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**ADDIS ABABA UNIVERSITY
SCHOOL OF INFORMATION SCIENCE
AND SCHOOL OF PUBLIC HEALTH
MSC IN HEALTH INFORMATICS PROGRAM**

**Development of a web-based Information Management System for
Communicable Disease Surveillance: for Dire Dawa regional health
bureau.**

By Seble Shiferaw

June, 2015

Addis Ababa, Ethiopia

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System for Communicable Disease Surveillance: for Dire
Dawa regional health bureau.**

**A project Submitted to the School of Information Science
and School of Public Health of Addis Ababa University in
partial Fulfillment of the Requirement for Degree of Master
of Science in Health Informatics**

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List of Acronyms

BPR	Business Process Reengineering
DHIMS	District Health Information Management System
DSS	Decision Support Systems
EIS	Executive Information Systems
ES	Expert System
ERD	Entity Relationship Diagrams
EHNRI	Ethiopian Health and Nutrition Research Institute
ESSENCE	Electronic Surveillance System for the Early Notification of Community-Based Epidemics
FSN	French Sentinel Network
GHS	Ghana Health Service
GIS	Geographic Information System
GPs	General Practitioners
HIS	Health Information System
IDSR	Integrated Disease Surveillance and Response
IHR	International Health Regulation
ISS	Integrated surveillance system
MDGs	Millennium Development Goals
MIS	Management Information System
MoH	Ministry of Health
OOA/D	Object-Oriented Analysis and Design
PHEM	Public Health Emergency Management
RODS	Real-time Outbreak and Disease Surveillance
RAD	Rapid Application Development

SARS	severe acute respiratory syndrome
UML	Unified Modeling Language
WHO	World Health Organization
WHO-AFRO	WHO Regional Office for Africa
WSIMS	Web-based Surveillance Information Management System

Abstract

Background: Surveillance with the context of health is the ongoing systematic collection, analysis, and interpretation of outcome specific data for use in planning, implementing and evaluating public health policies and practices. Disease surveillance is considered as a corner stone of any disease prevention, eradication, elimination and control program. Surveillance data are crucial for monitoring the health status of the population, detecting diseases and triggering action to prevent further illness, and to contain public health problems. Currently, all health care organizations in Dire Dawa that collect surveillance data use manual system for reporting to regional health bureau. The regional health bureau uses excel spreadsheet to store and analyze the data. However, there is lack of organized, efficient surveillance system to detect and predict disease outbreaks.

Objective: The general objective of this project was to develop a web-based information management system for communicable disease surveillance for Dire Dawa Regional Health Bureau

Methodology: This study used qualitative study design for assessing the existing surveillance system. Interview and document analysis were used as a main tool to capture the business system requirement along with observation. A phased based development, Rapid Application Development (RAD) methodology of object oriented approach was applied to design the system. Unified modeling language (UML) development technique was applied in the process of requirements capture, model organization business system and design.

Result: By using RAD approach of object oriented methodology different system requirements were identified. Based on that requirement, the designed information system incorporated: weekly case registration, outbreak notification and report generation.

Conclusion and Recommendation: Different problems were found in the existing system. There was lack of organized outbreak information and early detection for decision making. Appropriate and on time information was a critical component in all health organization. As a result of this proper and standardized way of information flow can improve communications among the business organizations and different stakeholders.

CHAPTER ONE

1. Introduction

Sound and reliable health information is the base for all health related decision making. [1]. A health information system collects data from the health sector and other relevant sectors, analyses and ensures their overall quality, relevance and timeliness, and converts data into information for health-related decision-making [2].

Public health information is required by all levels of the community for effective clinical management and for assessing the extent to which services are meeting the needs and demands of communities [3]. Health information is essential at all level to enable health planners and managers to make decisions regarding effective functioning of health facilities, strategic policy-making and resource allocation of the health system as a whole [3].

Universal access to information for health professionals is a prerequisite for meeting the Millennium Development Goals and achieving “Health for All” [4].

1.1 Background

Surveillance is an ongoing systematic collection, analysis, interpretation and dissemination of data regarding health-related event for public health action to reduce morbidity, mortality and to improve health [5]. 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, as in the case of epidemic diseases [2].

The term ‘outbreak’ has been defined as “an epidemic limited to a localized increase in the incidence of a disease, e.g. in a village, town, or closed institution” and an epidemic is defined as “the occurrence in a community or region of cases of an illness, specific health-related behavior, or other health-related events clearly in excess of normal expectancy”[6].

A communicable disease surveillance system serves two core functions which are early warning of potential threats to public health and programs monitoring which may be disease specific or multi-disease in nature [7].

“Disease surveillance is considered as a corner stone of any disease prevention, eradication, elimination and control program. Surveillance data are crucial for monitoring the health status of the population, detecting diseases and triggering action to prevent further illness, and to contain public health problems” [8]. When an outbreak occurs, it is vital to have a data management system that supports efficient data capture and information flow, and that can provide a master list of up-to-date case-based information in real time [9].

WHO Regional Office for Africa (WHO-AFRO) has adopted the integrated disease surveillance strategy since 1998. As of 2010, 86% of the 4386 districts in 45 countries in the region have implemented Integrated Disease Surveillance and Response (IDSR) in one form or the other. The government of Ethiopia adopted IDSR strategy in 1999, which aims at controlling infectious diseases through strengthening the disease surveillance system and analyzing the data to identify the causes [10]. Ethiopia has developed a five-year strategic plan and started implementing the IDSR consisting of 23 priority diseases that are epidemic-prone, have public health importance and are targeted for eradication and elimination [11].

According to the plan, three diseases were later reduced and only 20 of them were followed up in the sector. The systematic evaluation of the first five years of implementation indicated that the country has successfully expanded its surveillance system up to the health center and hospital level, improving the early detection, reporting, epidemic preparedness and response activities.

Sub-Saharan Africa will not reach the malnutrition and child mortality targets, as well as some areas in communicable diseases at current pace of implementation. It was also pointed out; there was a need to accelerate improvements in the country’s healthcare system if Ethiopia expects to reach its health targets and the MDGs for health. The Federal Ministry of Health (FMoH) introduced the Public Health Emergency Management (PHEM) core process giving the responsibilities of emergencies and disease outbreak condition with the implementation of BPR. Its aim was to improve performance through the introduction of business-process measures and indicators in the government system for communicable disease control and prevention. This might help improve technical and allocative efficiency and thereby increase standards and quality [12].

The use of the Web-based reporting and communication system has been the main impetus in the improvement of reporting, timeliness and completeness. Successful implementation of the Web-based reporting and communication system required an effective implementation plan (including adequate training) and active interaction [13].

The core functions in surveillance of any health event are:

- 📊 Case detection: ratio of cases detected by the National control program to the number of cases estimated to have occurred in the country
- 📊 Investigation and confirmation: investigation of suspected outbreaks and epidemiological and laboratory capacity for confirmation of cases.
- 📊 Reporting: reporting of data and suspected/confirmed outbreaks to central level [14].

Infectious diseases have for centuries ranked with wars and famine as major challenges to human progress and survival [15]. The emergences of ‘new’ infectious diseases, and the reemergence of ‘old’ infectious diseases, now present global problems. Preparedness for known and unknown infectious diseases is a top priority for public health systems [16].

In the first decade of the 21st century, several events further highlighted global shared interests in and vulnerability to infectious diseases. Like, Bioterrorist use of anthrax spores in 2001G.C, The epidemic of severe acute respiratory syndrome (SARS) in 2003G.C, re-emergence of a panzootic of avian influenza A H5N1 in 2005 G.C, and the sudden emergence of pandemic H1N1 in North America in 2009G.C all highlighted the importance of shared global responsibility for surveillance and disease control [17].

The sooner we can detect emergent public health events, the sooner we can take prompt actions against them [18]. Therefore, in order to mitigate potential damages, early warning of infectious disease epidemics has long been one of the fundamental tasks for infectious diseases surveillance and a primary concern for public health institutions [17]. As Ethiopian fact sheet of health statistics report, the burden of communicable disease in African region was 71%, in 2004G.C [19].

According to World Health Organization (WHO) annual report on the proportion of the burden of communicable disease in Ethiopia among all the diseases was high at 73.6% in 2004G.C. Moreover, the proportion of causes of death attributable to communicable

diseases among children under five years of age is estimated to be about half (48%) in 2008G.C. It is considered that most of the infectious diseases, which lead to death, can be cured by early diagnosis and appropriate treatment [20].

The surveillance system in Dire Dawa Regional Health Bureau was established in 1996 EC. Ministry of Health (MOH) assigned one IDSR focal person in the region to coordinate surveillance activities and to compile surveillance reports monthly. Currently, the regional case team (PHEM case team) works to promote the linkage between facility – based and community based surveillance system.

1.2 Statement of the problem

Most disease outbreaks are infectious in nature. If they are not detected early and responded with appropriate technology they can cause death to many people within a short period of time. Thus communicable disease prevention and control is the cornerstone of public health.

In order to obtain appropriate public health intervention, surveillance data are critical for detecting and managing outbreaks, monitoring the impact of interventions and reducing disease [17]. The collection and interpretation of infectious disease data supports the identification of individual and population risk factors, the prioritization of disease burdens, and the monitoring and evaluation of prevention and control activities [21]. Surveillance systems should be routinely evaluated and subjected to continuous improvement. Surveillance systems should be able to promptly and accurately answer and respond to urgent questions such as whether the situation is outbreak or not (Is this an outbreak?), the magnitude of the outbreak (How big is the outbreak? What is the level of incidence?) [22].

Better surveillance and response system for communicable disease occurrences will help Ethiopia for better implementation and improvements of the country's healthcare system and reach to its health targets and the MDGs. Therefore the country has implemented Business Process Reengineering (BPR) for health and analyzed the critical area of health in the country to improve health care system with skilled human resource. The PHEM sector data collection activities were performed in daily and weekly bases for planning and implementation [22].

Appropriate data collection process facilitates systematic recording of all the required details of the disease outbreak, thereby providing information for decision making activities on whether and how to proceed further. The information contributes for the recognition of linked multi-district outbreaks and early control measures [23]

Currently, all health care organizations in Dire Dawa that collect surveillance data use manual system for reporting to regional health bureau. The regional health bureau uses excel spreadsheet to store and analyze the data. However, there is no mechanism to detect an outbreak early and predict for the future. As a result of this there are different problems regarding in relation to information gathering, analysis, process, dissemination and use of surveillance information.

Some of the problems encountered in the existing system were revealed through the discussion with the domain experts in the region, are the following:

Dengue fever outbreak occurred in Dec, 2013.

- PHEM case team had a problem to get information on time about the situation;
- unable to take preventive measure and control action as soon as possible.
- As a result of this 9,258 suspected case of dengue fever and 40 confirmed cases were reported.

Generally, there is lack of standardized way of information flow and access. Therefore the development of Surveillance information management system is hoped to facilitate and ease the forecast of outbreaks and take preventive measure at the earliest time possible.

1.3 Objectives

1.3.1 General objectives

The general objective of the study was

- ❖ To develop a web-based information management system for communicable disease surveillance for Dire Dawa Regional Health bureau.

1.3.2 Specific objectives

The specific objectives of the project were:

- ❖ To assess the problems in the existing paper based surveillance information management system;
- ❖ To understand the flow of surveillance model information among health facilities;
- ❖ To analyze system requirements;
- ❖ To design system structure for the Regional Surveillance Department;
- ❖ To develop a prototype system; and
- ❖ To evaluate the performance of the system prototype with the user.

1.4 Scope and Limitation of the study

This project covered the development of Web-based information management system for Communicable Disease surveillance for Dire Dawa Regional Health Bureau. The main focus of the study was to analyze the requirements of users and design a web based information system.

The project was conducted from January to June 2015 in Dire Dawa Regional Health Bureau. In project implementation, the existing information management system was assessed to identify any problem on the system. Rapid Application Development methodology and object oriented approach for system development was used in the project. The major limitation of this project was time. Because of this it was difficult to develop a complete full-fledged Surveillance information management system.

1.5 Significance of the Project

For countries like Ethiopia, strengthening surveillance systems is absolutely essential to reduce morbidity and mortality. The consequence of not getting timely treatment results in loss of life which can be avoided through an effective, efficient and integrated Web-based surveillance information management system.

The new system will have a significant impact as it systematically lays a foundation for the implementation that enables easy and much flexible data analysis and report aggregation promptly. It enables the early detection of an outbreak with less cost as compared to the paper based manual information process.

Developing surveillance information management system will

- Support decision making functions of the organization by using the available information;
- Improve patient care and quality by providing available, accessible, and consistent and on time outbreak information;
- Allow access to, and better use of, improved surveillance information system for health professionals and decision makers;
- Provide an opportunity to share/ exchange surveillance information between different facilities;
- Improve data collection;
- Help to provide a structured way of data collection;
- Improve on time reporting to FMOH and different funders; and
- Improves data quality and reliability;

CHAPTER TWO

2. Literature review

2.1 General literature review

2.1.1 Web-based System

The World Wide Web (known as “WWW” or “Web”) is a source of information over the internet. It is growing at a phenomenal rate. Delivering data over the web is cost effective and fast, and gives Internet users easy access to databases from any locations. For this reason, databases are now largely Web-based. It is believed that the integration of the web and database technology will bring many opportunities for creating advanced information management applications.

Web-based technology platforms allow for seamless, integrated delivery of desired services to users with requisite access rights and privileges. Web-based and Web-enabled tools provide greater capacity to achieve efficiency in collecting and analyzing data and disseminating results [24].

2.1.2 Information system

Information systems are combinations of hardware, software and telecommunications networks that people build and use to collect, create, and distribute useful data typically in the organizational settings [25]. Information systems are interrelated components working together to collect, process, store, and disseminate information to support decision, making coordination, control, analysis, and visualization in an organization[26].

2.1.3 Health Information System

Health information systems serve multiple users and a wide array of purposes that can be summarized as the generation of information to enable decision-makers at all levels of the health system to identify problems and needs, make evidence-based decisions on health policy and allocate scarce resources optimally [2]. Health Information System is a system that integrates data collection, processing, reporting, and use of the information necessary for improving health service effectiveness and efficiency through better management at all levels of health services [27].

2.1.4 Health Management Information System (HMIS)

HMIS is an information system specially designed to assist in the management and planning of health programs, as opposed to delivery of care.

- **Management Information System (MIS):** A system or group of systems which collects and presents management information relating to a business in order to facilitate its control. Management Information Systems are those that support all management levels in the conduct of their functions, such as operations, administration, or planning and programming.
- **Decision Support Systems (DSS):** A system that provides interactive ad-hoc support for the decision making process of managers.
- **Expert System (ES):** A knowledge-based system that provides expert advice and acts as expert consultants to users.
- **Executive Information Systems (EIS):** A system that provides critical information tailored to the information needs of top management. This research project falls into transactional process systems mostly and management information system to certain extent [28].

2.1.5 Electronic Health Management Information System

The importance of electronic health information system management is well known by countries to improve service quality and solve the complexity within health sector. “ An analysis of health information landscape suggests that countries are moving from the established paper based implementation of district health information to the ‘second generation’’ Health Information System (HIS), where health encounter data are used to not only inform policy, but also to improve care at point of service[29].

2.1.6 Benefits of Electronic Health Record for Surveillance information

The benefits of using EHRs for surveillance include timely availability of data, cost-efficiency of data collection, access to detail clinical and laboratory information, large sample sizes that permit reliable studies of rare conditions of small subpopulations, and the ability to evaluate changes in health over time [30].

2.1.7 The role of Surveillance Information System for Surveillance Decision

According to Public Health Surveillance Toolkit, the goals of surveillance often differ at the various administrative levels of the public health system. Surveillance data are used to allocate resources and evaluate the impact of control and prevention strategies and programs at all levels. However, at the local level the use of surveillance to trigger basic public health investigations and implement specific control activities predominates for infectious diseases and environmental hazards [31].

Health surveillance can be described as “the tracking and forecasting of any health event or health determinant through the continuous collection of high quality data, the integration, analysis and interpretation of data results into surveillance products and the dissemination of surveillance products to those who need to know [to address] a specific public health purpose or policy objective [32]

In general, Health surveillance is an essential component of evidence-based decision making practices in public health system. Effective communicable disease control needs an effective disease surveillance system, which provides information for action on priority communicable diseases. It is the basis for public health decision-making worldwide [33]

2.1.8 Public Health Emergency Management in Ethiopia

According to Ethiopian Public Health Institute, Addis Ababa; (2008), the general definition of Public health emergency management is the process of anticipating, preventing, preparing for, detecting, responding to, controlling and recovering from consequences of public health threats in order that health and economic impacts are minimized (34).

The International Health Regulations (2005), (also referred to as the IHR) entered into force on 15 June 2007 for public health emergence management activities in Ethiopia. The Regulations are binding on all 46 WHO Member States in the African Region as all have agreed in 2005 to be bound by these Regulations.

The importance of disease surveillance in guiding health planning and interventions was recognized for a long time. In Ethiopia, “Quarantine ”rules were proclaimed in 1947 with emphasis on surveillance. Another legal notice was issued in 1951, binding all public health practitioners in the country to report communicable diseases. The Public Health

Emergency Management (PHEM) under the sponsorship of Ethiopian Health and Nutrition Research Institute (EHNRI) has submitted legislation to Council of Ministers for approval. The "Public Health Proclamation No.200/2000" orders that any individual who knows the existence of communicable diseases in his/her vicinity to report immediately to the nearest health institution and the institution receiving the report to take the necessary measures and report to the appropriate health authority. In 1948 an anti-epidemic service was established to deal with prevention and control of communicable diseases. In 1951, 35 priority diseases were selected and classified into first and second class to be notified to MoH, immediately or weekly as necessary. In the mid 1970`s the anti-epidemic unit was converted to epidemic control and surveillance unit under communicable diseases control division and vertical programs were conducting their own disease specific surveillance.

