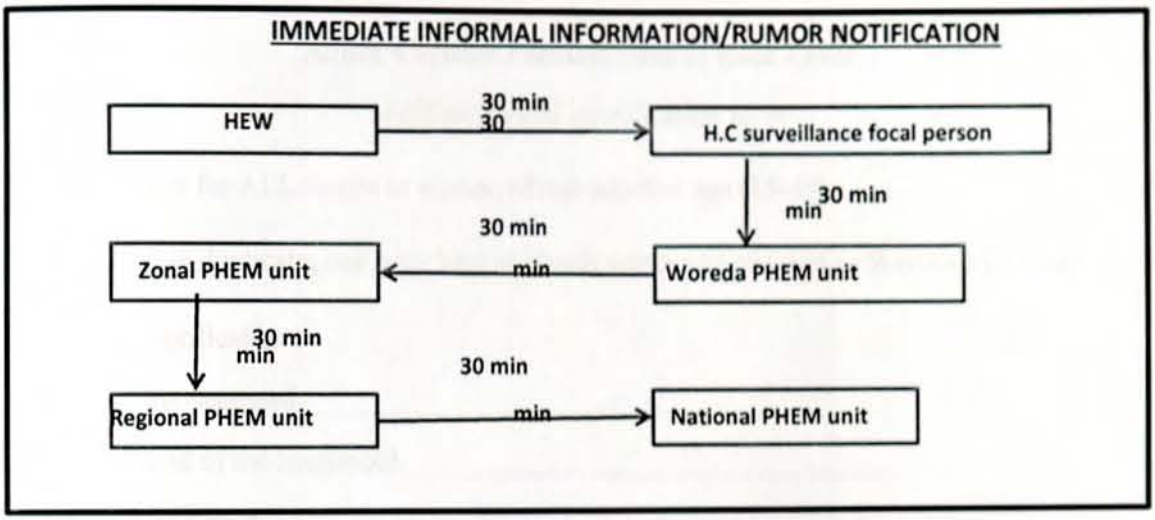
11. It was clear to access the saves entered data properly.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Annex 3 Reporting Flow of MDSR

Adopted from PHEM guide line




IMMEDIATE INFORMAL INFORMATION/RUMOR NOTIFICATION
HEW
30 min
30
H.C surveillance focal person
min
30 min
30 min
Zonal PHEM unit
min
Woreda PHEM unit
30 min
min
30 min
Regional PHEM unit
min
National PHEM unit

Annex 4 MDSR Formats Used at Each Level

Notification and identification form

To be filled out for ALL deaths to women of reproductive age (15-49)

(To be filled in duplicate; one copy kept at Health centre and one sent to Woreda MH Lead

I. Notification

1. Name of the deceased_____

2.Name of head of the household:_____

3. Household address:

Woreda/Subcity_____

Kebele_____

Gott_____

House number:_____

Date of the women's death:_____

4. Who informed the death of the woman?

1. HDA
2. Religious leader
3. Self (HEW)
4. Others (specify)_____
5. Date of Notification:_____
6. Name of the HEW:_____
7. Telephone number of HEWs:_____
8. Signature:_____

II. Screening (to be filled by Health Centre staff member)

1. Age of the woman:_____

2. Did she die while pregnant? 1. Yes 2. No

3. Did she die with 42 days of termination of pregnancy? 1. Yes 2. No 4. Has she missed her menses before she dies? 1. Yes 2. No 3.Unknown

4. Place of death:

i. Home

ii. On the way to HP

iii. HP

iv. On the way to Health facility (HCs, hospitals)

v. Managed at health facility

NB: If answer to ANY of questions 2-4 is YES, then the death is a suspected maternal death and requires a verbal autopsy to be conducted

5. Suspected maternal death: 1. Yes 2. No

6. Date and signature

I. Identification/ Back ground information:

INSTRUCTIONS FOR ALLOCATING AN ID NUMBER ARE AT THE END OF THIS FORM

No	Question	Response
1	ID Number (see instructions below)	
2	Age of deceased	(years)
3	Time of death and date of death	
4	Ethnicity	

