ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

FACULTY OF COMPUTER and MATHEMATICAL SCIENCES

DEPARTMENT OF COMPUTER SCIENCE

E-complaint Management System and GIS Mapping for Addis Ababa City Administration

By

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List of Acronyms

ICT	Information and Communication Technology
E-government	Electronic government
GIS	Geographic Information System
SMS	Short Message Service
CTN	Complaint Tracking Number
GSM	Global System for Mobile
ASP	Active Server Pages
IIS	Internet Information service
ECoMS	Elecctronic Complaint Management System

Abstract

Complaints are valuable sources of information that organizations can use to improve services provided by organizations. But, it is not an easy task to collect complaints and provide a solution for collected ones. An effective complaint management system plays crucial role to privde services in better manner. Realizing this, many countries use electronic complaint management system.

Current complaint management system of Addis Ababa City Administration has some limitations. First, it is difficult to reach large group of people and collect complaint from those groups. Second, it is difficult to manage even the collected ones. To alleviate these problems, we developed an electronic complaint management system. The system enables collection of complaint from large group of people using current technologies: Internet and mobile and makes management of complaints easy. Complaints may reach to the system through short message service (SMS) or through website. The system autonomously accepts the complaints and forward to the respective responsibility. To enable spatial analysis of collected data, a GIS map is integrated with the system.

Chapter One

Introduction

1.1 Overview

Information and communications technologies (ICTs) are playing an increasingly vital role in the daily lives of people, revolutionizing work and changing the rules of doing business. In the area of government, ICT applications are promising to enhance the delivery of public goods and services to citizens [1]. By applying information technology in government system, electronic government (e-government) will be created.

E-government allows citizens to interact with computers to achieve objectives at any time and any location, and eliminates the necessity for physical travel to government agents. Thus, the use of ICT has changed the way of interaction between governments and citizens. Taking this is into consideration, e-government applications are being developed.

Due to dynamic increase of Internet users and, needs and requirements of citizens to finish their tasks with minimum time, many governmental agencies are providing e-government services via website [13]. Internet technology can improve government performance, be cost effective, increase accountability, improve resource management and provide better ways of communication between citizens and the public sector [2].

Governments are aiming to meet the rising expectations of citizens using innovative information technologies and various service delivery channels in addition to the World Wide Web [2]. Non-Internet forms include telephone, fax, PDA, text messaging, etc. Short Message Services is one of those which can be used as a channel for citizens to communicate with government. For instance, in the Philippines, half of cabinet agencies have SMS-based services that allow citizens to ask for information or to comment and complain about government officials and services [3].

Quality of service inside public administration is something more than a beautiful expression. This is especially true in local administration. The complaints and suggestion administrative procedure is one of the most common systems that allows people to be heard by their local government. Citizens need to express what they think, and town councils need to know what their citizens think in order to improve services provided. It is not easy task to handle complaints, no matter how they arrive - by phone, in person, by letter or email. Using e-government

applications to ensure effective and consistent processes to manage complaints becomes a culture in different parts of the world [5, 6]. For example, in Seoul, Republic of Korea, the OPEN system helps to get transparency in city administration by preventing delays in processing of licenses and other government documents [4]. Prior to the introduction of the system, applicants often had to pay speed money; now processing is a matter of public record, on the web. If officials are unnecessarily delaying documents, citizens can complain and disciplinary action is taken [4].

Addis Ababa City Administration provides various services to the city residents and international organizations found in the city. One of the major duties of the city administration is handling any complaints comes from residents regarding services provided by the city administration and problems observed in the city. Currently, the city administration collects opinion and complaints from those who go in person to governmental agencies.

On the other hand, number of mobile and Internet users is increasing tremendously in the city [24]. To enable collection of complaints from those groups and to make management of complaint more convenient for Addis Ababa City Administration, we developed a web based complaint management system. The system will allow anyone to report incidents like missing street signs or potholes or dissatisfaction on services provided by the city administration using Internet or by sending SMS message round the clock (24*7) from anywhere. Hence, the system avoids necessity of going to office to register complaint by making possible to register complaints using SMS or the website. The registered complaint routed directly to the appropriate department. The system will allow a complainant to track the resolving process online by using his or her complaint tracking number (CTN) or by sending SMS message. In addition to this, spatial data analysis is incorporated.

1.2 Statement of the Problem

Many problems are observed in the current complaint handling system by the city administration. The major problems observed are described as follows.

The current complaint registration system is time taking and inconvenient for the complainant. Anyone who wants to register complaint should visit in person one of the offices found in “Woreda” or “Kifle Ketema” level. For example, if a person wants to report about a problem related with space for walking and driving caused because of construction which is beyond the

limit area should go to one of the offices in person to inform about the problem. Because of this constraint, those who do not have time to go to one of the offices have no alternative way to report about the problem. Even if they report the problem, they should go to the office in person to follow the status of the complaint. This hinders those who do not have time for placing complaints, but have Internet access or able to send SMS message, from reporting the problem and following its status. On the other hand, those who fears to report thinking something wrong might happen to them do not have other means to place their complaint. This creates a problem on collection of public opinion on services provided or problems observed in the city from some group of residents.

The other problem seen is related with officers who assigned to collect complaint from public. They "waste" their time in doing something that does not add value to provide a solution for the problem. They verify complaint form received from complainant, forward it to respective department, track the status of the complaint and inform the result to the complainant. Much time is wasted during this process.

As a rule, all complaints should be recorded in a simple and meaningful way, even if the complaint is perceived as a minor issue. But, there is no way to assure that the complaint is recorded and stored properly. Moreover, there is no way to assure that the received complaint is forwarded to appropriate department or person. If the officer who receives the complaint form forgets to forward to appropriate department or intentionally did not do it, the complaint registered becomes value-less.

The third problem is related with report generation. Report generation in general and generation of report related with location in particular is very difficult in current system. To generate a report which focuses on number and types of complaints registered, location of the problems and the solution given, it might take days, weeks or months depending on the level of the report. Because of this, decision needed to be made on time delayed.

In general, with the current time-consuming, labor intensive, paper-based procedures for accepting and processing complaints it is difficult to record and track the progress of a complaint from initial receipt to when the complainant is either satisfied or a final decision on the outcome of the complaint is made.

1.3 Objectives

The general and specific objectives of the project are described as follows:

1.3.1 General Objective

Objective of the project is to develop a web based complaint management system for Addis Ababa City Administration.