After the health system reform in 1994 nineteen diseases were selected for surveillance. Though, Ethiopia has started implementing public health surveillance strategy since 2000, there were impediments in the implementation of the public health surveillance strategy.

These include non-recording, failure to report diseases of epidemic potential in time, incomplete and late reporting of notifiable diseases, inadequate data analysis especially at peripheral level, failure to use available information to follow disease trends, inadequate laboratory involvement in case detection, poor feedback to health workers and communities, duplication of resources meant for surveillance and response, underutilization of surveillance information in decision-making, shortage of technical personnel, high turn-over of technical staff, lack of motivation, and under developed communication systems(35).

2.1.9 Web based System development methodology

System analysis and design is an approach to the development of information system which encompasses the first four phases of the systems development life cycle (SDLC)- Planning, Analysis, Design and Implementation. The SA&D process can encompass many tools and techniques. Broadly speaking; there are two main modeling approaches to SA&D:

- The tradition or “structured” approach, which uses Data Flow Diagrams (DFDs) and Entity Relationship Diagrams (ERDs) as its modeling tools;
- The object-oriented (OO) approach, for which the Unified Modeling Language (UML) has become the de facto standard.

The traditional approach to SA&D is generally considered process-centric and top-down, in so far as the problem under consideration is decomposed into a hierarchical set of processes.

In the traditional approach, the systems analysis phase consists of all activities needed to understand the system and specify in detail what the system is to do. The system design phase consists of all activities needed to specify the solution and how it will be physically implemented. The object oriented approach is generally considered data centric. It uses a set of entities (or more correctly, “classes”) that encapsulate both the data (attributes) and processes (“methods”) associated with each entity type (35).

2.1.9.1 Rapid Application Development (RAD)

Rapid Application Development (RAD)–based methodologies are a newer class of systems development methodologies that emerged in the 1990s. RAD-based methodologies attempt to address both weaknesses of structured design methodologies by adjusting the SDLC phases to get some part of the system developed quickly and into the hands of the users.

Object-oriented approaches to developing information systems, technically speaking, can use any of the traditional methodologies (waterfall development, parallel development, phased development, prototyping, and throwaway prototyping). However, Object-oriented systems analysis and design (OOSAD) is most associated with a phased development RAD-based methodology, where the time spent in each phase is very short. OOSAD uses a use-case driven, architecture-centric, iterative, and incremental information systems development approach. It supports three different views of the evolving system: functional, static, and dynamic. OOSAD allows the analyst to decompose complex problems into smaller, more manageable components using a commonly accepted set of notations. Also, many people believe that users do not think in terms of data or processes but instead think in terms of a collection of collaborating

objects. As such, object-oriented systems analysis and design allows the analyst to interact with the user with objects from the user's environment instead of a set of separate processes and data (36).

RAD refers to a development life cycle designed to give much faster development and higher quality systems than the traditional life cycle. It is designed to take advantage of powerful development software like CASE tools, prototyping tools and code generators. The key objectives of RAD are: High Speed, High Quality and Low Cost. RAD is a people-centered and incremental development approach. Active user involvement, as well as collaboration and co-operation between all stakeholders are imperative. Testing is integrated throughout the development life cycle so that the system is tested and reviewed by both developers and users incrementally (37).

2.1.9.2 Three Layer Architecture

The logical architecture is designed in terms of the logical grouping of components into separate layers that communicate with each other and with other clients and applications. Layers are directly related with the logical division of components and their functionality, and take no account of the physical location of components on different servers or in different locations [38].

Therefore, layers are the logical groupings of the software components that make up the application or service. They help to differentiate between the different kinds of tasks performed by the components, making easier to create a design that supports reusability of components. Splitting an application into separate layers that have distinct roles and functionalities helps maximize the maintainability of the code, optimize the way that the application works when deployed in different ways, and provide a clear delineation between locations where certain technology or design decisions must be made.

Presentation Layer

Presentation Layer is responsible for managing user interaction with the system, and generally consists of components located within the presentation layer. It provides a common bridge between the core business logic encapsulated in the business layer and the user interaction.

Business Layer

Business Layer implements the core functionality of the system, and encapsulates the relevant business logic. It generally consists of components located within the business layer, which may expose service interfaces that other callers can use. Therefore, there are software objects representing the domain concepts that fulfill application requirements, such as managing an individual diagnosis register.

Data Layer

Data Layer contains services that provide access to data that is hosted within the boundaries of the system, and data exposed by other back-end systems. The data layer exposes data to the business layer through generic interfaces designed to be convenient for use by business services (38).

2.2 Related work

In 1998, the Maryland Electronic Reporting – Surveillance System (MERSS) was the primary computer-based surveillance information system utilized by the city health department's program to gather information and investigate outbreaks of diseases Maryland State Health Department Division of Communicable Disease Surveillance. The database for the city exists physically at the state health department, and information was remotely entered at the city health department via dial-in access. Because of confidentiality and data security concerns, access to the system for data entry, management, or analysis was restricted to one computer at the city health department. The system was capable of generating reports including line listings and frequencies by event date, and reports were provided regularly to the city and state health departments as well as CDC (39).

In china there were numerous problems in surveillance data collection and early detection of epidemics with China's economic development, the government is increasingly attaching great importance on the establishment of early warning system of disease outbreak. According to Chinese Center for Disease Control and Prevention, in 2005, China CDC instituted a web-based case-reporting system across a number of different disease areas, including HIV/AIDS. This system allows end users to enter case report

data directly into an online system using automated forms, and it allows authorities to examine case report data in real time. In addition, the system allows users to generate automated reports that make it easier for public health staff and officials at every level to make use of data within their area of jurisdiction (39).

In 2010, European Commission started to fund a project on developing a syndromic surveillance system in rural China to complement the existing case reporting system. Then a new web-based syndromic surveillance system was developed, combining with modern communication and GIS technology. Outbreak detection and alerting, The Alarm Trigger module includes models to detect abnormalities of syndromic observations from daily surveillance data. When an alert is triggered, the system will automatically send e-mail notifications to subscribed communication groups. This system has greatly improved the timeliness and completeness of infectious disease notification.

In general, web-based surveillance management systems improve the collection and interpretation of infectious disease, the identification of individual and population risk factors, the prioritization of disease burdens, and the monitoring and evaluation of prevention and control activities [40].

In 1984 France developed an electronic epidemiologic surveillance system which is French Sentinel Network (FSN). The FSN is based on a nationwide network of voluntary GPs who report cases of several conditions, mostly childhood and acute infectious diseases. Estimates of disease incidence are computed from GPs reports and used for public health decision making. Our users' survey confirmed that better integration of surveillance within the GP clinical process was a key element for participation. Indeed, desktop availability made it possible to describe cases quickly, allowing the additional work required for surveillance to fit in the consultation time. Another positive effect of the better integration of surveillance in the clinical process was the reduction in reporting delays [40].

A study conducted in Mexico showed that Dengue fever incidence and its geographical distribution are increasing throughout the world [41]. Quality and timely information is essential for its prevention and control. A web based, geographically enabled, dengue

integral surveillance system (Dengue-GIS) was developed for the nation-wide collection, integration, analysis and reporting of geo-referenced epidemiologic, entomologic, and control interventions data. the main features of Dengue-GIS is its seamless capability to integrate, in an interoperable web based platform, the basic information needed for problem appraisal and control planning, which is readily available to users at all levels of the control program scaffold.

Previous to the Dengue-GIS implementation, epidemiological data, produced locally by health providers, travelled each week in paper forms to their respective sanitary jurisdictions and then to the State Epidemiology Department. The data was then entered into a local electronic system, which in term produced files to be sent to GDE either by disk in the early 90's or more recently by e-mails. With Dengue-GIS, It is now possible to identify at nation-wide scale where and when accumulation of probable dengue cases are occurring but with a spatial resolution suitable to direct and evaluate vector control activities. The use of cluster detection analyses and risk assessment on a weekly basis produce timely information for decision making at all levels of the dengue control program. Dengue-GIS implementation also introduced other improvements for epidemiological surveillance as the simultaneous registration and availability of the data from local to federal databases and thus the capability of close monitoring in almost real time at all administrative levels of the health system [41].

The Ghana Health Service implemented an innovative district health information management system (DHIMS) that has led to significant improvements in data collection, reporting, and analysis and has strengthened the country's health systems. The system has enhanced access to timely health information for managers within the GHS, empowering them to assess the performance of the health system and respond to identified challenges in a timely fashion. In September 2013, the African Development Bank recognized Ghana's achievement with an e-health award for improving access to health information. For years, Ghana relied on a paper based vertical system to capture and report data on health service delivery and surveillance. Then, in 2012, PMI provided support to develop a more robust web-based system. The DHIMS 2 system enables health facilities to enter their summary reports directly into an electronic database. It also has the capacity to auto

generate reports, map data through a geographic information systems (GIS) interface, and aid managers and users to process raw facility-level data into graphs that can be easily interpreted. The new system allows rapid access to malaria data at all levels of the health system and has facilitated the use of those data to plan and implement malaria interventions [42].

CHAPTER THREE

3. Methodology

The Methodology used for this project was Design Science.

Methods

Rapid Application Development (RAD) methodology and Object Oriented Approach for analysis and Design (OOAD).

Techniques

Qualitative study design was used for assessing the existing surveillance system. Unified modeling language (UML) use case description, activity diagram, sequence diagram uses in the process of requirements capture, model organization system and design.

Tools

Modeling tools used for this system prototype development were Visio software for user interface design and Argo UML for use case modeling, class diagram. MySQL database, Php and HTML were used to develop the prototype system.

3.1 The study setting

The project was conducted in Dire Dawa administration health bureau. The assessment included key informant interviews in Dire Dawa Regional Health Bureau and 2 public hospitals and 9 health centers.

3.2 Data Source and Study Population

The study population included the Dire Dawa Regional Health Bureau PHEM case team and surveillance focal person who participate in data collection and report generation in the urban health facilities. The study used purposive sampling technique to determine sample population.

3.3 Data Collection

For the purpose of requirement gathering interview and document review were used.

3.3.1 Interview

Interview is the major and popular tool used by requirement engineers to draw system requests and understand objectives of the system through verbal discussion with the stakeholders. Interview is a more flexible form than the questionnaire and if wisely used, can generally collect information of better depth and can be more sensitive to contextual changes in meaning. Interviewing also permits things to be explained more face to face

than questionnaire. The interview process was important as it gives direct references from respondents about their work. Interview was selected in this project because different stakeholders have dissimilarities in something like reporting tools and technique. The study was conducted through interview on regional health bureau and 9 urban public health facilities including 2 hospitals by using CDC Guidelines for Evaluating Surveillance interview.

Finally, the interview responses were summarized and included in the requirements document. Then it was described using essential use case modeling that helps the researcher to understand the existing system very well, identify difficulties for the current system in detail and identify gaps to be filled by the new designed system. More importantly the requirement documents were used as an input for the next stage of system development, Object Oriented Analysis (OOA). The documents, report forms, and analysis help the researcher to design user interface for the system.

3.4 Requirement Specification and Analysis

Requirement specification and analysis are the primary steps of Object Oriented Analysis and Design (OOAD). It deals with the investigation of the problem and the requirements or domain objects of the system. To describe the requirements one of the UML artifacts; use case and activity diagram is used. In any system, it is necessary to mention the systems behavior, functionality and constraints, and all these are referred to as requirements. The term requirement could be described as a user need or a necessary feature, functions, or attribute of a system

Requirements include both the functional and non-functional requirements. Functional requirements (behavioral requirements) define what the system does, namely, the functions (actions) of the system. They describe all inputs and out puts to and from the system as well as information concerning how the inputs and outputs are interrelated Nonfunctional requirements, on the other hand, define the quality of the system. They include the description of system usability, reliability, performance, security, maintainability, and interface

3.5 Data Management Analysis, Design and Implementation

Data depiction is made using activity diagrams, sequence diagrams, use case diagram, use case description and class diagrams. To help users critically examine the current state of systems and processes (the as-is system), identify exactly what needs to change, and develop a concept for a new system (the to-be system) is adopted that creates significant change on the existing system.

As phase based Rapid Application Development (RAD), was adopted by this study, less emphasis was made on the “as-is system” and more emphases was given for the “to-be system” to achieve the desired goal.

3.6 Method of Dissemination of Results

The study aimed to be compiled and disseminated as a project thesis report to the regional health Bureau and made available to the School of Information Science and School of Public Health Library. Attempt will also be made to publish on local as well as international publication outlets.

3.7 Ethical Clearance

This project was reviewed and approved by the University of Addis Ababa, School of Public Health Research Ethics Review Committee and Dire Dawa Regional Health Bureau. Information sheet and consent forms were delivered at each interview sessions and verbal consent were also obtained from all study participants and from every interviewee after the objective of the study was informed.

CHAPTER FOUR

4. Analysis and Design

4.1 Introduction

The findings from the data collected by interview are described in this chapter. Data collected from various health facilities and Regional Health Bureau as well as the experiences of the other researchers taken from the literature were the basic of analysis in this project. This chapter also describes the current system of Dire Dawa Health Bureau and the new surveillance information management system.

4.2 Findings from data collection

Reporting

The interview of the Regional Health Bureau surveillance officers and facility focal persons revealed that Surveillance data were collected weekly every Monday from health posts, health centers and hospital outpatient and inpatient log books. These data is then sent to Regional Health Bureau the next day (every Tuesday) by hard copy. The bureau analyzes and processes the received data up to Thursday and finally sends to the Ministry of Health. Feedback is sent for all facilities by hard copy after analyses to show any change in trends and abnormal increase in cases and deaths.

The reporting formats have the information on the number of cases and deaths for each reportable disease / condition for a week, summary for immediately reportable case-based disease or line lists during the reporting weeks. The outbreak was detected from weekly reports.

Communication

The interviewees disclosed that it has been difficult to get outbreak information on time. Participants in the interviews were the opinion in that developing the technological capacity of communication is important because Surveillance specific information need to be passed as fast as possible for early outbreak management and timely decision making.

Hard ware and Soft ware

There is a single computer which was being used for office purposes. They did have any specialized software except Ms Word and Excel which are used to produce the reports. All urban health facilities use broadband internet connection. It appears that the power and opportunities of IT in managing and delivering health services is well recognized and the head department indicated that the bureau is ready to process the acquisition of facilities, and implementation and networking of the facility.

Procedure

All reporting facilities sent their data to the Regional Health Bureau by hard copy. The bureau enters the collected data to computer. By using excel and epi info the collected data are analyzed and interpreted using graphs and charts weekly. The information is stored in hard copy by file cabinet in physically secured place.

Problems

Manual data collection and feeding these data to computer for analyses purpose is labor intensive and time consuming. Also the report format lacks geographic and demographic information. In addition, it is not amenable for analysis of the data by age, sex and geographical area. These problems were elaborated by the respondents from Regional Health Bureau as well as facility respondents.

4.2.2 Requirement Specification

Requirement constitutes a specification for the new system. It is the starting point for measuring the performance, accuracy, and completeness of the finished system before entering in to system design. Requirements include both functional requirements and non-functional requirements. Functional requirements (behavioral requirement) define what the system does, namely, the functions (actions) of the system. They describe all the inputs and outputs to and from the system as well as the information concerning how the inputs and outputs are interrelated. Non-functional requirements, on the other hand, define the quality of the system.

4.2.2.1 Functional Requirements

The system should be able to provide the following functionalities

Table 1: Functional requirement

ReqID	Requirement	Rank	Source
RQ-1	The system shall enable the administrator to record setups (user, facility, disease)	Mandatory	UC-2
RQ-2	The System shall enable the registered users to register weekly and immediately reportable disease conditions.	Mandatory	UC-3
RQ-3	The System shall enable the registered users to register outbreak cases.	Mandatory	UC-4
RQ-4	The System shall enable to generate notification message and display on screen during outbreaks.	Mandatory	UC-5
RQ-5	The system shall enable system users to generate immediately, weekly, outbreak report based on the collected data and information	Mandatory	UC-6
RQ-6	The system shall enable system users to send feedback for facilities.	Optional	UC-7
RQ-7	Data requirements of the system The system shall comprise of a database with search capabilities. The data shall be patient demography, disease condition, and inpatient and outpatient case.	Optional Mandatory	
RQ-8	Business rules and logic Only Users allowed to use the system, username and password required		

4.2.2.2 Non-functional requirements

Requirements like usability, reliability, performance, supportability, recovery, interface, implementation, operation, and language are considered as nonfunctional requirements.

- **User interface**

Users communicate with the system through the application interface which has to be user friendly. To ensure user satisfaction and usability of the system, attractive user interface with data input, fixed drop down option were used. This will minimize the time needed for data entry and make it easy to adopt the system.

- **Security issues**

To protect data from unauthorized access and use, the system should provide restriction in using the functionality and information right to use by user, i.e. the system use role based authorization technique while user accesses the data.

- **Error Handling**

The system shall generate error message whenever the user attempts to enter invalid data, so as to inform the user about their mistake. Most of data input of the system are selection, this is to minimize committing error during data entry.

- **Scalability**

The surveillance information management system involves activities that interact with different workers in health care so the system should be scalable, to support the integration and deployment in large health care environments.