5	Address where death occurred (Select ONE) COMMENTS: (provide	Home/ Relatives' Home _____ Health Post _____ Health Centre _____ Hospital _____
	address if death occurred in a home, name of HP, HC or hospital, or how far from destination if in transit)	In Transit _____ Comments: _____
6	Place of usual residence	Woreda/subcity _____ Got_____ Kebele _____ House number_____
7	Marital status of the deceased	1. Single 2. Married 3. Divorced 4. Widowed 5. Others (specify)
8	Religion	1. Orthodox 2. Muslim 3. Protestant 4. Others (specify)------
9	Educational status of the deceased	1.Illiterate 2.No education, but can read and write 3. Grade completed _____ 4. Don't know
10	Level of education of the husband	1.Illiterate 2.No education, but can read and write 3. Grade completed _____ 4. Don't know

11	Occupation of the deceased	1. Farmer 2. Merchant/tradesperson 3. Public employee 4. Daily labourer 5. Unemployed 6. Others (e.g. housewife) _____
12	Occupation of the husband	1. Farmer 2. Merchant/tradesperson 3. Public employee 4. Daily labourer 5. Unemployed 6. Others (specify) _____
13	Family's monthly income if possible	birr

Do you have a death certificate? 1. Yes 2. No If yes, ask to see the document. Record important cause of death and identified problems

1. Pre Existing Problems:

Has she ever attended basic Antenatal care (ANC)?	1. Yes 2. No 3. Not known
If yes, where did she receive ANC services (Check all that apply)	1. HP 2. Public HC 3. Public Hospital 4. Private clinic or hospital (specify)

Were any of the following conditions identified during ANC or previously? Check ALL that apply:

CONDITION	CHECK IF IDENTIFIED	WHEN WAS THE CONDITION IDENFITIED?
Malaria (fever, chills, rigors)		
Tuberculosis (cough> 3 weeks, fever, night sweating, etc.)		
HIV/AIDS		
Anemia		
Hypertension		
Diabetes		
Epilepsy		
Others (Specify)		

1.2. Did she receive treatment for any of the conditions mentioned above? Specify Treatment provided for each condition (separating modern and traditional treatments) If NO treatment was provided, leave blank.

Disease	Modern treatment	Traditional/cultural treatment
Malaria (fever, chills, rigors)		
Tuberculosis (cough> 3 weeks, fever, night sweating, etc.)		
HIV/AIDS		
Anemia		
Hypertension		
Diabetes		
Others (Specify)		

IV. Pregnancy related questions

No.	Questions	Response
1	Number of pregnancies including those that ended in miscarriage and still births	
2	Number of living children	
3	Duration of the index pregnancy in months	
4	State of the pregnancy at the time of death	1. Delivered live birth 2. Delivered still birth 3. Undelivered 4. Abortion
5	If it was delivery, who assisted the delivery?	1. Family/elderly 2. HEWs 3. HCWs 4. Others (specify)
6	Were any of the following problems experienced during pregnancy?	
	Tick ALL those that apply • Seizure/abnormal body movement • Bleeding • Fever • Other (specify) _____	☐ ☐ ☐
	Did she seek care?	1. YES 2. NO If YES, briefly DESCRIBE

V. Community factors

No	Item	Response
1	Number of days/hours she was sick before she died (Number of hours and days - specify)	
2	Problems before she died: Tick ALL that apply • Vaginal bleeding • Fits • Fever • Baby stuck/Prolonged labor • Other (specify)	☐ ☐ ☐ ☐ ☐
3	Was any care sought for the problem?	1. Yes 2. No
	If "No" to question number 3 go to number 9	
4	If yes to Q3 above, how long after the problem/illness was detected? (Number of hours and days - specify)	
5	Where was care sought and obtained?	1. Traditional Healer 2. Health Extension Worker 3. Health Centre 4. Hospital
6	How long after seeking care did she arrive at a modern health facility? (Number of hours and days - specify)	
7	What mode of transport was used if care was obtained?	
8	For how long was the care given? (Number of hours and days - specify)	
9	If no to Q3 above, what was the main reason why care was not sought?	1. Not knowing the impact of the illness