1.3.2 Specific Objectives

The specific objective includes:

- Conducting literature review to study related systems which are already implemented.
- Identify requirement of the system.
- Developing a prototype of the system and implementing the system.
- Testing the developed system.
- Improving current complaint report system.

1.4 Scope of the Project

The project focuses on collection of complaints regarding services provided by Addis Ababa City Administration and problems seen on the city from residents by using SMS and Internet, then displaying the registered complaints on a map and enabling users of the system to follow status of complaint using website or by sending SMS message to the system. The system also enables to manage the registered complaints.

The system does not accept complaints come through phone, fax or email. Complaints reached to the office using those channels can be collected by officers and entered to the system.

The system accepts only SMS data which satisfy predefined pattern. Plain SMS text message reaches to the system cannot be interpreted by using natural language processing techniques to determine the nature of the complaint (department and the complaint type) and other details like location.

Due to time and resource limitation it is difficult to collect all coordinates of the city to exactly identify specific locations. Therefore, we collect only 70 coordinates of most known places in the city and built the system.

The data accepted from mobile devices only limited to SMS, multimedia messages will not be accepted.

1.5 Methodology

In order to accomplish the objectives of the project, projects related with complaint management previously developed were reviewed, necessary data were collected, and appropriate programming tools and techniques were used. Next, the methods used in the project are described.

1.5.1 Literature review

The literature review part has focused on reviewing issues related with e-government, SMS and GIS related e-government services.

1.5.2 Data collection

For the purpose of requirement gathering and determination of the system both primary and secondary sources of data are used. Primary data source includes: interviewing workers of the city administration and residents of the city, and observation of the current work process. Whereas secondary data source comprises documents that the city administration currently using to handle complaints and forms that being used in complaint collection. The interview questions are annexed.

1.6 Organization of the Document

This document is divided in to six chapters including this chapter. On the second chapter of the document, literature review is presented. Requirements of the system and analysis of the system is given on the third chapter. The design issues of the system are presented on the fourth chapter. In the fifth chapter, the tools used to develop the system and the prototype of the system is described. In the last chapter conclusion of the project and future works is presented.

Chapter Two

Literature Review

Governments around the world have engaged in the process of developing a wide range of electronic services by using information technologies, particularly, web based Internet applications. Recently introduced mobile Internet and related technology are among the most advanced delivery channels that are leading to a new era of mobile government services and business models.

In the first section of this chapter, concept of e-government is discussed and some e-government applications are described. In the second section, geographic information system (GIS) related e-government concept and e-government GIS application is discussed. Lastly, we discussed about SMS related e-government applications.

2.1 E-government Applications

The World Bank defines E-government as the use of ICTs (such as wide area networks, the Internet and mobile computing) by government agencies to transform government by making it more accessible, effective and accountable [12]. Traditionally, interaction between citizens and government took places in government offices. The introduction of the technology changed this tradition and makes services available near to citizens. These technologies can serve a variety of different ends: higher quality, cost effective and transparent delivery of government services to citizens, improved relationship between government and citizens, citizen empowerment through access to information and more efficient government management. The resulting benefits may be greater convenience, increased transparency and accountability in public decisions, revenue growth, less fraud and/or cost reductions.

It is clear that the use of ICT is only a means to an end. The aim is to deliver better service to all stakeholders in government services. E-government is a structural reform process based on a view of information as a strategic resource in all areas of government activity.

According to [15], the primary e-government types or models include:

A. Government-to-Citizen (G2C) - is communication link between government and citizens. The communication usually takes places using ICT, media campaigns and direct mail. G2C

includes information dissemination to the public, basic citizen services such as license renewals, ordering of birth/death/marriage certificates and filing of income taxes, as well as citizen assistance for such basic services as education, health care, hospital information, libraries, and the like.

B. Government-to- Business (G2B) - is communication link between government and business organizations. G2B transactions include various services exchanged between government and the business community, including dissemination of policies, memos, rules and regulations. Business services offered include obtaining current business information, downloading application forms, renewing licenses, registering businesses, obtaining permits, and payment of taxes.

C. Government-to-Government (G2G) - G2G services take place at two levels: at the local or domestic level and at the international level. G2G services are transactions between the central/national and local governments, and between department-level and attached agencies and bureaus. At the same time, G2G services are transactions between governments, and can be used as an instrument of international relations and diplomacy.

Our main focus is on G2C model. Based on this model, a lot of applications were developed. Let see some of them.

2.1.1 Complaint Tracker

Complaint Tracker is customizable software developed by Cynosure Software [11]. It allows to record the complaints that received in a consistent manner, collect them all in a single place, and review and analyze both the complaint resolution process and the type of complaints received. Complaint Tracker has an easy-to-use screen that allows to easily enter complaint information. Much of the information is entered from drop-down lists or checkboxes that are filled. In addition, Complaint Tracker automatically generates an easy-to-read summary of the complaint as data entered.

2.1.2 CiviRep

CiviRep is an application that allows citizens to report crimes via SMS [18]. The system offers noise filtering mechanism to validate reports. This information is then processed and aggregated at the CiviRep engine and displayed on a web-map in real time. By receiving this data in real time, more rapid and efficient responses can be elicited from governments, organizations,

authorities and others, and will make them more aware of the needs of their citizens. The report of the information collected will be displayed on a web-map to provide a transparent view of the criminal situation in a particular context to government authorities, international organizations and communities around the world that have access to the Internet.

2.1.3 Ushahidi

Ushahidi is a free and open-source software platform used to collect and visualize information [14]. It was first developed in early 2008 to map reports of violence in Kenya after post-election fallout.

The Ushahidi platform is used for everything from social activism, citizen journalism, crisis reporting, public accountability campaigns, and many other possible uses. Local observers can report incidents via SMS or through a form accessed on website; their reports are then uploaded to a website and the incident location is plotted on a map (usually using Google Maps) in almost-real time. This collection of information serves as a repository for concerned citizens to view and the aggregated data also acts as an archive of events.

2.1.4 eTracker

eTracker is a web-based application designed to track customer complaints from the initial call to customer service representative to the final implementation of a solution [9]. It is designed to allow managers to be able to route specific call types to those responsible to handle those calls while providing flexibility to allow customer service representatives to reassign the complaint if needed. The system allows tracking complaint status, resolution status, complaint and resolution details, and resolution log (shows user activity as complaint is precede).