4.3 System Analysis Models

For better understanding of the requirements of the system, use case modeling is used. This model represents the requirements in user-centric approach in order to describe all the tasks that the user need to perform with in the system. It is a powerful technique that describes the kind of functionality that a user expects from the system. It does this by defining actors, which model the roles that users can play when interacting with the system, and describing the use case that those actors can participate in. The major parts drawn on the use-case diagram are the system boundary, the use-cases themselves, the actors, and the various associations between these components. The major strength of the use-case diagram is that it provides the user with an overview of the detailed use cases.

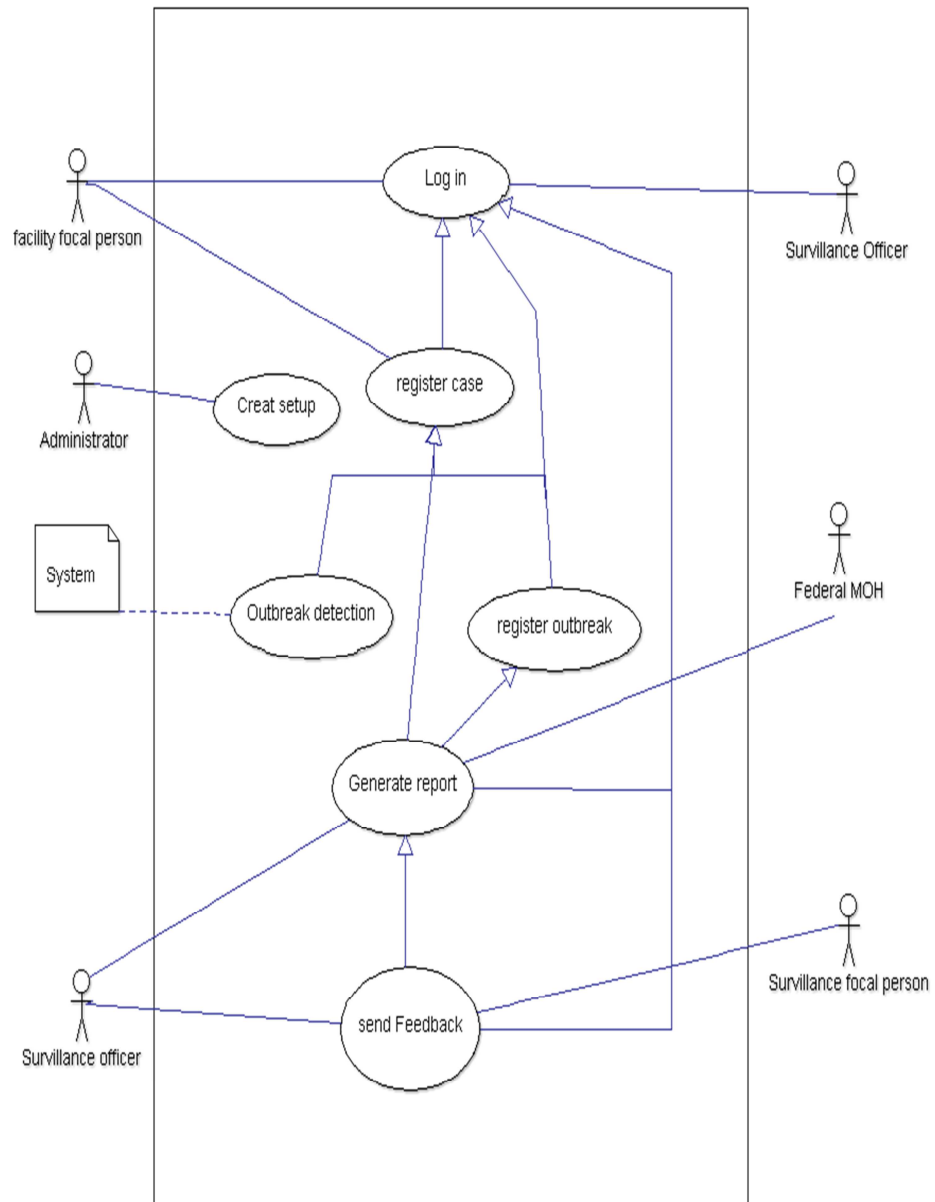


Figure 1. System use case diagram for Surveillance information management system

4.3.1 Use case Description

The description of each use case shown within the use case diagram can be also narrated in detail in the form of a table. The use case description documents the name of the use case, the actor, description of the use case, a step by step list of the tasks and action required for successful completion, a descriptive courses of action, preconditions, post condition, and business rule. It show also classes, attributes and method identified base on use case as well as system boundary clearly.

Outbreak case registration

The following tables describe outbreak case registration use case identified in the new Surveillance information management system. This use case starts when the surveillance officer open the data entry option in the system. When outbreaks occur the officer collects all the necessary information and register on the system. The information includes:

- Patient demographics
- Disease onset
- Date notified for health facility
- Date sample collected and types of specimen.

In this case more than one case at the same time will be reported. The primary actor of this use case is surveillance focal person that has authorized user name and password.

Administration

Based on the activities necessary for managing the setup information the administrator manage different setups

- control user
- creating and updating of setups

Reporting

Based on different option and the type of information needed the surveillance officer request the system to generate report.

- Different stakeholders FMOH, Partners and CDC/ need on time report

Use Case ID	UC-04
Use Case Name	Register an outbreak
Use case Description	This use case describes daily outbreak data entry process.
Primary Actor	Surveillance focal person
Trigger	The surveillance focal person clicks on outbreak data entry button from the main menu.
Pre-Conditions	The focal person is logged in to the system.
Post-Conditions	The outbreak case is registered to the database
Main course	1. The system displays main menu screen; 2. The surveillance focal person clicks on the outbreak data entry button from the main menu screen; 3. The system displays the outbreak data entry form; 4. The focal person fills the form and submits to the system; 5. The system validates and adds outbreak information on the database.
Alternative course	
Frequency of Use	30/month
Business role	

4.3.2 Activity Diagram

A UML activity diagram offers rich notation to show a sequence of activities. An activity diagram models the actions the object will perform and in what order.

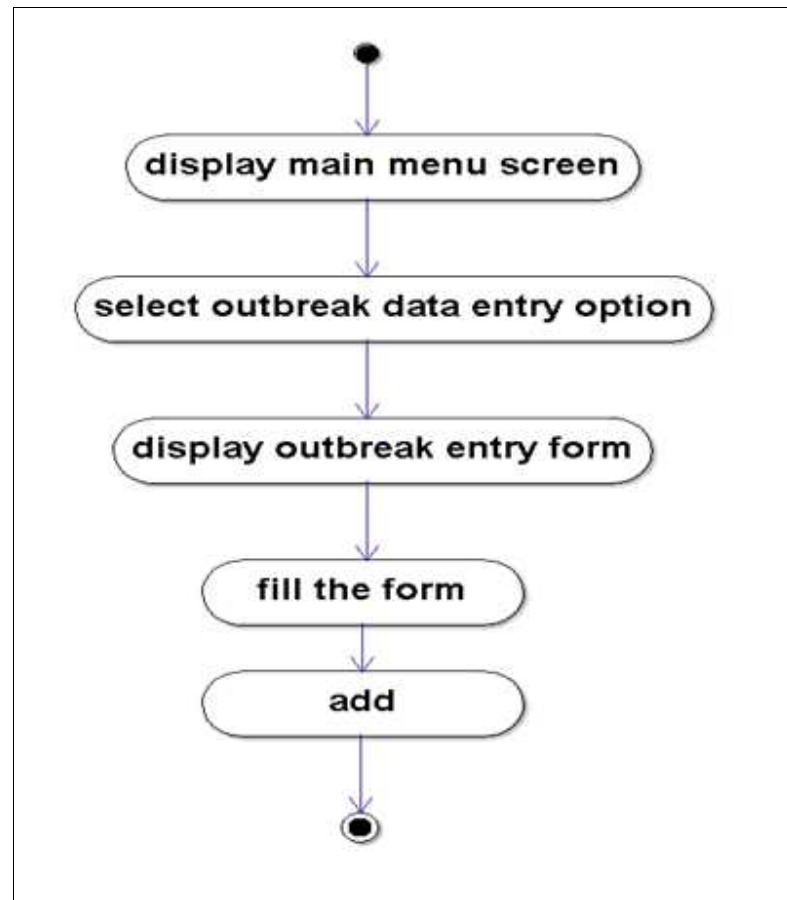


Figure 2. Outbreak data entry activity diagram

4.3.3 User Interface Prototyping

The UI is the portion of software with which a user of surveillance system directly interacts. It models UI requirements; which evolved through analysis and design to result in the final UI for the system. It introduces technology to prototyping efforts that is most likely made a design decision about the implementation technology.

The following part shows UI prototype in developing the web-based Information Management System for Communicable Disease Surveillance in Dire Dawa.

Weekly Disease Data entry Form

Health facility Name:
 Types of Report:

Reporting time: To

1.Total Number of cases and Deaths for each disease/ condition for a week

Indicator	Out patient cases	In patient cases	Deaths
Total malaria (confirmed and clinical):			
Total malaria suspected fever cases examined by RDT or microscopy			
Number of cases positive for malaria parasites			
Meningitis			
Dysentery			
Typhoid fever			
Relapsing fever			
Epidemic Typhus			
Severe acute Malnutrition			

Alerts

Text

Figure 4. Surveillance information management system weekly data entry form

This form allows the surveillance focal person to register weekly reportable cases and also capture summery of immediately reportable cases. The user fill the required information and click submit. The system adds the information on the database.

Weekly Report form

Health facility Time duration

Reporting options Disease type

Reported cases	Total No Cases	Total No of deaths:
Malaria	10	0
Meningitis	0	0
Dysentery	12	0
Typhoid fever	5	0
Relapsing fever	0	0
Cholera	0	0
AFP/Polio:	0	0
Anthrax:	1	0
Sever acute Malnutrition	4	0

9

Figure 5. Surveillance system weekly Report form

After data about surveillance is successfully registered the system generating report when focal person want report on the required time. The form used to generate report by different option, disease type, and demography and by geographic area.

4.4 System Design Model

OOD is a phase which is concerned with defining software objects their responsibilities, and collaborations in surveillance system to full fill the requirements independent of implementation details. There are a set of diagrams that are used to describe the design for software objects of surveillance system in object oriented design phases. This includes software class diagrams, sequence diagram also known as object interaction diagrams.

This study used UML sequence diagram along with class diagrams to design the web-based Information Management System for Communicable Disease Surveillance. Physical data models which is the most important design level models for database application development, is employed for surveillance database management system. Another task performed in this phase is designing UI which is based on surveillance data entry and report forms as described in UI flow diagraming section.

4.4.1 Class Diagram

In addition to a dynamic view of collaborating objects in web-based Information Management System for Communicable Disease Surveillance shown in activity diagrams earlier, a static view of the class definitions is also shown with a class diagram. The class diagram shows attributes and methods of the classes identified from surveillance system. In contrast to the domain model that shows real-world classes, the design class diagram shows software classes. In class diagraming a class with its attributes and methods is clearly represented. We use class diagrams to describe the structure of the system. Classes are abstractions that specify the common structure and behavior of a set of objects. Objects are instances of classes that are created, modified, and destroyed during the execution of the system. Objects have state that includes the values of its attributes and its relationships with other objects. Class diagrams describe the system in terms of objects, classes, attributes, operations, and their associations.

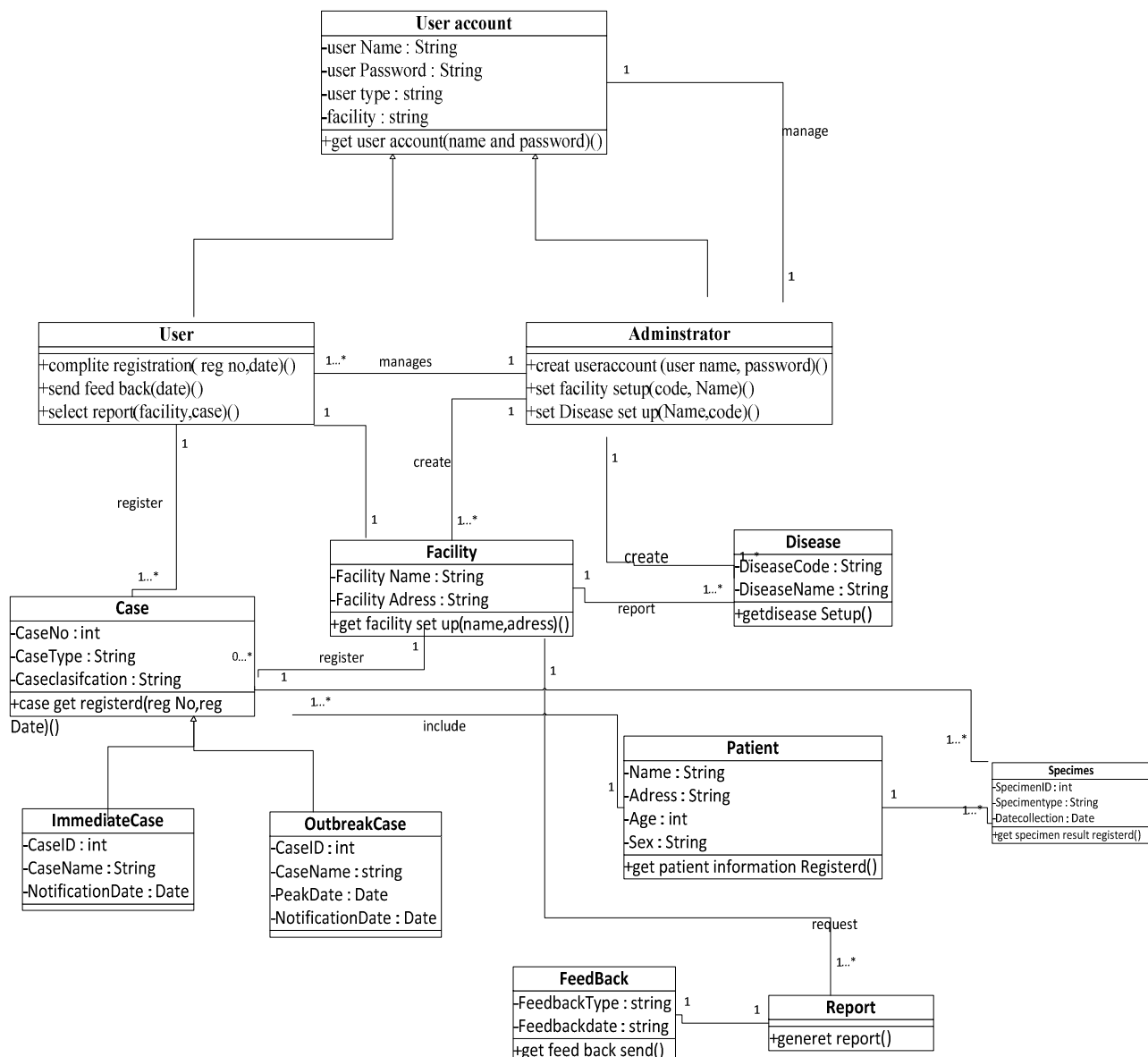


Figure 6. surveillance information system class diagrams

4.4.2 Sequence Diagram

UML Sequence diagrams model the flow of logic within the information system being developed in a visual manner, enabling both to document and validate the system logic. Sequence diagrams are commonly used for both analysis and design purposes. It is a common notation to illustrate collaborations among objects and shows the flow of messages between objects.

The following section depicts system sequence diagram for surveillance information management system.