		2. Past good obstetric out comes at home 3. Lack of money 4. Lack of transport 5. No nearby health facility 6. Others (Specify)
10	How long would it take to walk from this house to the nearest (Number of hours and days - specify): Health post , Health center , Hospital	Hours /days
11	If you want to go to health center or hospital, what mode of transport would you be able to use? (Tick ALL that apply)	1. Rented public transport 2. Police car 3. Ambulance 4. Private car 5. Others (specify)

Alphabetical List of Zonal codes

	Addis Ababa	ADDIS KETEMA	ADD-ADK		48	Oromia	HORO GUDURU	ORO-HOR
2	Addis Ababa	AKAKI/KALITI	ADD-AKK		49	Oromia	ILLUABABORA	ORO-ILB
3	Addis Ababa	ARADA	ADD-ARA		50	Oromia	JIMA	ORO-JIM
4	Addis Ababa	BOLE	ADD-BOL		51	Oromia	Jima Town	ORO-JMT
5	Addis Ababa	KIRKOS	ADD-KIR		52	Oromia	KELEM	ORO-KEL
6	Addis Ababa	GULELE	ADD-GUL		53	Oromia	Nekempt Town	ORO-NEK
7	Addis Ababa	KOLFE KERANIO	ADD-KOK		54	Oromia	N SHOA	ORO-NSH
8	Addis Ababa	LIDETA	ADD-LID		55	Oromia	SHASHEMENE Town	ORO-SHA
9	Addis Ababa	NEFAS-SILK LAFTO	ADD-NSL		56	Oromia	SW SHEWA	ORO-SWS
10	Addis Ababa	YEKA	ADD-YEK		57	Oromia	W ARSI	ORO-WAR
11	Afar	AFAR 1	AFA-AF1		58	Oromia	W HARERGHE	ORO-WHA
12	Afar	AFAR 2	AFA-AF2		59	Oromia	W SHEWA	ORO-WSH
13	Afar	AFAR 3	AFA-AF3		60	Oromia	W WELLEGA	ORO-WWE
14	Afar	AFAR 4	AFA-AF4		61	SNNPR	ALABA	SOU-ALA
15	Afar	AFAR 5	AFA-AF5		62	SNNPR	BENCH MAJI	SOU-BEN
16	Amhara	AWI	AMH-AWI		63	SNNPR	DAWRO	SOU-DAW
17	Amhara	BAHIR DAR	AMH-BAH		64	SNNPR	GAMO GOFA	SOU-GAM
18	Amhara	E GOJJAM	AMH-EGJ		65	SNNPR	GEDEO	SOU-GED
19	Amhara	N. GONDAR	AMH-NGN		66	SNNPR	GURAGHE	SOU-GUR
20	Amhara	N. SHEWA	AMH-NSA		67	SNNPR	HADIYA	SOU-HAD
21	Amhara	N. WOLLO	AMH-NWO		68	SNNPR	HAWASSA CA	SOU-HWA
22	Amhara	OROMIA	AMH-ORO		69	SNNPR	KEFA	SOU-KEF
23	Amhara	S. GONDAR	AMH-SGN		70	SNNPR	KEMBATA/TEMBARO	SOU-KET
24	Amhara	S. WELLO	AMH-SWO		71	SNNPR	KONTA	SOU-KOT
25	Amhara	WAG HIMRA	AMH-WAG		72	SNNPR	Segen	SOU-SEG
26	Amhara	W. GOJJAM	AMH-WGJ		73	SNNPR	SHEKA	SOU-SHK
27	Benshangul-Gumuz	ASOSA	BEN-ASO		74	SNNPR	SIDAMA	SOU-SID
28	Benshangul-Gumuz	KEMASHI	BEN-KEM		75	SNNPR	SILTI	SOU-SIL
29	Benshangul-Gumuz	MAO-KOMO	BEN-MAK		76	SNNPR	S Omo	SOU-SOU
30	Benshangul-Gumuz	METEKEL	BEN-MET		77	SNNPR	WOLAYTA	SOU-WOL
31	Benshangul-	PAWE	BEN-PAW		78	SNNPR	YEM	SOU-YEM