2.2 GIS and E-government

A geographic information system is a computer-based system for managing, storing, querying, analyzing, modeling and displaying map database information which enabled users to view spatial data in its appropriate format [20]. The objective of GIS is to make full use (data input, analyzing, storing, updating and output) of spatial data beyond the limits of ordinary paper maps. GIS has many applications in various fields today. The applications range from traditional applications like urban planning to business. In a GIS, geographic information is described

explicitly in terms of geographic coordinates (latitude and longitude or some national grid coordinates) or implicitly in terms of a street address, postal code, or forest stand identifier

When GIS data and functionality are available on the Internet, the system is referred to as Internet GIS (Web-GIS). GIS systems deployed on Internet allows users to perform spatial analysis without installing the software on users machine [21]. GIS can be integrated with e-government applications to provide location based information for the public. Figure 2.1 shows a GIS map.

Figure 2.1 GIS Map (Image Source: http://maps.google.com.et)

Geographic Crime Analysis Program is a best example for of e-government based GIS applications developed. Geographic Crime Analysis Program was a desktop application which latter changed to GIS Internet mapping application developed for city of Aurora, the third largest city in Colorado[10]. The system allows citizens to query crime incidents based on time and location. It provides general-purpose mapping tools including: zoom in, zoom out, pan, full view

and identify, and specialized crime query tools. The system displays the details of the crime on a map.

The system has three servers. There are data servers, a web server and an application. The data server stores the GIS shape files and the crime incidents database. The web server and application server are integrated on one computer. HTML and JavaScript was used to build the browser interface in client side while server side was built by Avenue Script.

2.3 SMS Based E-complaint System

SMS is a technology that enables sending and receiving alphanumerical messages to and from a mobile phone [16]. It is commonly referred to as text messaging or "texting" as well. The first short message is believed to have been sent in December 1992 from a Personal Computer (PC) to a mobile phone on the Vodaphone global system for mobile (GSM) network in the UK [23]. A single message is limited to 160 characters of text in length.

SMS is a store and forward method. If the end user is not available or the mobile unit is powered off or the unit is outside a service area, SMS Center stores the SMS message and when the unit comes back on line the message will appear. A SMS message can also be sent "certified," where it will notify the message originator of the end user's receipt of the message.

According to [22], over 6.1 trillion messages sent worldwide in 2010, that is triple the number sent in 2007 (1.8 trillion). That means 200,000 text messages are sent every second. SMS has established itself as an essential revenue component of the mobile communications industry, and has been put to use in many forms and innovative schemes.

At present SMS is widely used because of the following points:

- ✓ Ability to receive or submit a message while a call is taking place,
- ✓ Conformation of message delivery,
- ✓ Low cost,
- ✓ Delivery of messages is virtually instantaneous, and
- ✓ Alternative means of communication for deaf.

In addition to personal usage, SMS is being used for various purposes. For example, shows which have a voting system, such as American Idol, have begun integrating SMS voting,

allowing viewers to easily make their choices using their cell phone. SMS can also be used by local authorities to deliver public services [8].

SMS applications are also being used by some countries for collection of complaints. For example, in Philippines, a text messaging system introduced in 2002 to enable the public to report wrongdoings by police officers (as well as by criminals) [4]. The system is developed to provide a low-cost method by which members of the public could be encouraged to report crimes, including crime and wrongdoing by the police and to report corruption in other public agencies, which the police themselves could then investigate. It was specifically marketed as a means for the public to report abusive, bad, and corrupt police officers.

When text message sent by citizens to the system it goes into a computer at the Complaints Referral Action Centre (CRAC). With the mobile phone number recorded, the monitoring team of the Philippines National Police text system informs the sender on the status of the case reported, and on any action taken. CRAC maintains a record of each complaint until that complaint is finally dealt with.

Chapter Three

System Analysis

3.1 Current System

Among many other things one of the chief responsibilities of Addis Ababa City Administration includes addressing the complaints that the residents of the city might have. Social Affairs Process, under Addis Ababa City Administration, is in charge of handling any complaints raised by residents regarding services provided at any level of Addis Ababa City Administration (woreda, sub-city or municipality) or various problems and issues in the city, such as broken pipe lines and road pot holes.

The complainants should go to office in order to register their complaints. There is a complaint registration office in a woreda and kifle-ketema level. Complainants write their complaints in paper and give to workers of the office. The offices are open only during office hours to receive the complaints. The complaints are separated category-wise and then assigned to workers (appropriate department). After the complaint is attended to, the status of the complaint is written in complaint registration paper filled by the complaints.

3.2 Proposed System

3.2.1 Overview of the System

To improve the current complaint handling system by the city administration, we have proposed a web based complaint management system. The system simplifies registration process of complaints. The system enables users of the system to register complaints by using website or by sending SMS message to the system. Complaint information collected from those who come in person will be entered to system by workers who assigned to collect complaint from public.

Users can follow status of the registered complaint online or using SMS. Complaint information provided to the public through website in an effort to better share data about complaint incidents.

The registered complaint automatically forwarded to the office/department in charge of handling the issue. This will reduce time needed to process and provide a solution for complaint.

The system accepts SMS text. The SMS text sent to the system should satisfy predefined pattern in order to be processed by the system. To assure that the system understands the message, the

user should use some predefined pattern. For registration the following is the SMS input format for the system:

<First two characters of name of Kifle-Ketema and First two characters of name of Woreda >

<Details>

If the message is valid, the system will send conformation message to the user with CTN. Otherwise, the system will send appropriate pattern to the user.

To get status of registered complaint, the format is:

<1><CTN>

If the message is valid, the system sends status of the complaint. Otherwise, the system informs the user that the sent CTN is invalid.

The system generates various reports based on criteria set by the user. The criteria might include: complaints category, location ("kifle-ketema" or "Woreda"), specific date or range of dates. The system displays the summary of the registered complaint along with the detail information of registered complaint.

To enable registration of complaints online, the system can be integrated with the website that currently used by the city administration. Website of the city administration is shown in figure 3.1.