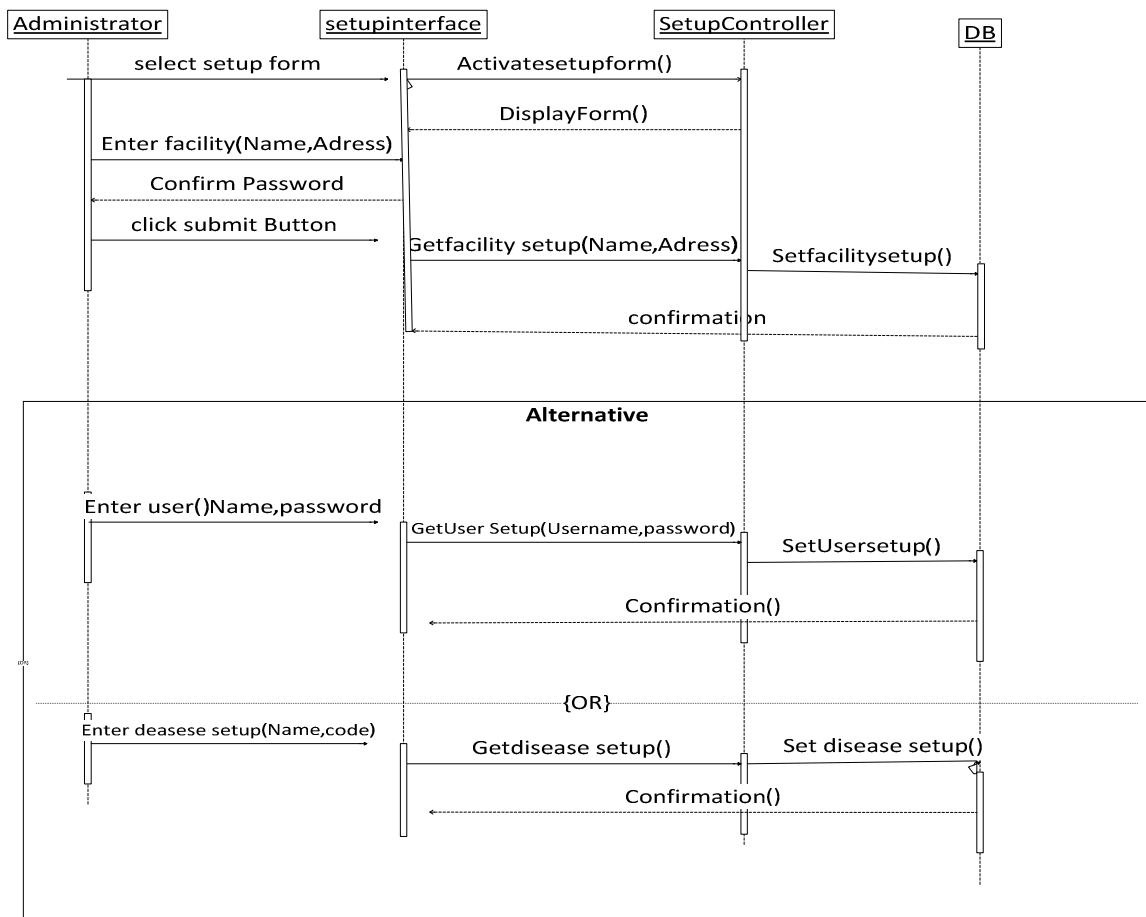


Figure 7. DDRHB Create set up Sequence diagram

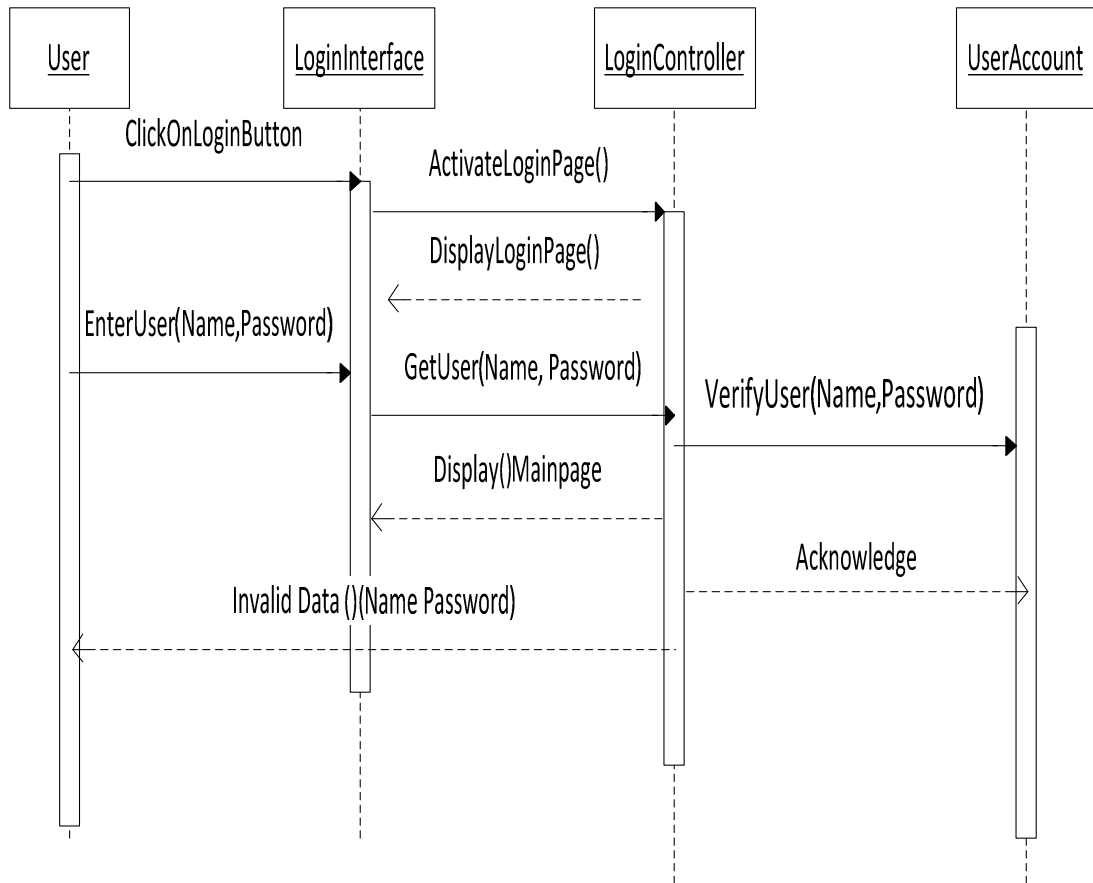


Figure 8. DDRHB login Sequence diagram

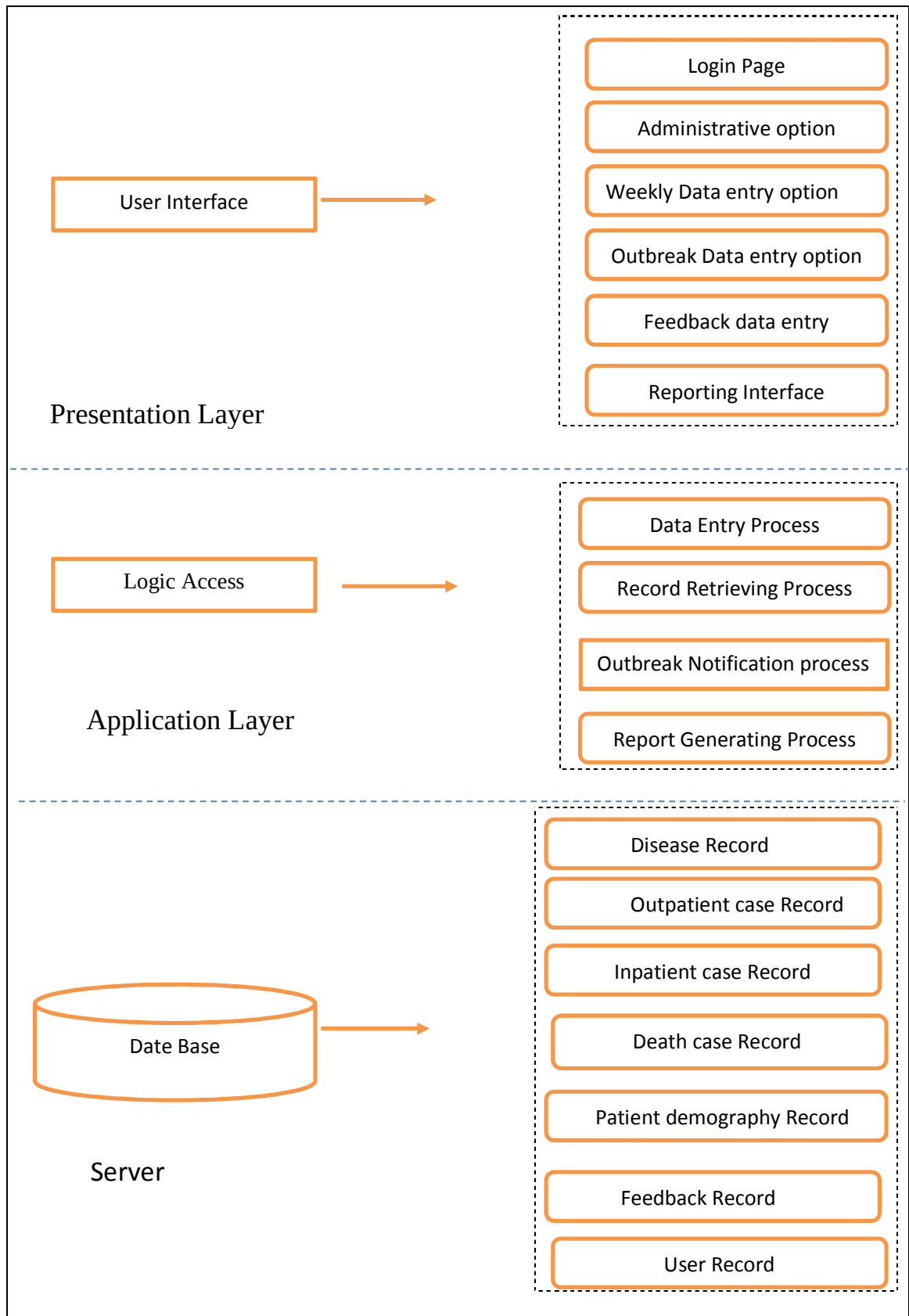
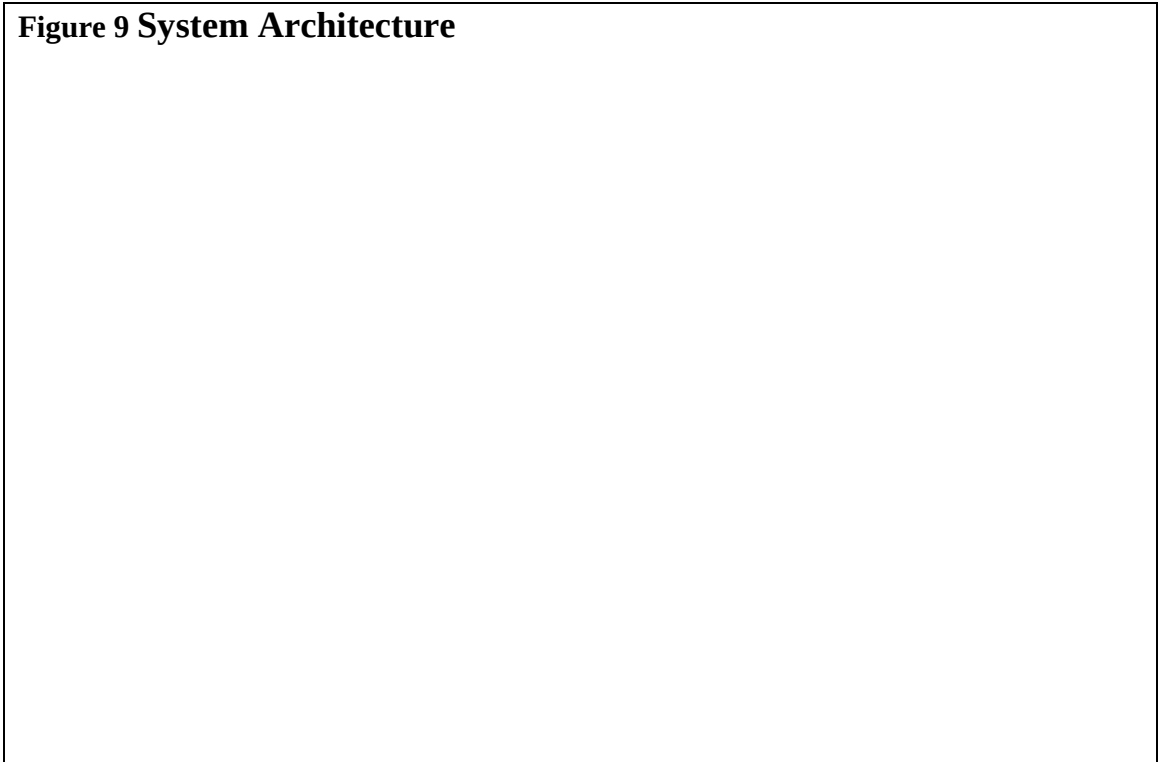


Figure 9 System Architecture



4.5 Prototyping

4.5.1 User-interface Flow Diagrams

UI flow diagrams are diagram that depict major UI elements and how users transition between them in the developed system. It also used to explore the high-level usability of a system and document the user interface of a web-based Information Management System for Communicable Disease Surveillance: The case of Dire Dawa regional health bureau. IT offers a high-level view of the interface of the system, software with which a user directly interacts. The surveillance user can quickly gain understanding of how the system is expected to work using UI flow diagraming and puts the user in a position where the user can validate the overall flow of the application's user interface.

This study employed UI flow diagrams which contain important forms and screens depicted in Figure 10 that lets surveillance users to navigate through. The UI developed

- Firstly, model the interactions that users have with the software, as defined in a single use case.
- Secondly, enable users to gain a high- level overview of the UI for web-based Information Management System for Communicable Disease Surveillance. This overview is effectively the combination of all the behavioral views derived from the use cases.

The figure below shows the high-level over view architectural approach for system UI, the approach that enables to understand the complete UI flow diagramming for WIMS.

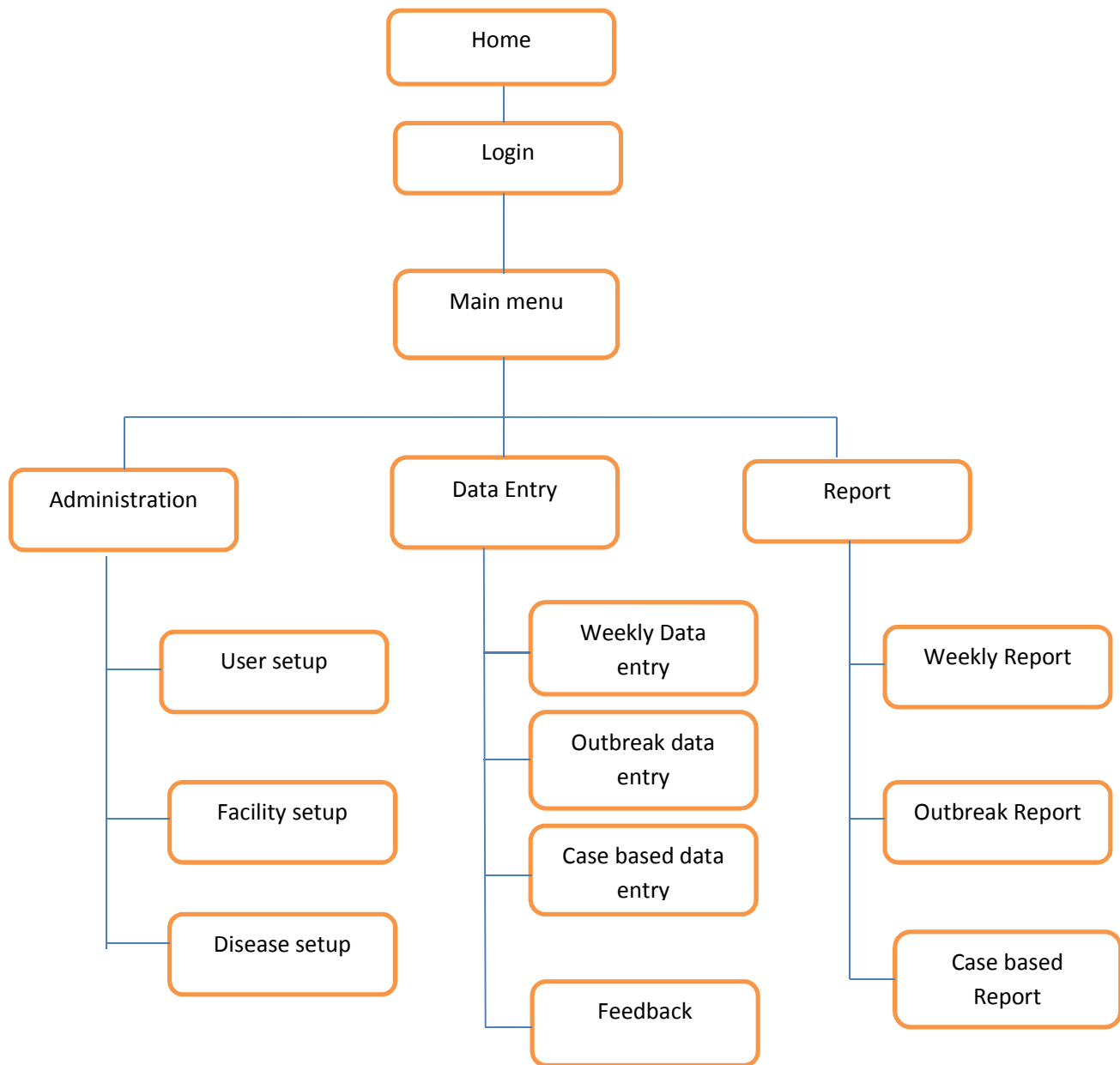


Figure 10. UI flow diagram

4.5.2 User interface

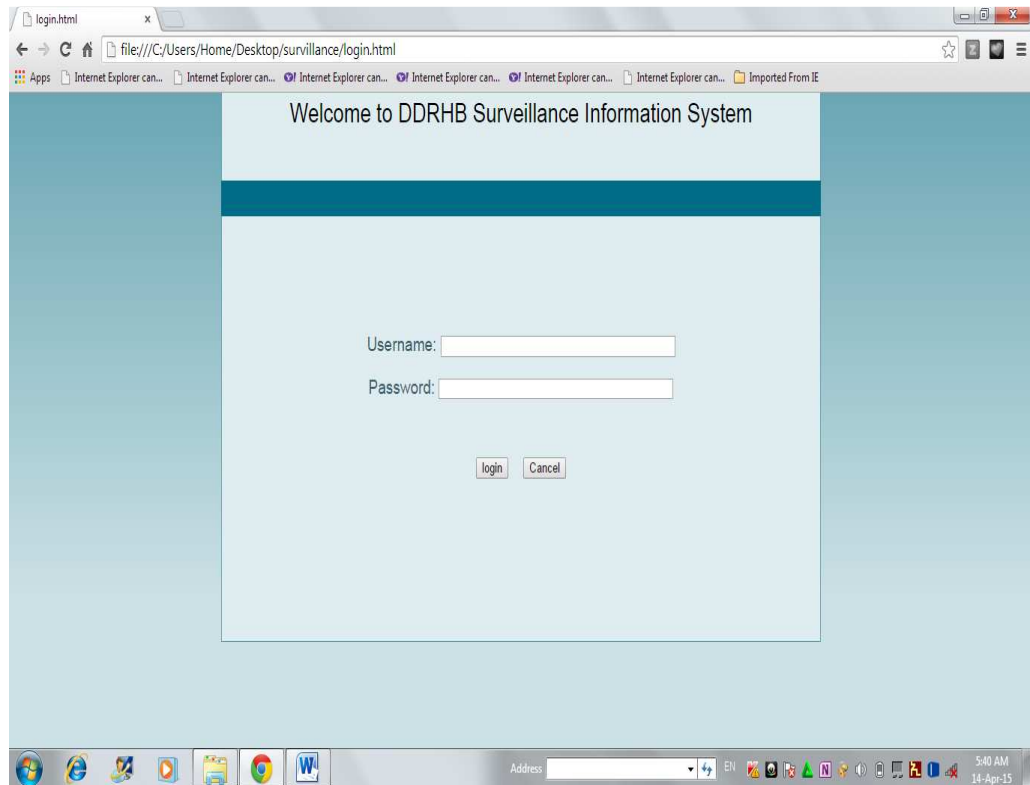


Figure 10. SIMS system login screen

The user enters valid user name and password to enter the system. The system validate the account and display main menu by user type like for administrator admin main screen for others user main screen. If user name and password are incorrect the system display error message, after 3 trials the system suspends for 1 minute.