	Gumuz						
32	Dire-Dawa	DIRE-DAWA	DIR-DIR	79	Somali	AFDER	SOM-AFD
33	Gambela	AGNUAK	GAM-AGN	80	Somali	DOLLO	SOM-DOL
34	Gambela	GAMBELLA	GAM-GAM	81	Somali	FAFAN	SOM-FAN
35	Gambela	MEJENGER	GAM-MEJ	82	Somali	JARAR	SOM-JAR
36	Gambela	NUER	GAM-NUE	83	Somali	KORAH	SOM-KOR
37	Hareri	HARERI	HAR-HAR	84	Somali	LIBEN	SOM-LIB
38	Oromia	ADAMA Town	ORO-ADA	85	Somali	NOGOB	SOM-NOG
39	Oromia	ARSI	ORO-ARI	86	Somali	SHEBELE	SOM-SHE
40	Oromia	BALE	ORO-BAL	87	Somali	SITI	SOM-SIT
41	Oromia	BISHOFTU Town.	ORO-BIS	88	Tigray	C .TIGARY	TIG-CTI
42	Oromia	BORENA	ORO-BOR	89	Tigray	E .TIGARY	TIG-EST
43	Oromia	E HARERGHE	ORO-EHA	90	Tigray	MEKELLE	TIG-MEK
44	Oromia	E SHEWA	ORO-ESH	91	Tigray	NW TIGARY	TIG-NWT
45	Oromia	E WELLEGA	ORO-EWE	92	Tigray	SE TIGARY	TIG-SET
46	Oromia	Finfine Zuria	ORO-FIZ	93	Tigray	S .TIGARY	TIG-STI
47	Oromia	GUJI	ORO-GUJ	94	Tigray	W. TIGARY	TIG-WTI

Facility based maternal death form

Abstractor related

1. Name of the abstractor:_____
2. Qualification of the Abstractor_____
3. Telephone number of the abstractor:_____
4. Date of abstraction:_____
5. Was the abstractor involved in the management of the case? 1. Yes 2. No

II. Identification/ Back ground information

No	Question	Response
1	Medical Record Number of the deceased	
2	Age of deceased	Years
3	Time of death and date of death	
4	Ethnicity	
5	When did the death occur?	In transit _____ While waiting for treatment _____ Following start of treatment _____
6	Place of usual residence	Woreda/subcity_____ Kebele_____ Got_____ House number____
7	Religion	1. Orthodox 2. Muslim 3 Protestant 4. Others (specify)------
8	Educational status of the deceased	1.Illiterate 2.No education, but can read and write 3.Grade complete Don't know
9	Marital status of the deceased	1. Single 2.Married 3. Divorced 4. Widowed 5. Others (specify)

10	Level of education of the husband	1.Illiterate 2.No education, but can read and write 3. Grade completed _____ 4. Don't know
11	Occupation of the deceased	1. Farmer 2. Merchant/tradesperson 3. Public employee 4. Daily labourer 5. Unemployed 6. Others (e.g. housewife) _____
12	Occupation of the husband	1. Farmer 2. Merchant/tradesperson 3. Public employee 4. Daily labourer 5. Unemployed 6. Others (specify) _____
13	Monthly income if possible	____birr