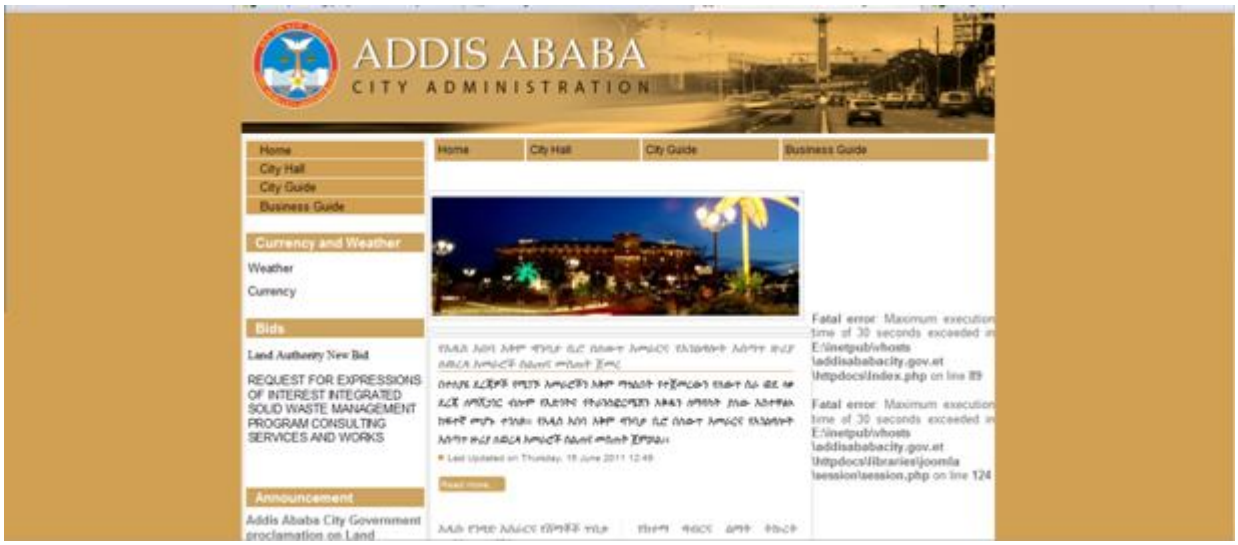

Figure 3.1 Website of Addis Ababa City Administration

3.2.2 Functional Requirements

Functional requirements capture the intended behavior of the system. This behavior may be expressed as services, tasks or functions the system is required to perform. Main functional requirements of the system include:

- Allow the user to interact with server side application using web browsers.
- Allow registering complaints using website or by sending SMS text, sending acknowledgment with CTN after the data is received.
- Enable to process the received SMS text to convert to a meaningful report.
- Allow workers to view registered complaints to update the status of the complaint.
- Enable users to query.
- Allow complainant to track the status of the complaint.
- Allow anyone to obtain details of registered complaints.
- Allow the administrator to manage access to the system.
- Allow to generating different types of reports which include types of complaints registered on specific date, month or year, viewing summarized report.

3.2.3 Non-functional Requirements

Non-Functional requirement is a requirement that specifies criteria that can be used to judge to operation of a system, rather than specific behaviors. The requirements include security, usability, safety, reliability and performance requirements. Non-Functional requirements of the system described as follows;

I. User interface and Human Factor

The system is a web-based application. Complaint form is available online. Users can have access to the system from anywhere using the web browsers (Internet Explorer, Firefox, Google Chrome, etc). We should make the system web pages front-end simple and easy to understand and to interact with. It should be easy and painless for the user to register and view information online.

II. Documentation

To simplify usage of the system a user manual document which contains major points on how to operate the system is prepared. The document will help the system administrator to understand

how to operate the system and to understand the details of the system including database schema, and code of the system. This will help the system administrator to understand the structure of the system to easily maintain the system whenever a problem occurs.

III. Performance Characteristics

As the system is a web-based system, it can be accessed by many users simultaneously. So, the system should be capable of handling as many users as possible while maintaining the performance of the system.

IV. Error Handling

The system is expected to handle errors while input. Errors that occurred from the wrong doing of users will be handled by appropriate exception handling mechanisms. If an error occurs, for instance if required fields missed while the user submit complaint using website, the system will identify the error and notify the user so that he/she can take the appropriate corrections.

V. System Modifications

Over time the system can be enhanced with additional features like including multimedia messages, therefore the application is designed in such a way that whenever any change is initiated to easily incorporate with the system.

VI. Security Issues

The system shall ensue that data is protected from unauthorized access. Any user who wants to login to the system must identify themselves using a login name and password. Only users who are authorized in this way may access protected data. A user in any section will be given the right to access and/or modify the data related to that section. In addition, the system allows only one user to use a single user name at a time. Generally, the system should be secure to a level that, even when it is available online, critical information should not be available to non-authorized users.

3.3 Analysis Model

3.3.1 Actors of the System

Actors represent roles that can are played by users of the system. They are parties outside the system that interact with the system [17]. The list of actors identified for the system along with their description is presented in table 3.1.

Table 3.1 Actors and their Description

Actors	Description
User	A user is a citizen who is interested to register complaint; view the status of registered complaint online; or navigates the website to get information of registered complaints.
Officer	Officer is a person who works in the city administration and either responsible to provide solution for registered complaint or a person who is assigned to collect complaints from those who come in person and complaints reached to the office by email, fax or by letter and enter complaint information to the system.
Administrator	Administrator is a person who is responsible to control overall activity of the system. The responsibility of the administrator includes adding officer, removing officer, modifying privilege of officers, and categorizing complaint to appropriate department or "kifle-ketma".

3.3.2 Use Case Diagram

Use Case Diagram is a graphical representation that describes how users will interact with the proposed system [17]. Figure 3.2 and figure 3.3 shows the use case diagram of the proposed system.