The screenshot shows a web browser window with the title "New acc.html". The address bar displays the file path: `file:///C:/Users/Home/Desktop/surveillance/New%20acc.html`. The browser's tab bar shows multiple "Internet Explorer can..." tabs and an "Imported From IE" folder. The main content area features a header "Surveillance Information System User setup" and a navigation bar with buttons for "Home", "Administration", "Data Entry", and "Report". The "Home" button is highlighted. Below the navigation bar is a form titled "Create a New User Account". The form contains the following fields: "Health facility Name" (a dropdown menu), "First Name" (text input with placeholder "Name"), "Second Name" (text input with placeholder "Father Name"), "Last Name" (text input with placeholder "Grand father Name"), "User Name" (text input with placeholder "User Name"), "Password" (text input), "Confirm password" (text input), "Email" (text input with placeholder "Enter your Email"), and "User Type" (a dropdown menu). At the bottom of the form are "Create" and "Cancel" buttons. The Windows taskbar at the bottom shows various application icons, the system clock, and the date "14-Apr-15".

Figure 11. SIMS User setup form

This form allows the Administrator to create user setup and authenticate each user working on the system by registering user type and privilege, user name and password offered for all system uses.

File Edit View History Bookmarks Tools Help

localhost / 127.0.0.1 / survil... file:///C:/Users...llance/data.html

file:///C:/Users/Home/Desktop/surveillance/data.html

Search The Web

Search All-in-One Convert Convert Files Measurement Converter Translate Facebook Weather

Surveillance Information System Weekly Data Entry

Home Data Entry Report

Health facility Name

Time Duration : From To:

Total Number of Cases and Deaths for each disease for a week

Indicator	Out patient cases	In patient cases	Deaths
Total malaria confirmed:			
Total malaria suspected:			
positive malaria cases:			
Meningitis:			
Dysentery:			
Typhoid fever:			
Relapsing fever:			
Epidemic Typhus:			

Outbreak Notification

There is an emergency condition please click the link to see the detail information:

[Immediate](#)

Address EN 2:10 AM 01-Jun-15

Figure 12. SIMS weekly data entry form

The weekly data entry form used to register weekly reportable case and death. The user fill the required information and click submit. The form also allows the user to clear the filled data by clicking on reset button and back button to go back to the main menu.

The screenshot shows a web browser window displaying the 'Surveillance Information System Weekly Report' form. The browser's address bar shows the file path: `file:///C:/Users/Home/Desktop/surveillance/weeklyReport%20.html`. The form has a navigation bar with 'Home', 'Data Entry', and 'Report' tabs. The 'Report' tab is active.

The main form area contains the following sections:

- Filters:**
 - Health facility:
 - Disease Type:
 - Time Duration: From To:
- Case Reported:**
 - Total malaria (confirmed and clinical):
 - Total malaria Suspected:
 - No of cases positive for malaria:
 - Meningitis:
 - Dysentery:
 - Typhoid fever:
 - Relapsing fever:
 - Epidemic Typhus:
 - Sever acute Malnutrition:
 - AFP/Polio:
 - Anthrax:
- Summary:**
 - Total No of cases
 - Total No of Deaths
- Outbreak Notification:**
 - There is an emergency condition please click the link to see the detail information: [Immediate](#)

The Windows taskbar at the bottom shows the system clock as 5:35 AM on 14-Apr-15.

Figure 13. SIMS weekly report form

The surveillance officers select the report option and select the weekly report form, this form used to select report by required option like by facility, demographics and so on. The form also allows the user to print and send report for CDC and MOH.

4.5.3 Database Design

The Physical data model of DDRHBSIMS is depicted below

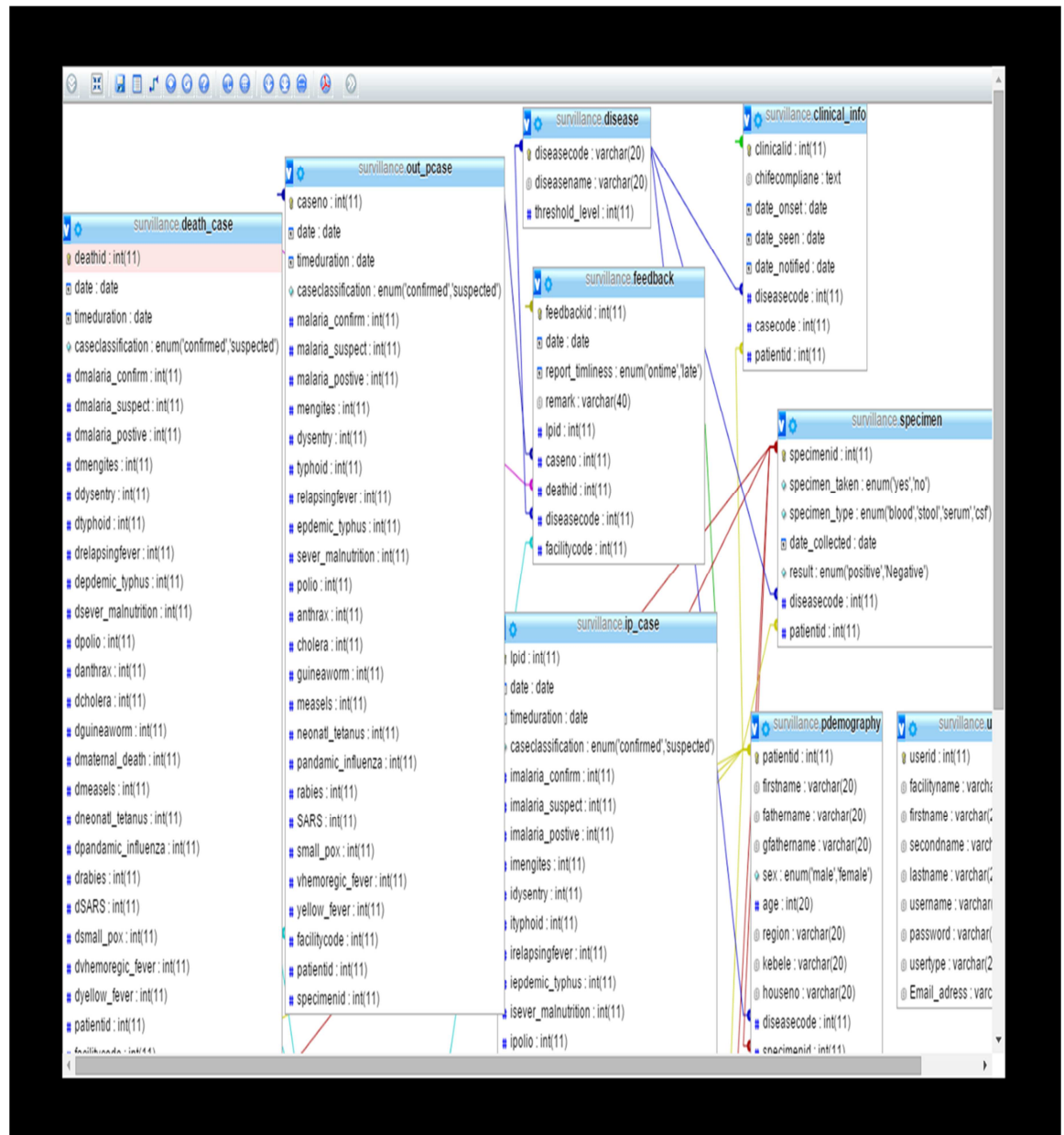


Figure14. SIMS Database design

4.6 User-interface Evaluation

During system development evaluation of the proposed system were made. This evaluation includee 10 users, 4 of them from regional health and the remaining 6 from health facilities. The following table shows Summary of system evaluation.

No	Criteria	Agree	Disagree	Un decided
1	I would like to use this system frequently	70%	20%	10%
2	I thought that the system is easy to use	80%	10%	10%
3	I think that I would need the support of a technical person to be able to use this system	50%	20%	30%
4	I thought there was too much in consistency in this system	20%	80%	
5	I found the various functions in this system were well integrated	70%	10%	20%
6	I think the color of the screen is very interesting	60%	40%	
7	I found the system unnecessarily complex	10%	90%	

The above questions helped us to capture the opinion of the respondents and individual interest for system use. From the total of ten users, seven of them were interested to use this system and described the functions in the system were well integrated. The remaining three users were not interested. On the other hand eight of the ten users rated the system as easy to use and the remaining two indicated that the system lacks consistency.

The study showed that users were interested in the user-interface, however, it still needs some revision to address the concerns and suggestions of given by the few. Therefore as per user interface evaluation result, user interface need to be improved on its consistency and learnability

CHAPTER FIVE

5. Conclusions and Recommendations

5.1 Conclusions

This surveillance information management system which is used to register weekly reportable cases and summary of immediately reportable cases in Dire Dawa Regional Health Bureau and urban health facilities in the region was studied in order to develop a web-based information management system for communicable disease surveillance for bureau. The project identified wide-ranging issues including business requirements, information flow, and Surveillance data sources. Moreover national standards and guidelines documents were consulted along with interviews and discussions with surveillance officers in order to determine the requirement for the new system. This project showed the development process of SIMS. As it follow iterative system development process, the project showed the first blue print of the system then it was improved through the development process which was iterative and incremental. During system analysis and design process of the project the researcher identified the system boundary.

The existing surveillance information system management uses manual documentation and serves as a base for the new system development. The existing system needs to be strengthened on the outbreak detection mechanism within rural health facilities. It is identified that the people that will use the newly developed system need additional training on IT. There are opportunities like access to computers facilities and internet at the central office. On the other hand, the security issues and hardware design were not well addressed in this project. It was also found that the facilities should be networked for the functionality of the system, to generate report on time and get outbreak notification. However, during system development process, the issue of networking and infrastructure was not included and addressed.

The study showed that users were interested in the user-interface. However, the user interface of the system needs to be improved taking in to consideration the inputs from the test results.

Although this project does not show the final product of the system, it provided system prototype for further continuous evaluation and development along with the user feedback. In addition, this surveillance information management system will serve as a base for developing a more complete information system for the institution in the future.

5.2 Recommendations

Dire Dawa Regional Health Bureau

Recommendation is given to the Regional Health Bureau to strengthen the data collection system by;

- Including all emerging and reemerging disease outbreak cases
- Networking all health facilities in the region to facilitate complete information system.

Health facilities

The Health Bureau is recommended to strengthen the documentation system and data quality at the facility level by;

- Including all important information in the document and,
- Strengthening manual system of the facilities.

Researchers

The investigator would like to recommend to future researchers;

- Put their effort on the analysis and design a system which integrates Smart Care with the Surveillance information system
- Improve and complete system development by reviewing and addressing the security issue, hardware design and usability testing of the system.

Ministry of health

The Ministry of Health should encourage the Regional Health Bureaus to implement SIMS by identifying and coordinating with stakeholders.

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Appendix 1

Software Requirement Specification Document

For

**Development of a web-based Information Management System
for Communicable Disease Surveillance: for Dire Dawa
regional health bureau.**

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Appendix 1: System requirement

CHAPTER ONE

1. INTRODUCTION

Disease surveillance is considered as a corner stone of any disease prevention, eradication, elimination and control program. Surveillance data are crucial for monitoring the health status of the population, detecting diseases and triggering action to prevent further illness and to contain public health problems”. When an outbreak occurs, it is vital to have a data management system that supports efficient data capture and information flow, and that can provide a master list of up-to-date case-based information in real time.

1.1 Purpose

The new system will hopefully have a significant impact as it systematically lays a foundation for the implementation that enables easy and much flexible data analysis and report aggregation in a timely manner. Early detection of an outbreak with less cost as compared to the paper based manual information process.

1.2 Scope

This project covers the development of Web-based information management system for Communicable Disease surveillance for Dire Dawa regional health bureau. The main focus of the study were, analyze the existing system, designing a system structure and evaluate the performance of the system prototype with the user.

1.3 Objective

To develop a web-based information management system for communicable disease surveillance: for Dire Dawa Regional Health bureau

CHAPTER TWO

2. Requirement Specification

Requirement constitutes a specification for the new system. It is the starting point for measuring the performance, accuracy, and completeness of the finished system before entering in to system design. Requirements include both functional requirements and non-functional requirements. Functional requirements (behavioral requirement) define what the system does, namely, the functions (actions) of the system. They describe all the inputs and outputs to and from the system as well as information concerning how the inputs and outputs are interrelated. Non-functional requirements, on the other hand, define the quality of the system.

2.1 Functional Requirements

The system should be able to provide the following functionalities

Table 1: Functional requirement

ReqID	Requirement	Rank	Source
RQ-1	The system shall authenticate each user by role before allowing access to system	Mandatory	UC-2
RQ-2	The System shall enable the registered users to register weekly and immediately reportable disease conditions.	Mandatory	UC-3
RQ-3	The System shall enable the registered users to register outbreak cases.	Mandatory	UC-4
RQ-4	The System shall enable to generate notification message and display on screen during outbreaks.	Mandatory	UC-5
RQ-5	The system shall enable system users to generate immediately, weekly, outbreak report based on the collected data and information	Mandatory	UC-6
RQ-6	The system shall enable system users to send feedback for facilities.	Optional	UC-7
RQ-7	Data requirements of the system The system shall comprise of a database with search capabilities. The data shall be patient demography, disease condition, and inpatient and outpatient case.	Optional Mandatory	
RQ-8	Business rules and logic Only Users allowed to use the system, username and password required		

CHAPTER THREE

3. Non-functional requirements

Requirements like usability, reliability, performance, supportability, recovery, interface, implementation, operation, and language are considered as nonfunctional requirements.

- **User interface**

Users are communicating with the system through the application interface which is user friendly. To user satisfaction and usability of the system, attractive user interface with data input, fixed drop down option were used. This will minimize the time needed for data entry and easy to adopt the system.

- **Security issues**

To protect data from unauthorized access and use, the system should provide restriction in using the functionality and information right to use by user, i.e. the system use role based authorization technique while user accesses the data.

- **Error Handling**

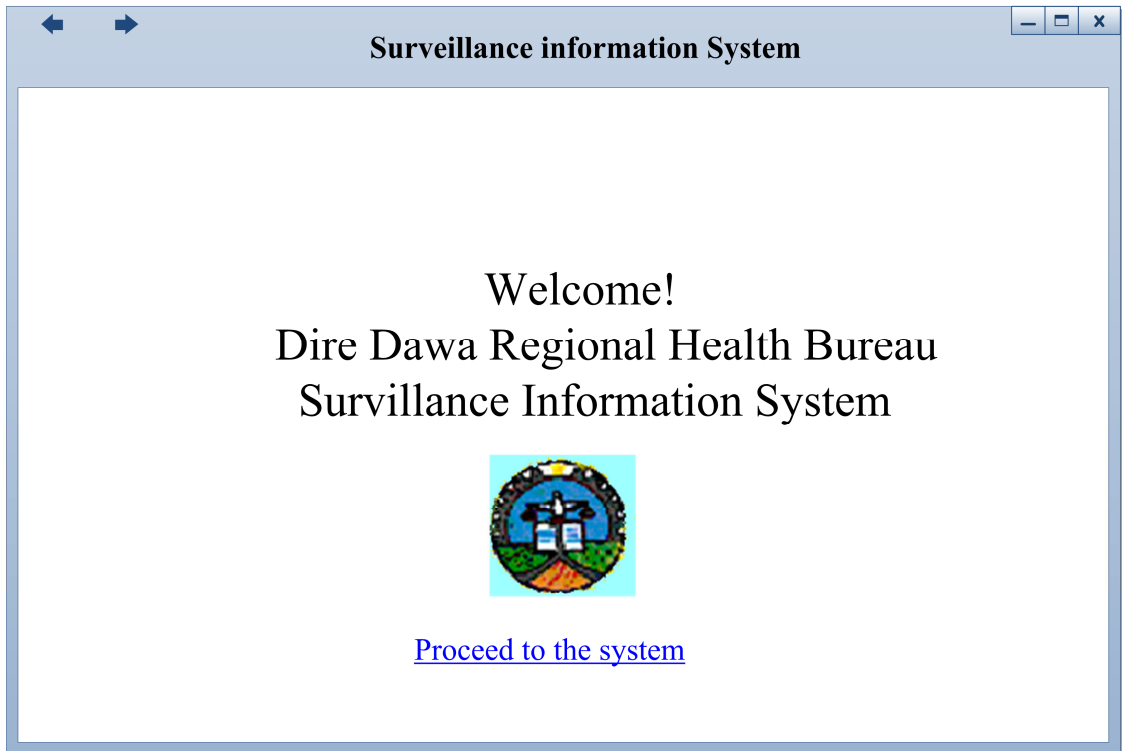
The system shall generate error message whenever the user attempts to enter invalid data, so as to inform the user about their mistake. Most of data input of the system are selection, this is to minimize committing error during data entry.