VI. Obstetric characteristics

No	Question	Response
1	Gravidity	
2	Parity	
3	Number of living children	
4	Attended ANC?	1. Yes 2. No 3. Not known
5	If yes, where is the ANC?	1. Health post 2. Health center 3. Hospital
		4. Other (specify)
6	If yes, number of visits	
7	Basic package of services provided (Tick ALL that apply) RPR Hgb, Blood group, HIV status, U/A BP measurement during the follow up Fefol supplementation TT immunization Other (Specify) _____	■ □ □ □ □ □ □ □ □

8	Problems or risk factors in the current pregnancy: (Tick ALL that apply) I. Pre existing problems Hypertension Anaemia Diabetes HIV positive Cardiac problem Malaria Tuberculosis Hepatitis Other (Specify) _____ II. Antenatal/ intranatal problems/risks (Tick ALL that apply) Preeclampsia / eclampsia Placenta previa Previous Caesarean Section Multiple gestation Abnormal lie/presentation Anemia Malaria UTI/pyelonephritis Unintended pregnancy Other (specify)	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
9	State of pregnancy at the time of death	1. Antepartum 2. Intra partum 3. Postpartum 4. Post abortion 5. Ectopic
10	If delivered, what is the outcome?	1. Live birth 2. Stillbirth
11	Date and place of delivery	Date: _____ Place of delivery: _____
12	Gestational Age at the time of death in antepartum and /or intra partum events (specify time period in months & weeks)	

13	If the death was postpartum or post abortion, after how many days did the death occur?	days

Facility Episode

No	Question		Response
1	Date of admission		
2	Day of admission		1. Working days 2. Weekends 3. Holiday
3	Time of admission		1. Working hours 2. Nonworking hours
4	Main reason/symptom for admission		
5	Is it a referred case?		1. Yes 2. No
If "No" to question number 5 go to number 9			
6	Referred from (Name of health facility)		
7	Reason for referral		
8	Comment on referral • Accompanied by HCWs • Appropriate management		
9	Summary of management at hospital		
10	Qualification of the most senior attending health professional(s)		
11	Primary cause of death		
12	Is this preventable death?		
13	If preventable maternal death, specify factors according to the three delay model	Delay in seeking care	
		Delay in reaching at right facility	
		Delay within the facility (diagnostic and therapeutic)	

INSTRUCTIONS: This form should be stored with a copy of the relevant Verbal Autopsy Summary form (Annex 3) and Annex 4 in a secured location (e.g. locked cupboard in HC manager's office)

Summary Form for Verbal Autopsy

1. . Number _____ (This should be the number from the verbal autopsy)
2. Age_____
3. Address: Region:_____ Zone:_____ Woreda:_____Kebele:____ HouseNo:_____
4. Marital status: single:___ Married:____ widowed:_____ other(specify):_____
5. Religion:_____
6. Ethnicity:_____
7. Occupation:_____
8. Level of education:_____
9. Income:_____
10. Gravidity:_____
11. Parity:_____
12. Abortions:_____
13. Place of death:_____
14. Date of death _____
15. Death occurrence in relation to pregnancy/labour/ postpartum:_____
16. Likely cause of death: _____
17. Contributory causes:

Delays	Contributory factors	Tick if Relevant
Delay 1	Harmful traditional practices	
	Family poverty	
	Failure of recognition of the problem	
	Lack of decision to go to health facility	
	Delayed referral from home	
Delay 2	Delayed arrival to referred facility	
	Lack of roads	
	Lack of transportation	
	No facility within reasonable distance	
Delay 3	Delayed arrival to next facility from referral from another facility	
	Delayed management after admission	
	Delayed or lacking supplies and equipment(specify)	
	Human error or mismanagement	

Action Plan Template

(To be completed by Review Committees at Facility and Health Centre Levels)

Case ID (Medical Record Number):

Date of meeting:

Date of Death:

Death preventable yes no

What actions will you take as a result of this case?