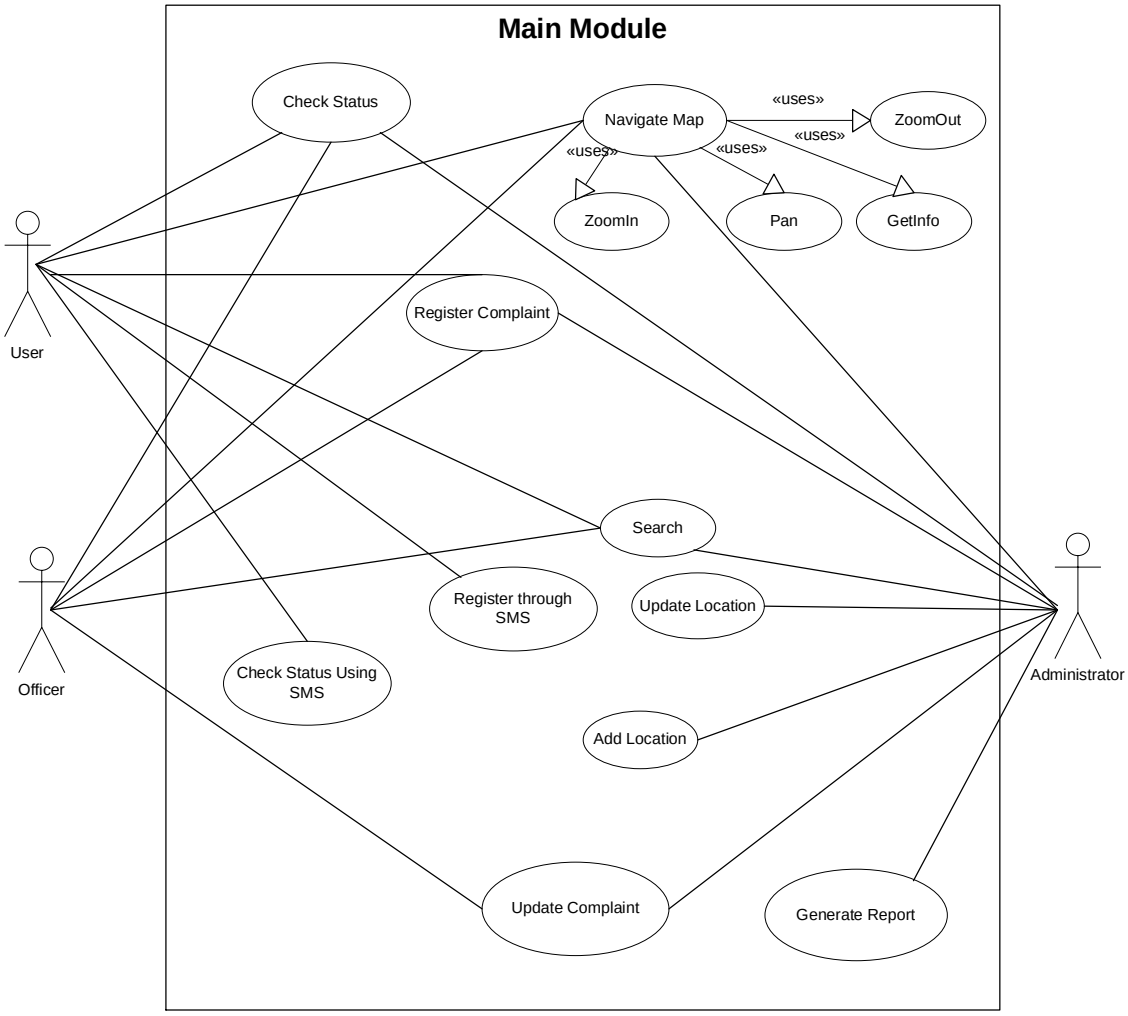

Figure 3.2 Main Module Use Case Diagram

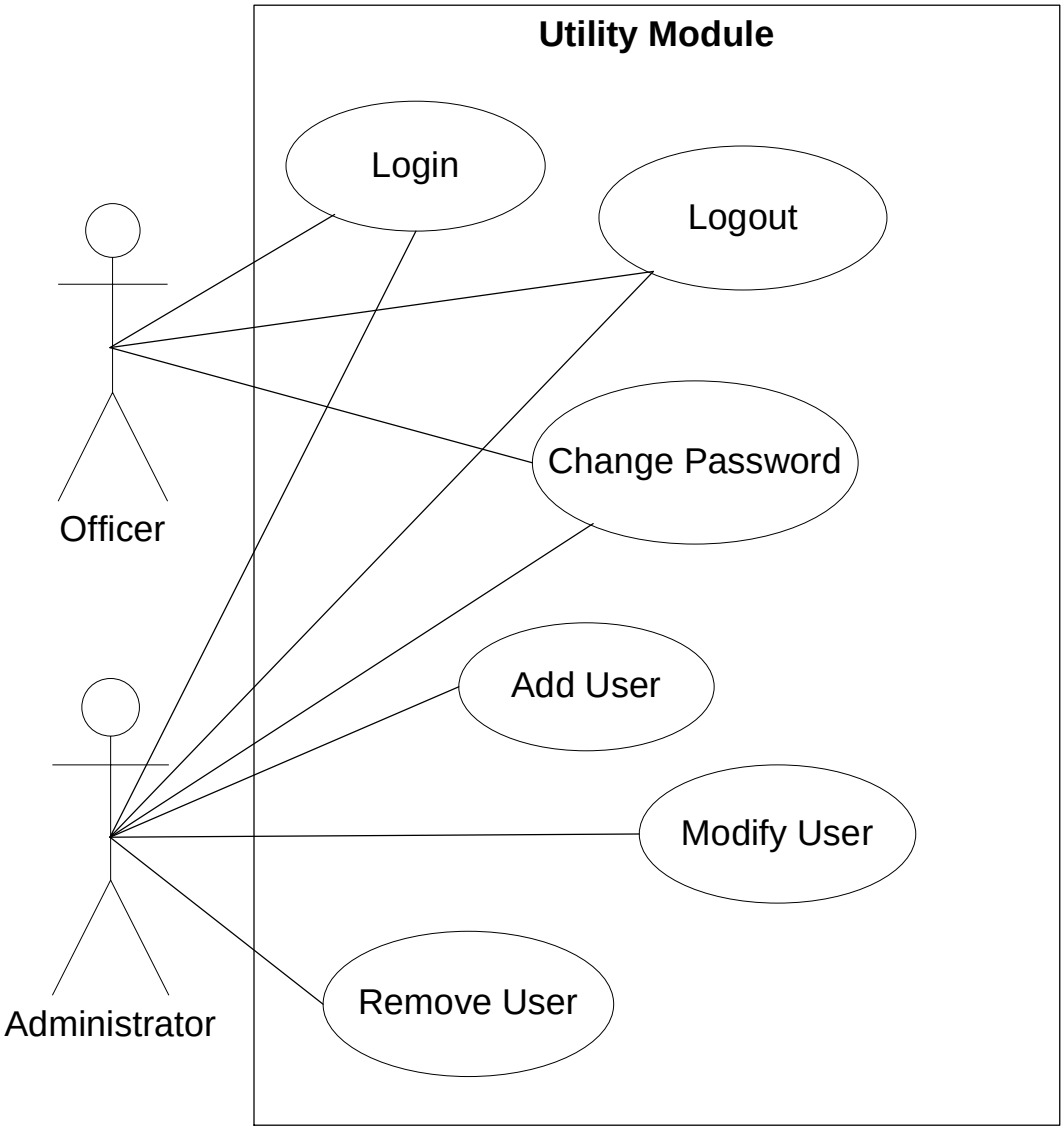

Figure 3.3 Utility Module Use Case Diagram

3.3.3 Use Case Description

From table 3.2 to table 3.20 the description of each use cases are given.