- **Scalability**

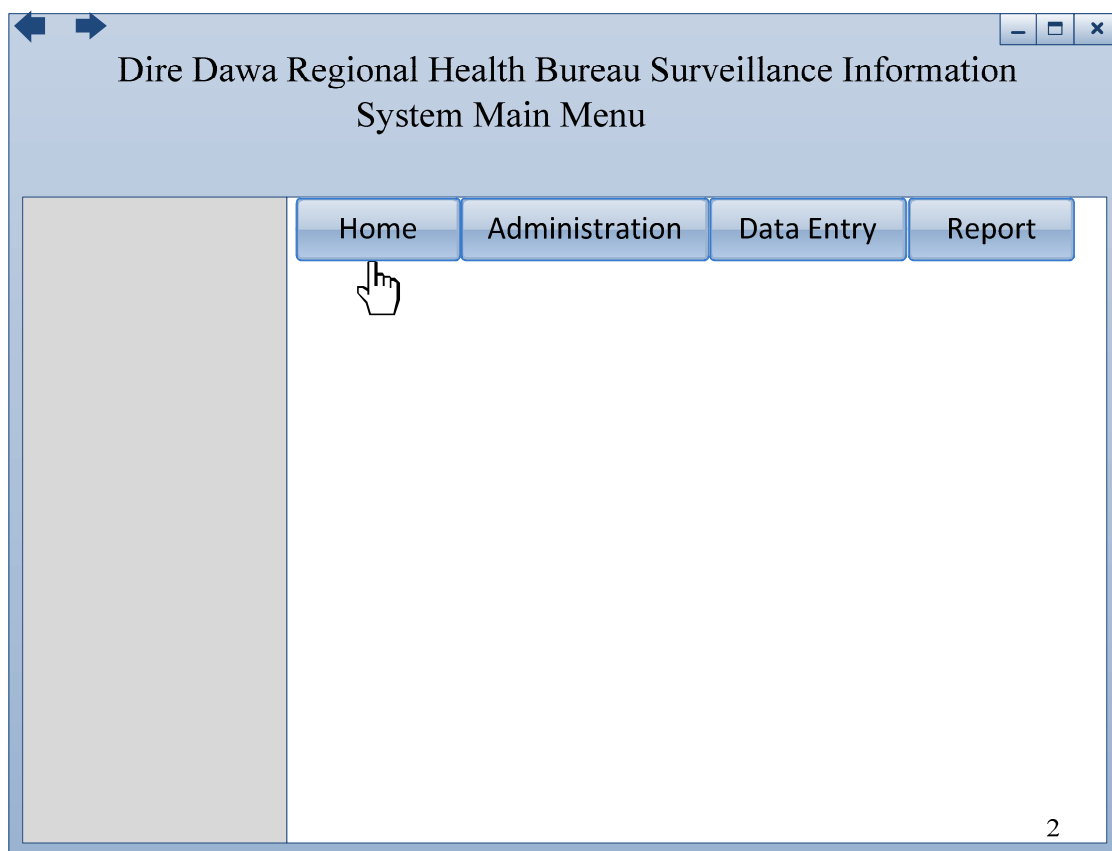
The surveillance information management system involves activities that interact with different workers in health care so the system should be scalable, to support the integration and deployment in large health care environments.

CHAPTER FOUR

4.1 System analysis models



A screenshot of a web browser window titled "Welcome to DDHB Surveillance Information System". The window has a light blue header bar with navigation arrows on the left and window control buttons (minimize, maximize, close) on the right. The main content area is light blue and contains a login form. The form has two labels, "User name" and "Password", each followed by a white text input field. Below the input fields are two buttons: "Submit" and "Reset". In the bottom right corner of the window, there is a small number "1".



The screenshot shows a web application window with a light blue border and standard window controls (minimize, maximize, close) in the top right corner. A navigation bar at the top contains four buttons: "Home", "Administration", "Data Entry", and "Report". The "Administration" button is highlighted with a mouse cursor, and a dropdown menu is visible below it containing the text "User authentication". Below the navigation bar, the main content area has a title "Create a New Account form". The form consists of several input fields arranged in two columns. The left column contains labels for "Facility Name:", "First Name:", "Last Name:", "User Name:", "Password:", "Confirm password:", and "User Type:". The right column contains corresponding empty text input boxes. The "User Type:" field is a dropdown menu currently showing "Administrator". At the bottom left of the form is a blue "Create" button. A vertical scrollbar is visible on the right side of the form area. The page number "3" is displayed in the bottom right corner of the window.

Home Administration Data Entry Report

User authentication

Create a New Account form

Facility Name:

First Name:

Last Name:

User Name:

Password:

Confirm password:

User Type:

Administrator

Create

3

Weekly Disease Data entry Form

Home

Administration

Data Entry

Report

Health facility Name:

LHC

Types of Report

Reporting time
To

1.Total Number of cases and Deaths for each disease/ condition for a week

Indicator	Out patient cases	In patient cases	Deaths
Total malaria (confirmed and clinical):			
Total malaria suspected fever cases examined by RDT or microscopy			
Number of cases positive for malaria parasites			
Meningitis			
Dysentery			
Typhoid fever			
Relapsing fever			
Epidemic Typhus			
Severe acute Malnutrition			

Next

Alerts

Text

Weekly Disease Data entry Form

Home

Administration

Data Entry

Report

Outbreak notification message

2.Summary for immediately Reportable Case-based Disease / conditions(Total cases and deaths reported on Case-based forms or line lists during the reporting week)

Disease	No of cases	No of Deaths
AFP/Polio		
Anthrax		
Cholera		
Draunculiasis(Guinea worm)		
Maternal Death		
Measles		
Neonatal Tetanus		
Pandemic influenza		
Rabies		

Back

Save

Reset

4

Text

←

→

Case Based Data entry Form

Home

Administration

Data Entry

Report

Reporting Health Facility

Reporting unit

Disease type

Reporting time

Types of report

Patient Demographic Information

Name of Patient:

Date of Birth:

Sex: Male Female

Address

Region:

Woreda:

Keble:

House No:

Patient Clinical information

C/C

Date seen at Health Facility

Date Health Facility Notified

Date of specimen collection

Date of Onset

Classification of case

Confirmed

Type of specimen

Blood

Back

Save

Reset

5

Outbreak notification message

Label:

← →
— □ ×

Outbreak Data entry form

Home

Administration

Data Entry

Report

Outbreak
notification
message

Health facility Name

Disease Type

Reporting unit

Reporting time

Types of report

Patient Demographic Information:

Name:

Age:

Sex: M ☒ F ☐

Address: Region

Woreda

Kebele:

House No:

Specimen taken: Yes ☒ No ☐

Result: Positive ☐ Negative ☒

Back

Save

Reset

6

Use Case ID	UC-01
Use Case Name	login
Use case Description	This use case describes the system log in process.
Primary Actor	Surveillance focal person, Surveillance Officer, system administrator
Trigger	The user opens surveillance information system login screen.
Pre-Conditions	The user has authorized user name and password.
Post-Conditions	The user logs in to the system
Main course	1. The User opens surveillance information system; 2. The user clicks on the login button; 3. The system displays login screen; 4. The user enters username and password and clicks on login button; 5. The system verifies username and password; 6. The system displays main menu screen;
Alternative course	5.1. If the user enters wrong username and password 5.1.a The system displays error message and prompts the user to enter the correct user name and password
Frequency of Use	50 times /month
Business rules	After 3 trials the system suspends automatically for 1 minute suspends

←

→

×

Case Based Data entry Form

Home

Administration

Data Entry

Report

Reporting Health Facility

Reporting unit

Disease type

Reporting time

Types of report

Patient Demographic Information

Name of Patient:

Date of Birth:

Sex: Male Female

Address

Region:

Woreda:

Keble:

House No:

Patient Clinical information

C/C

Date seen at Health Facility

Date Health Facility Notified

Date of specimen collection

Date of Onset

Classification of case

Confirmed

Type of specimen

Blood

Back

Save

Reset

5

Outbreak notification message

Label:

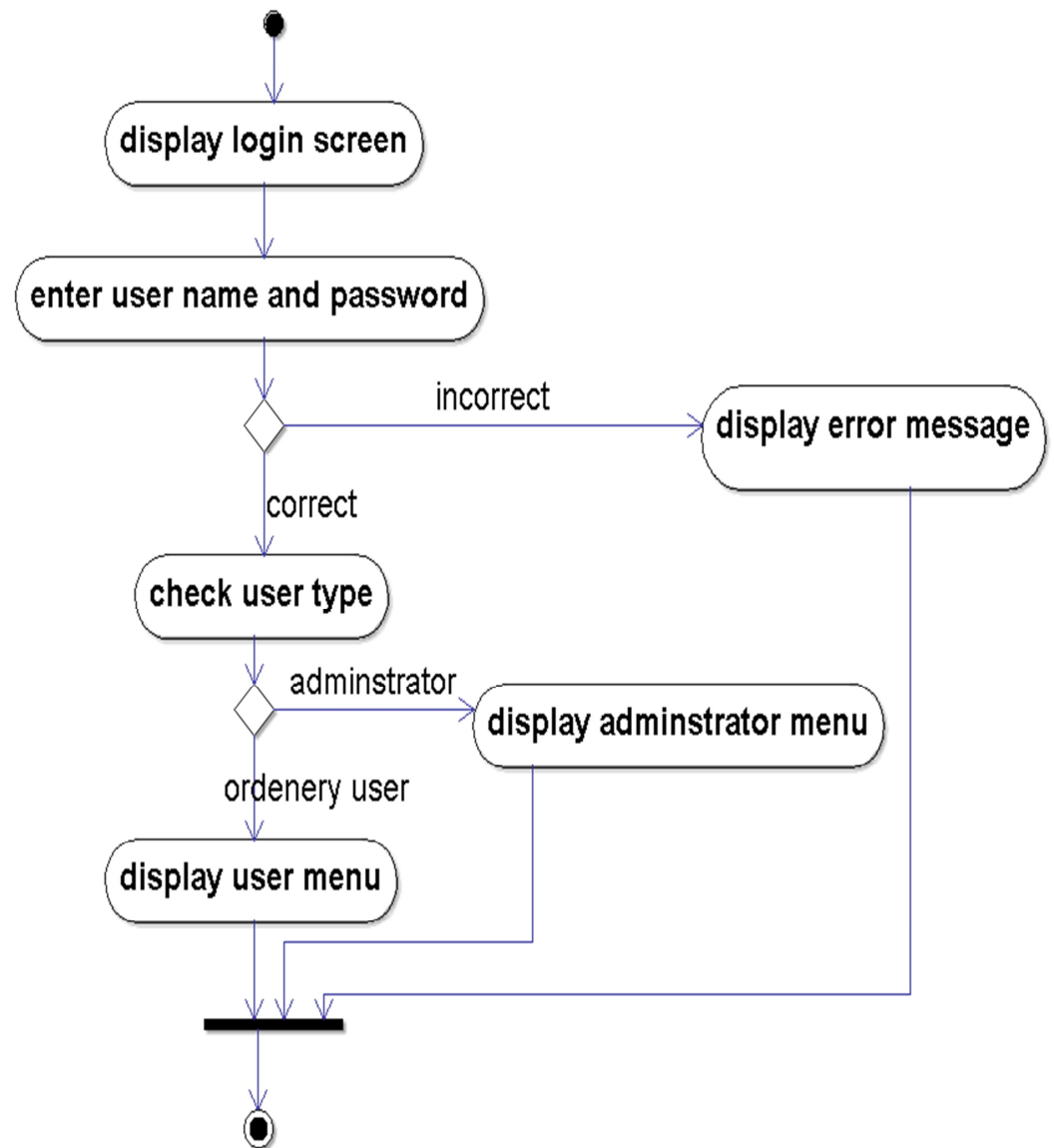


Figure 1. Log in activity diagram

Use Case ID	UC-02
Use Case Name	create setup
Use case Description	This use case describes setup adding process for user, facility and disease
Primary Actor	Administrator
Trigger	Administrator clicks on the administration button from the main menu
Pre-Conditions	The Administrator has logged in to the system
Post-Conditions	The setup is created in the database
Main course	1. The system displays main menu screen; 2. The Administrator clicks on the administration tab on main menu; 3. The system displays the Administration option; 4. The administrator selects user setup; 5. The system displays the user setup form; 6. The Administrator fills the form and submits to the system; 7. The system adds user information on the database.
Alternative course	5.a If the administrator selects facility setup 5.a.1 The system display facility setup form 5.a.2 The administrator fills the form and submit to the system 5.b If the administrator select disease setup 5.b.1 The system display disease setup form 5.b.2 The administrator fills the form and submit to the system
Frequency of Use	30-35 /month for each
Business rules	

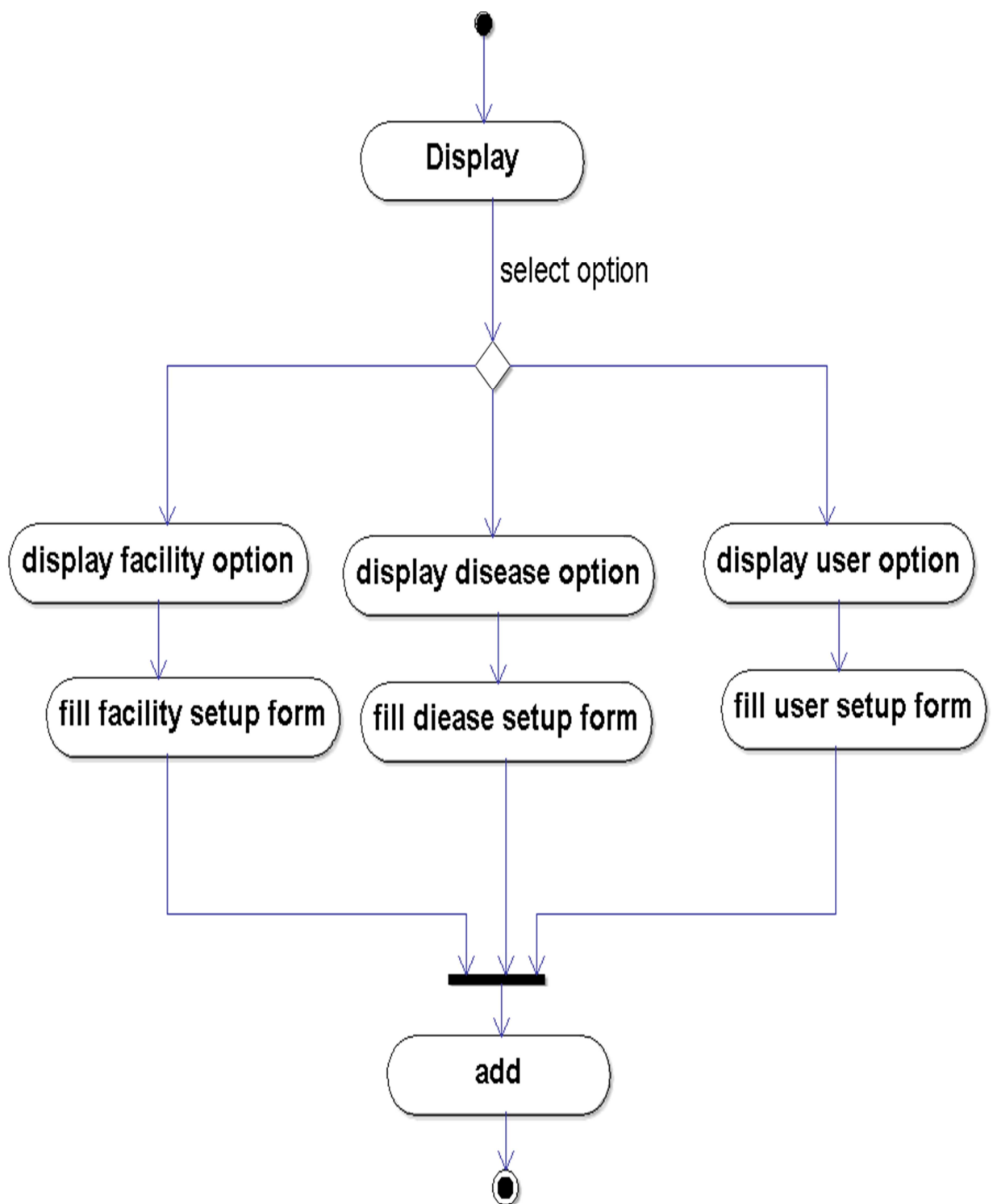


Figure 2. Administration activity diagram

Use Case ID	UC-03
Use Case Name	Register case
Use case Description	This use case describes the data entry process of reportable cases.
Primary Actor	Surveillance focal person
Trigger	The surveillance focal person clicks on the data entry button from the main menu.
Pre-Conditions	The focal person has logged in to the system.
Post-Conditions	The surveillance case is registered on the database
Main course	1.The system displays main menu screen; 2.The surveillance focal person click on the data entry tab on main menu; 3.The system displays the data entry submenus; 4.The focal person selects weekly data entry; 5.The system displays the weekly data entry form; 6.The focal person fills the form and submits to the system; 7. The system validates and adds surveillance data to the database.
Alternative course	4.1.aTo register immediately reportable cases 4.1. The focal person selects immediate data entry submenus 4.2.The system displays immediate data entry form
Frequency of Use	30-35 /month
Business rules	