Avoidable Factor	Action to be taken as a result of the case	Person responsible for the action to be taken	Timescale	Comment and challenges to completeness of action	Action completed-date	Remark

Three copies of this form should be made, one is kept at the facility, one at the woreda and one at the zone. Name of the reviewer: _____ sign: _____ date: _____

Reporting template from Health facility to next level (fill it in duplicates)

1. Date of reporting:_____
2. 2. Name of the facility:_____
3. Next level:_____
4. ID No of deceased: _____
5. Place of death _____
6. Date of death _____
7. Age:_____
8. Marital status:_____
9. Religion:_____
10. Ethnicity:_____
11. Address: Urban___ Rural ____
12. Level of education _____
13. Gravidity _____
14. Parity _____
15. Cause of death _____
16. Death in relation to pregnancy/ L& D/puerperium:

Contributory factors/non-medical- tick all that apply

Delays	Contributory factors	Tick ALL that apply
Delay 1	Harmful traditional practices	
	Family poverty	
	Failure of recognition of the problem	
	Lack of decision to go to health facility	
	Delayed referral from home	
Delay 2	Delayed arrival to referred facility	
	Lack of roads	
	Lack of transportation	
	No facility within reasonable distance	
Delay 3	Delayed arrival to next facility from referral from another facility	
	Delayed management after admission	
	Delayed or lacking supplies and equipments (specify)	
	Human error or mismanagement	

17. Preventable death (yes or no):

INSTRUCTION: Copy kept at facility with Annex 2 and Annex 4; Copy sent to next level

Reporting format from Woreda/Zone to region

THIS FORM SHOULD BE SUBMITTED BY THE END OF THE FIRST WEEK OF EACH MONTH (USING DATA FROM PREVIOUS MONTH)

Date of reporting:_____ Reporting woreda:_____

Parameter		Death1	Death 2	Death 3	Death 4	Death5
ID Number (from verbal autopsy and summary forms)						
Date of Death						
Place of Death (Home, Health Post, Health Centre, Hospital, In Transit)						
Age						
Marital status						
Parity						
Educational status						
Timing in relation to pregnancy (antepartum, intrapartum, postpartum)						
Likely cause of death						
Contributory factors to death Delay 1	Harmful traditional practices					
	Family poverty					
	Failure of recognition of the problem					
	Lack of decision to go to health facility					
	Delayed referral from home					
Delay 2	Delayed arrival to referred facility					
	Lack of roads					
	Lack of transportation					
	No facility within reasonable distance					
Delay 3	Delayed arrival to next facility from referral from another facility					
	Delayed management after admission					

	Delayed or lacking supplies and equipment(specify)					
	Human error or mismanagement					

Reported by: signature:

Reporting format from Region to National Levels Date of reporting:_____ Reporting Region:_____

Parameter	Quantity/Number	Remark
Age (number)		
≤19 years	_____	
20-29 years	_____	
30-39 ears	_____	
≥40 years	_____	
Marital status		
Single	_____	
Married	_____	
Others	_____	
Address		
Rural urban	_____	
Educational status		
None	_____	
Primary school	_____	
Secondary school	_____	
University/college	_____	
Don't Know	_____	
Parity		
I	_____	

II-IV ≥V	_____ _____	
Location of Death (tick ONE) Home – Health post Health center Hospital In transit		
Timing of death in relation to pregnancy, delivery or puerperium Antepartum, Intrapartum, Postpartum		
Cause of maternal death Direct obstetric causes PPH Uterine Rupture Obstructed labour Eclampsia Sepsis Abortion Others Indirect obstetric causes Others	 _____ _____ _____ _____ _____ _____ _____ _____	Specify Indirect or Other causes:
Contributory factors Delay I Delay II Delay III	 _____ _____ _____	
Preventable death: Yes No	 _____ _____	
Number deaths reviewed by regional SMTWG/RH task force in last one month	_____	

Reported by: _____ signature: _____

DECLARATION

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

Signature:.....

This research project has been submitted for examination with my approval as university advisor

Signature Date

Ato Getachew Jemaneh _____

Ato Wendmu Ayele _____

June 2017

Addis Ababa Ethiopia