Table 3.2 Description of Register Complaint Use Case

Use case Name	**Register Complaint**
Participating Actors	All
Description	Allows registering complaints.
Entry Condition	None
Flow of Events	1. User access website hosting the application. 2. The user selects “Register Complaint” link. 3. The system displays a form to be filled. 4. The user fills and submits the form. 5. The system prompts for conformation. 6. The user chooses “Yes” button. [A1] 7. The system displays a CTN with acknowledgment. [A2]
A1	If the user chooses “No”, Go to Step 3.
A2	Required fields missed. 1. The system displays appropriate message based on missed filled(s). 2. Go to step 3.
Exit Condition	Complaint form is sent to the system.

Table 3.3 Description of Register through SMS Use Case

Use case Name	**Register through SMS**
Participating Actors	User
Description	Allows residents to register complaints.
Entry Condition	SMS user has to know query pattern.
Flow of Events	1. User sends SMS text to the system. 2. The system sends a CTN with acknowledgment for the sender. [A1]
A1	Invalid SMS pattern. If the SMS text does not satisfy the predefined pattern, the system rejects the message and send back appropriate message along with pattern to register complaint for the sender.
Exit Condition	SMS message stored in database.

Table 3.4 Description of Check Status Use Case

Use case Name	**Check Status**
Participating Actors	All
Description	Once user submits complaint can use CTN to view status of the complaint.
Entry Condition	Valid CTN.
Flow of Events	1. The user accesses the website hosting the application. 2. The user enters CTN on "CTN text box". 3. The user presses submit button. 4. The system displays the status of the complaint. A1
A1	Invalid CTN entered 1. If the entered CTN is invalid, the system informs the user that invalid number is entered. 2. Go to step 2 or exit.
Exit Condition	Status of the complaint is viewed by the user.

Table 3.5 Description of Check Status Using SMS Use Case

Use case Name	**Check Status Using SMS**
Participating Actors	User
Description	Once user submits complaint can use CTN to know status of the complaint.
Entry Condition	Valid CTN.
Flow of Events	1. The user sends SMS message to the system to know status of the complaint. 2. The system sends SMS message containing the status of the complaint to the sender. [A1]
A1	If the sent CTN is invalid, the system informs the user that invalid number is sent.
Exit Condition	Status of the complaint checked by the user.

Table 3.6 Description of Search Use Case

Use case Name	**Search**
Participating Actors	All
Description	Allows getting detail information of registered complaints.
Entry Condition	None
Flow of Events	1. The user access the website hosting the application. 2. The user selects search criteria. 3. The user presses submit button. 4. The system displays detail information based on criteria.
Exit Condition	Detail information of the complaints viewed by the user.

Table 3.7 Description of Navigate Map Use Case

Use case Name	**Navigate Map**
Participating Actors	All
Description	Users of the system can use the GIS map to view the details of the complaint along with the complaint information in a map.
Entry Condition	None
Flow of Events	1. The user access the website hosting the application. 2. The system displays home page with map on the home page. The user can zoom in, zoom out or pan to navigate the map.
Exit Condition	The system displays the map with location information.

Table 3.8 Description of ZoomIn Use Case

Use case Name	**ZoomIn**
Participating Actors	All
Description	Lets user to enlarge the view of the map.
Entry Condition	The webpage is opened.
Flow of Events	1. The user selects “ZoomIn” toolbar and clicks on a map. 2. The system enlarges the view of the location.
Exit Condition	The map is enlarged.

Table 3.9 Description of Pan Use Case

Use case Name	**Pan**
Participating Actors	All
Description	Lets user to put the view of the map to default view size.
Entry Condition	The webpage is opened.
Flow of Events	1. The user selects “Pan” toolbar and clicks on a map. 2. The system displays the map in the default view size.
Exit Condition	The map viewed in normal view size.

Table 3.10 Description of ZoomOut Use Case

Use case Name	**ZoomOut**
Participating Actors	All
Description	Lets user to reduce the view of the map.
Entry Condition	The webpage is opened.
Flow of Events	1. The user selects “ZoomOut” toolbar and clicks on a map. 2. The system reduces the view of location.
Exit Condition	The map view is reduced.

Table 3.11 Description of GetInfo Use Case

Use case Name	**GetInfo**
Participating Actors	All
Description	Provides information for users of the system.
Entry Condition	The webpage is opened.
Flow of Events	1. The system displays complaint information on map with a symbol describing the type of complaint. 2. User can click on the symbol to get information.
Exit Condition	Complaint information is viewed.

Table 3.12 Description of Add Location Use Case

Use case Name	**Add Location**
Participating Actors	Administrator
Description	The administrator adds location name along with description of location to database.
Entry Condition	The administrator logged in to the system.
Flow of Events	1. The administrator selects “Add location” link. 2. The system displays add location form. 3. The administrator enters latitude, longitude, sub city, and location name. 4. The administrator clicks “Submit” button. 5. System does the validation. [A1] 6. The system displays acknowledgment message.
A1	1. The system displays error message if required fields missed or the new location name already exist in database. 2. Go to step 3.
Exit Condition	New location added to the system.

Table 3.13 Description of Update Location Use Case

Use case Name	**Update Location**
Participating Actors	Administrator
Description	Allows the administrator to change the information of location.
Entry Condition	Administrator logged in.
Flow of Events	1. The administrator clicks on “Update” link. 2. The system displays “modify form”. A1 3. The administrator modifies the location. 4. The administrator submits it to the system. 5. The system displays success message. A2
A1	If the administrator selects “Home” link, the system displays home page.
A2	Location name already exists 1. The system displays error message 2. Go to step 2.
Exit Condition	Location information is modified.