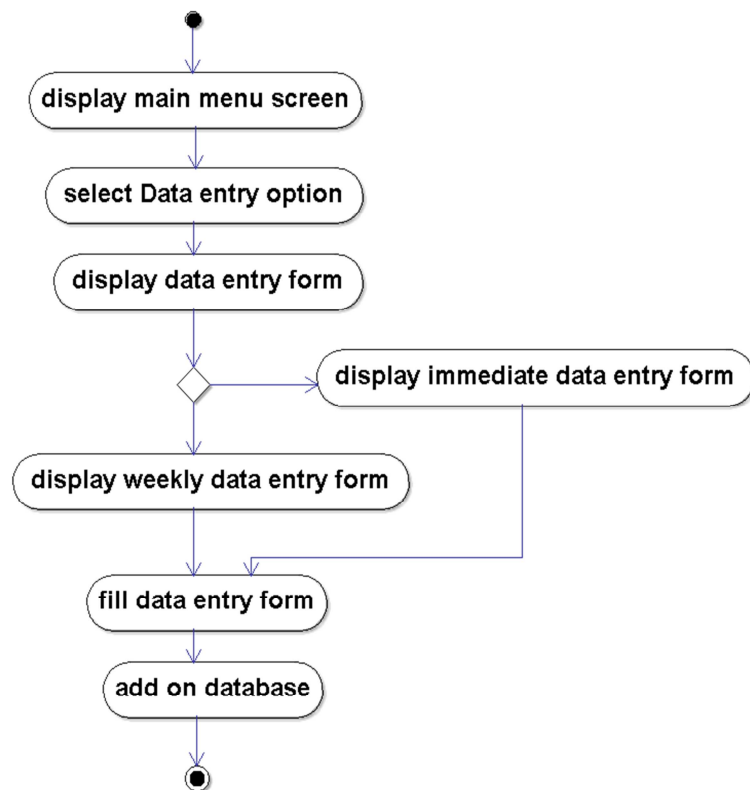


Figure 3. Data entry activity diagram

Use Case ID	UC-05
Use Case Name	Generate Notification message
Use case Description	This use case describes an outbreak threshold detection process
Primary Actor	The system
Trigger	The system tries to create alert
Pre-Conditions	All reportable case has been registered in the system database
Post-Conditions	The system automatically display notification message on the screen.
process of main courses	1. The system checks threshold; 2. The system select from database allrecords that passed threshold; 3. The system automatically display notification message on the screen.
Alternative courses	2.1.a If the user wants to see the detail; 2.1 The user selects on detail of the information; 2.2 The system displays the detail;
Frequency of Use	30 times /month

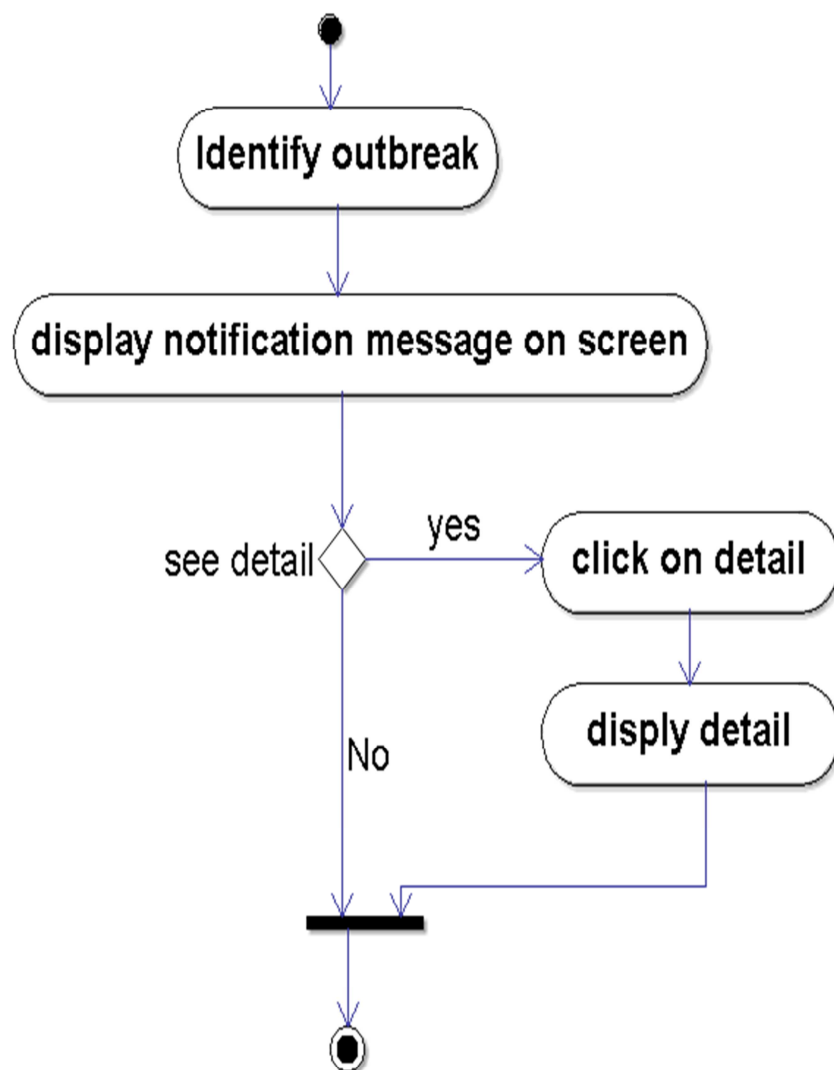


Figure 5. Notification message activity diagram

Use Case ID	UC-06
Use Case Name	Generate report
Use case Description	This use case describes the surveillance report generation process.
Primary Actor	Surveillance officers
Trigger	The officer clicks on report button from the main menu screen
Pre-Conditions	Officer has logged in to the system.
Post-Conditions	Report is generated
process of main courses	1. The system displays main menu screen; 2. The user clicks on the report button from the main menu screen; 3. The system displays the report option; 4. The user selects the weekly report option by facility, demography and so on; 5. The system generates the weekly report; 6. The user sends the report by email for MoH, CDC;
Alternative courses	If the officer want to report outbreak cases 4.1a The officer select outbreak report option 4.1b The system generate outbreak report If the user wants to print out 6.1.a The user requests the system to print out If the user wants to export 6.2.a The user requests the system to export
`	10 /month
Business roles	

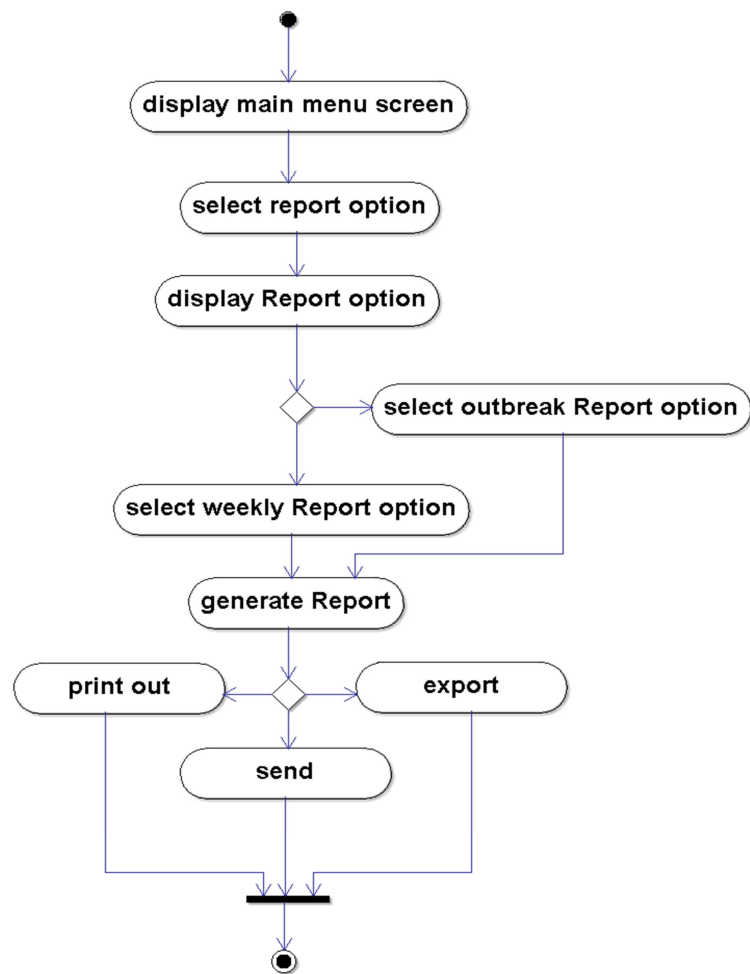


Figure 6. Report generation activity diagram

Use Case ID	UC07
Use Case Name	Compile and Send feed back
Use case Description	This use case describes the surveillance feedback compilation and sending process.
Primary Actor	Surveillance officer
Trigger	The officer selects feedback button from main menu screen.
Pre-Conditions	Officer is logged in to the system.
Post-Conditions	The feedback sent to focal person and print out.
process of main courses	1. The system displays the main menu; 2. The officer selects the data entry button on the main screen; 3. The officer select feedback option; 4. The system displays feedback form; 5. The officer fills the feedback form; 6. The officers saves and sends the feedback to facilities and print out; 7. The system adds the information on the database.
Alternative courses	No
Frequency of Use	35/ month
Business role	