Table 3.14 Description of Login Use Case

Use case Name	**Login**
Participating Actors	Officer and Administrator
Description	The Log In use case allows user to authenticate him/her with the system to use functionality of the system restricted to authorized users.
Entry Condition	The user is already registered.
Flow of Events	1. The user presses “Login” link. 2. The system displays login form. [A1] 3. The user enters user name and password and presses submit button. 4. The system does validation. [A2] 5. The system displays pages restricted to authorized users based on privilege of the user.
A1	If user presses “Back”, the system will go back to previously visited page.
A2	Wrong user name or password entered. 1. The system displays error message. 2. Go to step 2.
Exit Condition	The user logged in.

Table 3.15 Description of Logout Use Case

Use case Name	**Logout**
Participating Actors	Officer and Administrator
Description	After using the system, the user should be logged out from the system.
Entry Condition	The user is already logged in.
Flow of Events	1. The user presses “Logout”. 2. The system will go back to home page.
Exit Condition	The user is logged out.

Table 3.16 Description of Change Password Use Case

Use case Name	**Change Password**
Participating Actors	Officer and Administrator
Description	Once the user obtains account, can change his/her password.
Entry Condition	User already logged in.
Flow of Events	1. The user selects “Change password” link. 2. User is prompted for user name and old password, new password and confirmation of new password. 3. The user enters the user name, old and new password and submits to the system. 4. System does the authentication. [A1] 5. The system displays an acknowledgment.
A1	Authorization fails 1. If the old password is invalid, the system informs that user has entered wrong password or if the new password does not match with confirmation password, the system displays error message and allows re-entering of the attributes. 2. Go to step 2.
Exit Condition	Password is changed.

Table 3.17 Description of Add User Use Case

Use case Name	**Add User**
Participating Actors	Administrator
Description	The administrator adds user name and password to database to create new user.
Entry Condition	User with administrator privilege logged in to the system.
Flow of Events	1. The administrator selects “Add User” link. 2. The system displays add user form. 3. The administrator enters user name, password, conformation password, worker name and position. 4. The administrator clicks “Submit” link. 5. System does the validation. [A1] 6. The system displays acknowledgment message.
A1	1. The system displays error message if required fields missed or the newly created account name already exist in database or if the password does not match with conformation password or if the worker has already account. 2. Go to step 3.
Exit Condition	New user added to the system.

Table 3.18 Description of Remove User Use Case

Use case Name	**Remove User**
Participating Actors	Administrator
Description	The administrator can remove if account in use does not needed more.
Entry Condition	Administrator logged in.
Flow of Events	1. The administrator clicks on “Remove User” link. 2. The system populates available user names to a combo box. [A1] 3. The administrator selects user name and clicks “Remove” button. 4. The system prompts for conformation. 5. The administrator chooses “Yes” button. [A2] 6. The system displays success message.
A1	If the administrator selects “Home” link, the system displays home page.
A2	If the administrator chooses “No”, Go to Step 2
Exit Condition	User account deleted from the database.

Table 3.19 Description of Modify User Use Case

Use case Name	**Modify User**
Participating Actors	Administrator
Description	Once the user obtains account, the administrator can change the access privilege of the user.
Entry Condition	Administrator logged in.
Flow of Events	1. The administrator clicks on “Update” link. 2. The system displays “modify form”. A1 3. The administrator modifies the account by selecting old account name and new access privilege. 4. The administrator presses submit button. 5. The system prompts for conformation. 6. The administrator chooses “Yes”. A1 7. The system displays success message.
A1	If the administrator selects “No”, go to step 2.
Exit Condition	Account type of user is modified.

Table 3.20 Description of Update Complaint Use Case

Use Case Name	**Update Complaint**
Participating Actors	Administrator, Officer
Description	Allows updating complaint information and saving changes.
Entry Condition	Administrator (officer) logged in.
Flow of Events	1. The administrator or officer opens "Registered Complaints". 2. Checking access privilege of the user, the system displays registered complaints. 3. The administrator (officer) selects a complaint which status to be changed. 4. The administrator (officer) updates status of the complaint and saves change. 5. The system updates the database to change the information of the complaint.
Exit Condition	The complaint status is changed.

Table 3.21 Description of Generate Report Use Case

Use Case Name	**Generate Report**
Participating Actors	Administrator
Description	This use case describes the event of creating a report based on the information collected by the system.
Entry Condition	The administrator is logged on
Flow of Events	1. The use case activated when the administrator selects "Report". 2. The system displays "View Report Page". 3. The user enters report criteria from drop down menu. 4. The system generates report based on the criteria.
Exit Condition	Report from database is generated and the user view or print the report.

3.3.4 Sequence Diagrams

Sequence diagram of the system is given below.