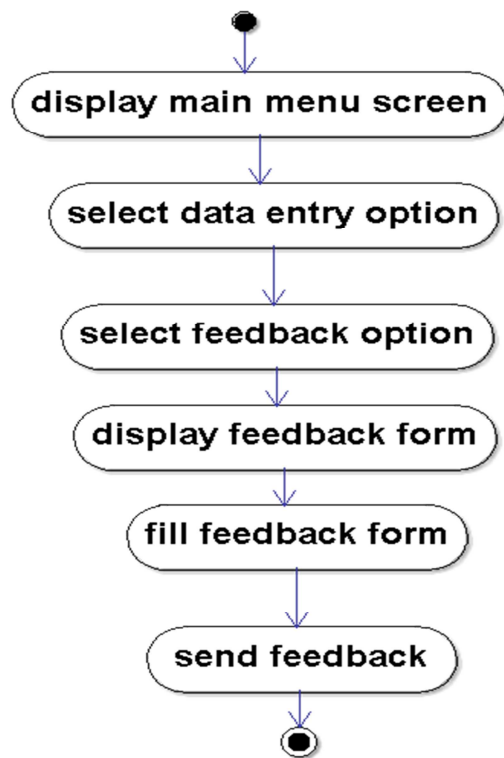


Figure 7. feedback sending activity diagram

4.2 System Design Model

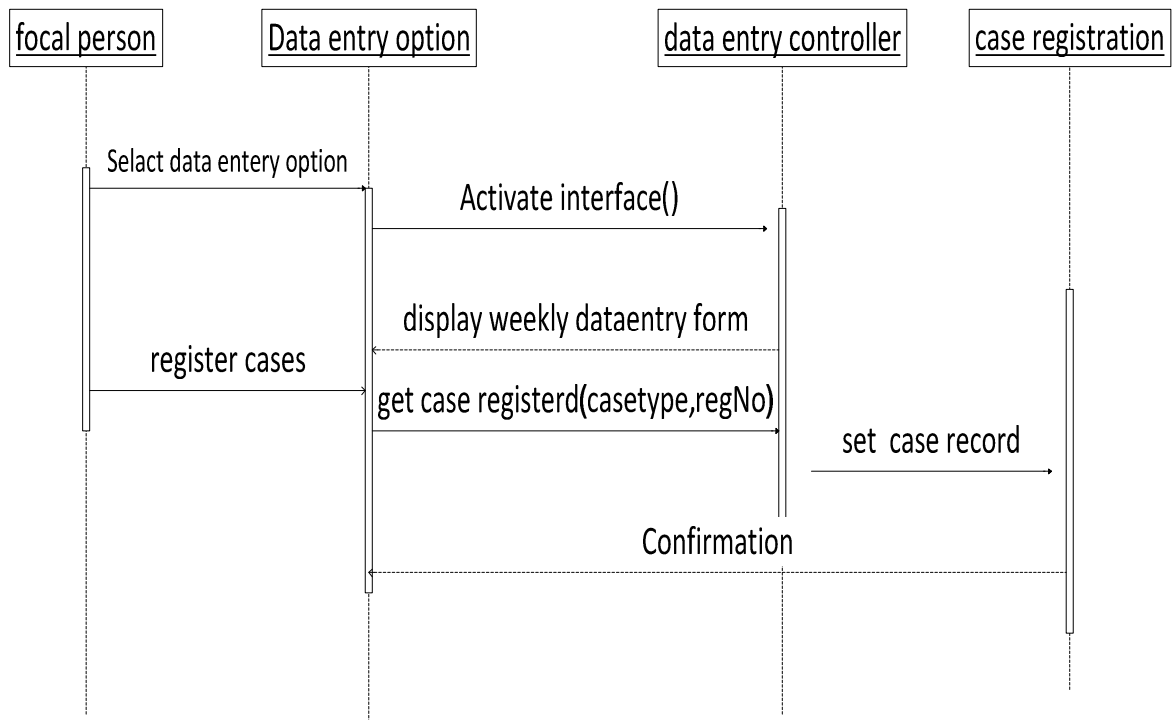


Figure 8. DDRHB Register cases Sequence diagram

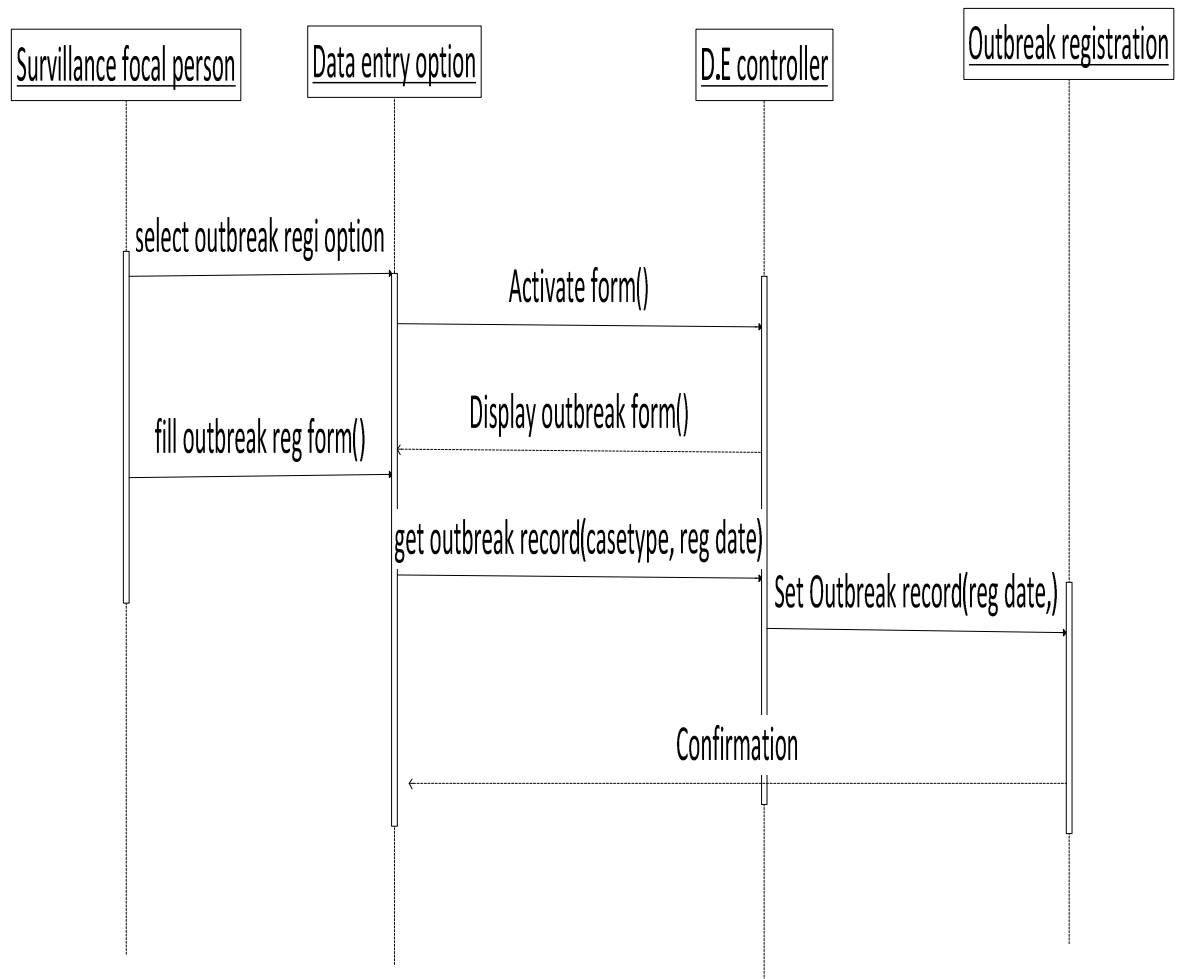


Figure 9. DDRHB outbreak registration sequence diagram

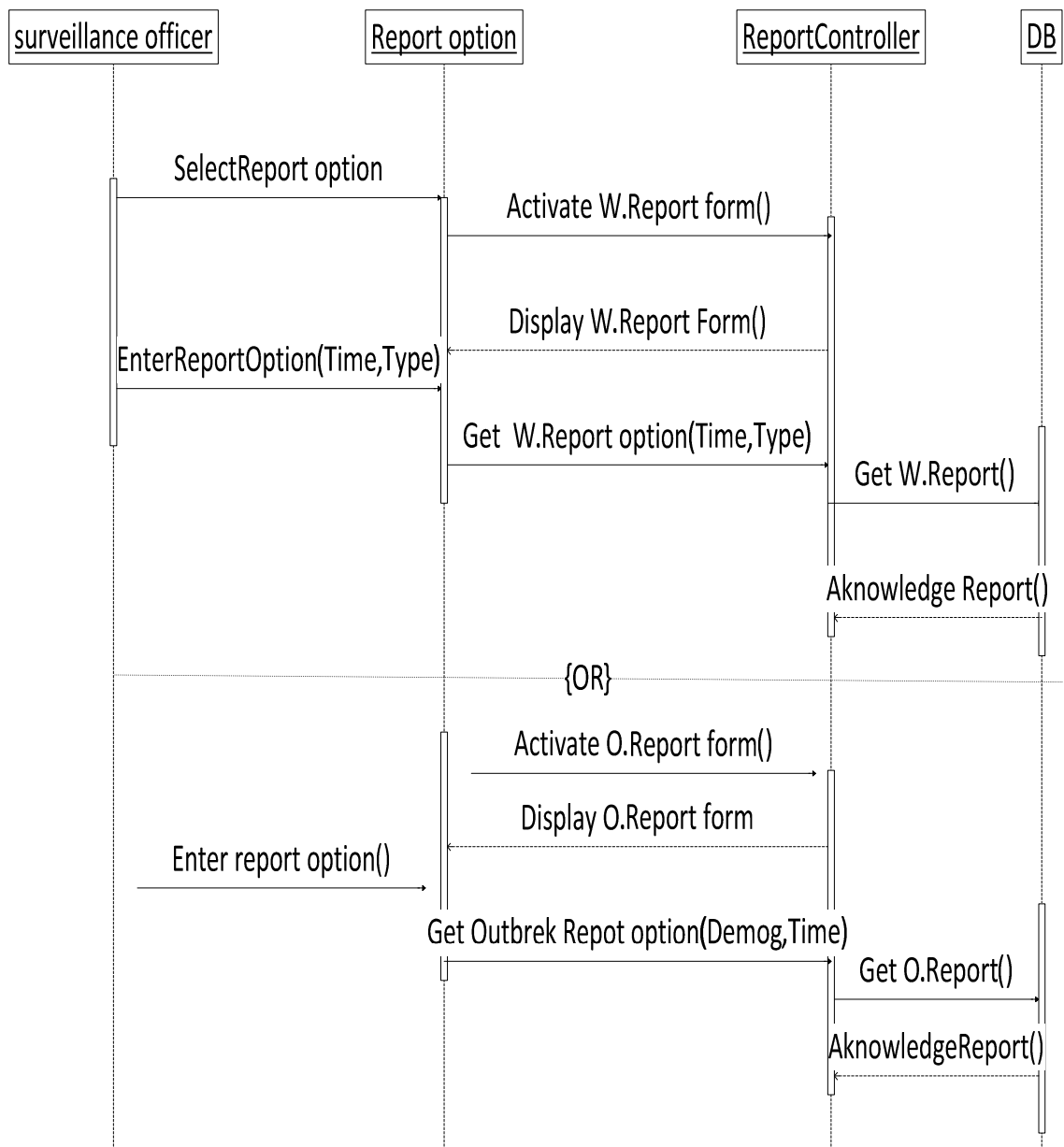


Figure 10. DDRHB report generation sequence diagram

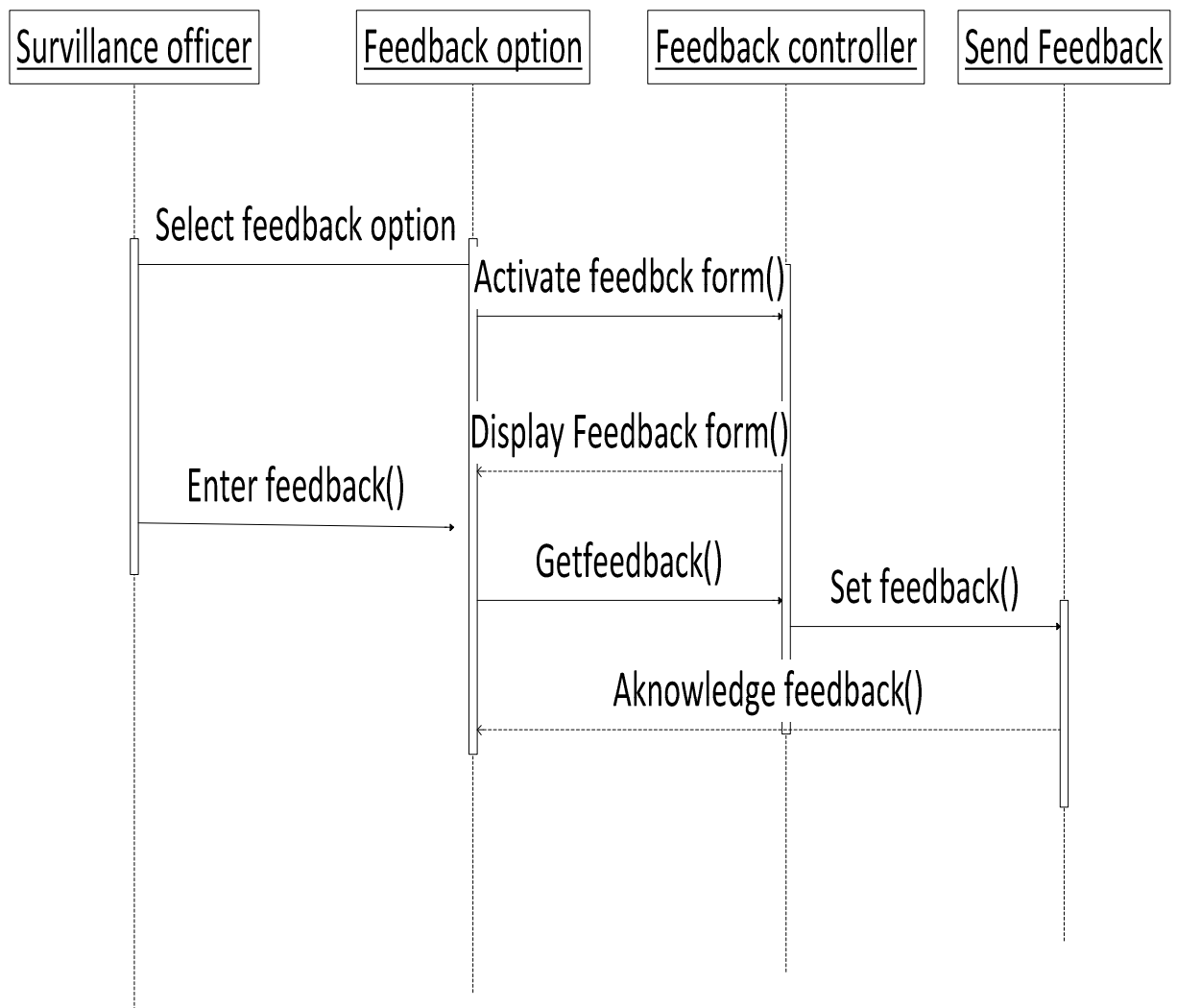


Figure 11. DDRHB Feedback sequence diagram

4.3 System Prototype

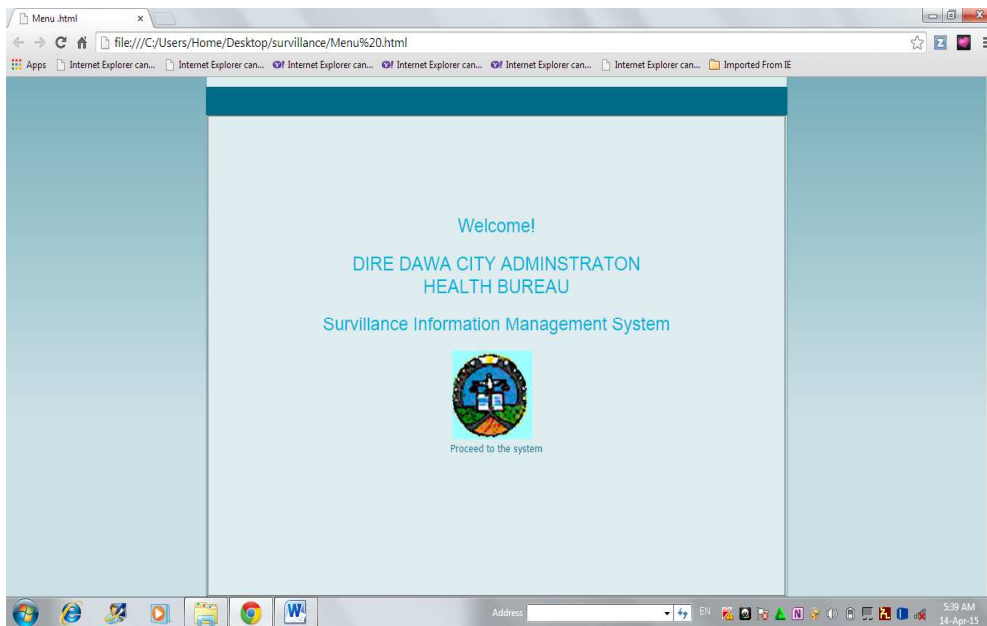


Figure 12. Surveillance information management system Home page

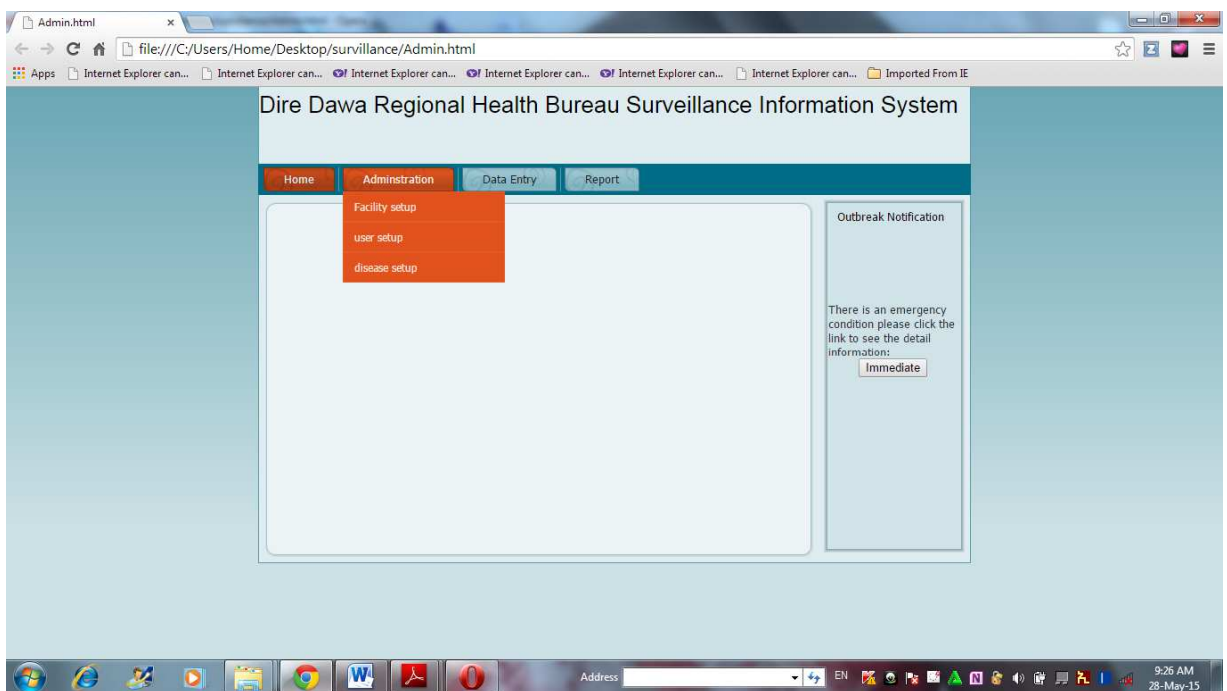


Figure 13 Surveillance information management system main menu

The screenshot shows a web browser window titled 'Facility.html' with the address bar showing 'file:///C:/Users/Home/Desktop/surveillance/Facility.html'. The page has a header 'Surveillance Information System Facility setup' and a navigation bar with 'Home', 'Administration', 'Data Entry', and 'Report' tabs. The main content area contains a form with three input fields: 'Facility Name:', 'Region:', and 'kebele:'. Below these fields are 'Create' and 'Cancel' buttons. The Windows taskbar at the bottom shows the time as 5:27 AM on 14-Apr-15.

Figure 14 Surveillance information management system facility setup form

The screenshot shows a web browser window titled 'disease.html' with the address bar showing 'file:///C:/Users/Home/Desktop/surveillance/disease.html'. The page has a header 'Surveillance Information System Disease setup' and a navigation bar with 'Home', 'Administration', 'Data Entry', and 'Report' tabs. The main content area contains a form with three input fields: 'Disease Code:' with a placeholder 'Enter Disease code', 'Disease Name:' with a placeholder 'Enter Disease Name', and 'Threshold Level:'. Below these fields are 'Create' and 'Cancel' buttons. The Windows taskbar at the bottom shows the time as 5:28 AM on 14-Apr-15.

Figure 15 Surveillance information management system disease setup form

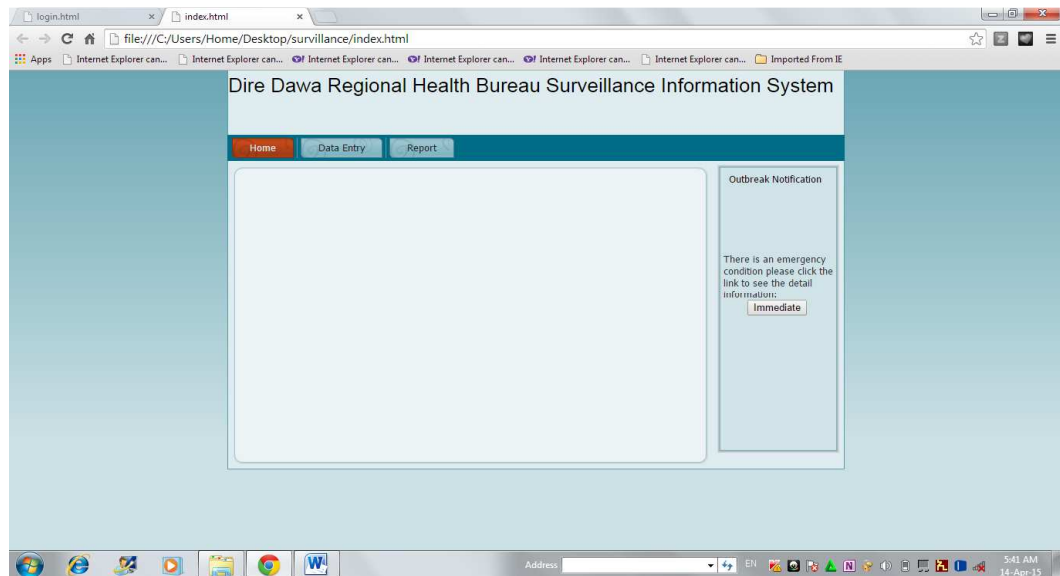


Figure 16 Surveillance information management system user main menu

Figure 17 Surveillance information management system disease case based data entry form

The case based registration form holds the individuals surveillance case demographic information and clinical diagnosis information. The form also allows the user to view outbreak notification message by clicking immediate report link.

Figure 18 surveillance information management system feedback form

This form allow user to register feedback for facility. The user fill the required information click send for concerned body.

Figure 19 Surveillance information management system outbreak report form

Appendix 2:

Interview Guide

ADDIS ABABA UNIVERSITY

School of information science And School of public health

MSc in health informatics program

Consent form

This Interview guide is for a Development of a web-based Information Management System for Communicable Disease Surveillance: The case of Dire Dawa regional health bureau.

To the respondents:

The result of this interview will be utilized for project purpose only. It is hoped that the outcome of this study will contribute to the improvement of Surveillance Information Management in Dire Dawa regional health bureau. Therefore, you are kindly requested to provide genuine response to the questions that follow.

Thank you in advance for your Cooperation

1. Data collection tool

Formal Interview Guide

Data

1. What is the period of time of the data collection?
2. What information is collected?
3. How do you detect an outbreak?
4. How do you document an outbreak management plan?
5. Is there any limitations regarding to reporting format?

People

6. Who provides the surveillance information?
7. To who are reports distributed?

Communication

8. How is the information transferred from health facilities?
9. What types of communication are available?
10. What methods are available to collect feedback on the communications?

Hard ware

11. Do you have computer for surveillance purpose?
12. Does the organization ready to fulfill suitable hardware infrastructure in the development of surveillance information management system?

Soft ware

13. Do you have any software used to prepare reports? Which software?
14. Do you have a plan to implement computerized system?

Procedure

15. How is the information stored?
16. How are the data analyzed and how often?
17. How often are reports disseminated?
18. Is there any mechanism of public health alert?

General

19.Is there any problem regarding to Surveillance data collection, analysis and process?

20.How many human resources do you have in surveillance activity?

Declaration

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

Seble Shiferaw

This project has been submitted for examination with our approval as university advisors.

Dr. Adamu Adisse

Ato Ermias Abebe

Place and Date of submission: Addis Ababa, June 2015