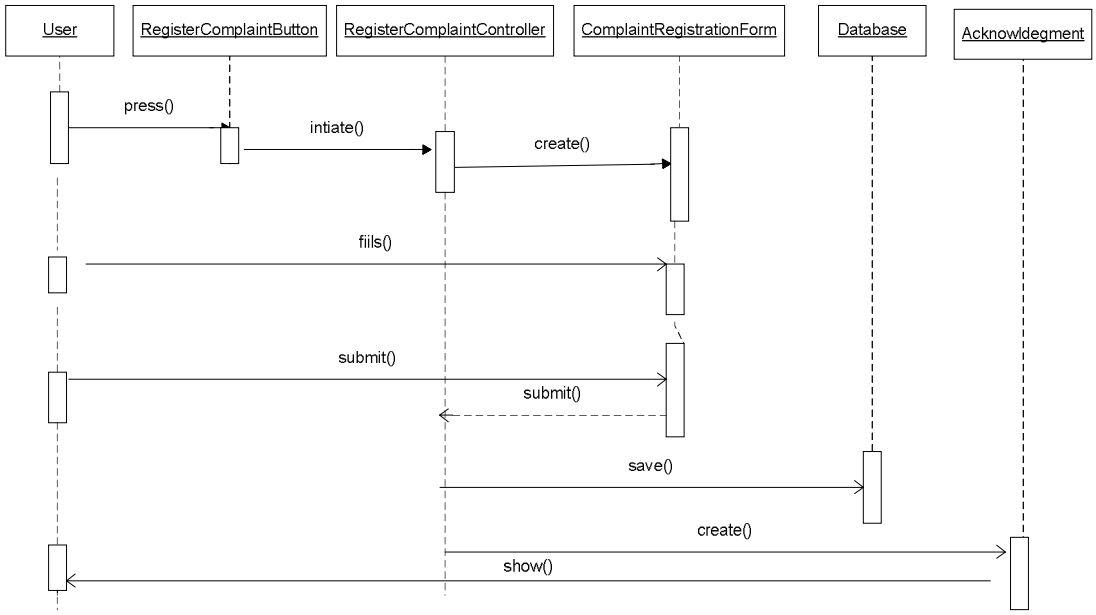

Figure 3.4 Sequence Diagram for Complaint Registration Use Case

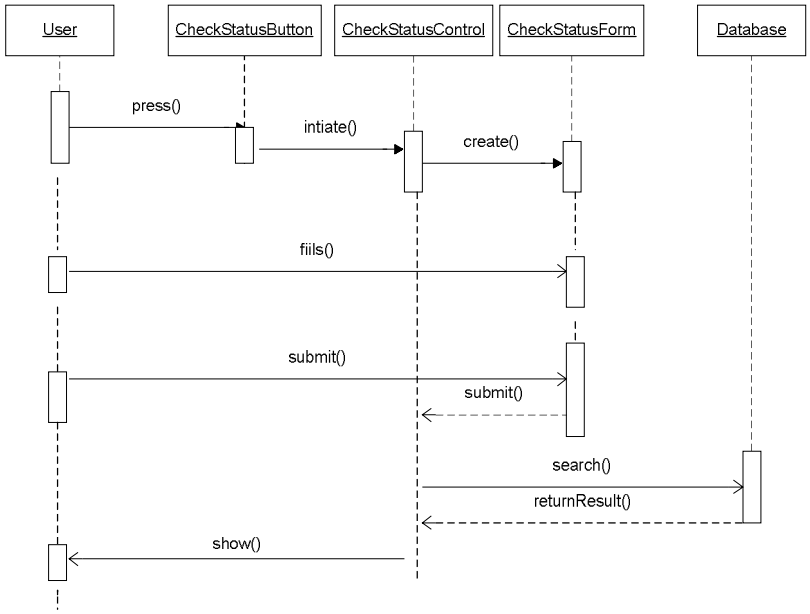

Figure 3.5 Sequence Diagram for Check Status Use Case

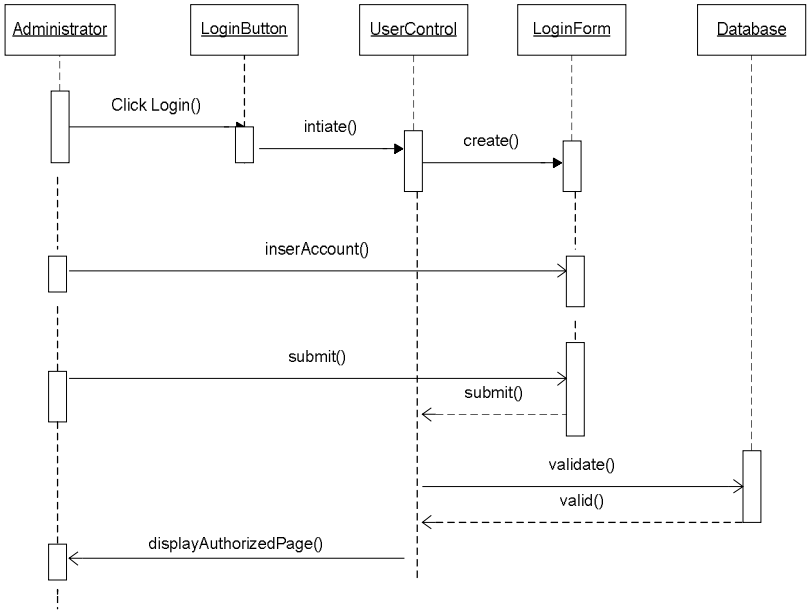

Figure 3.6 Sequence Diagram for Login Use Case

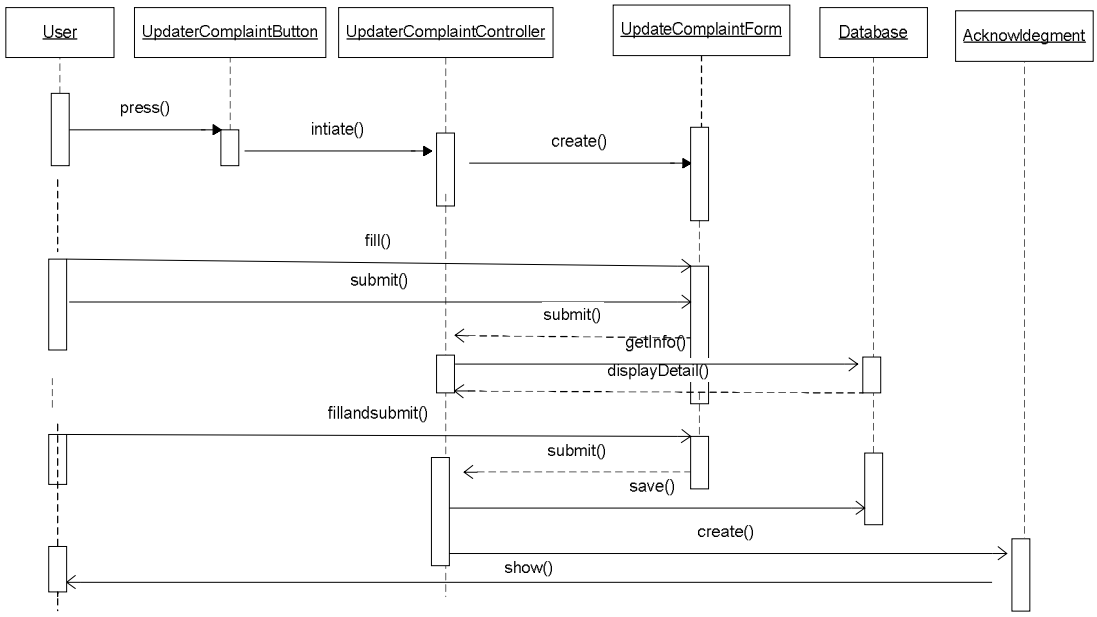

Figure 3.7 Sequence Diagram for Update Complaint Use Case

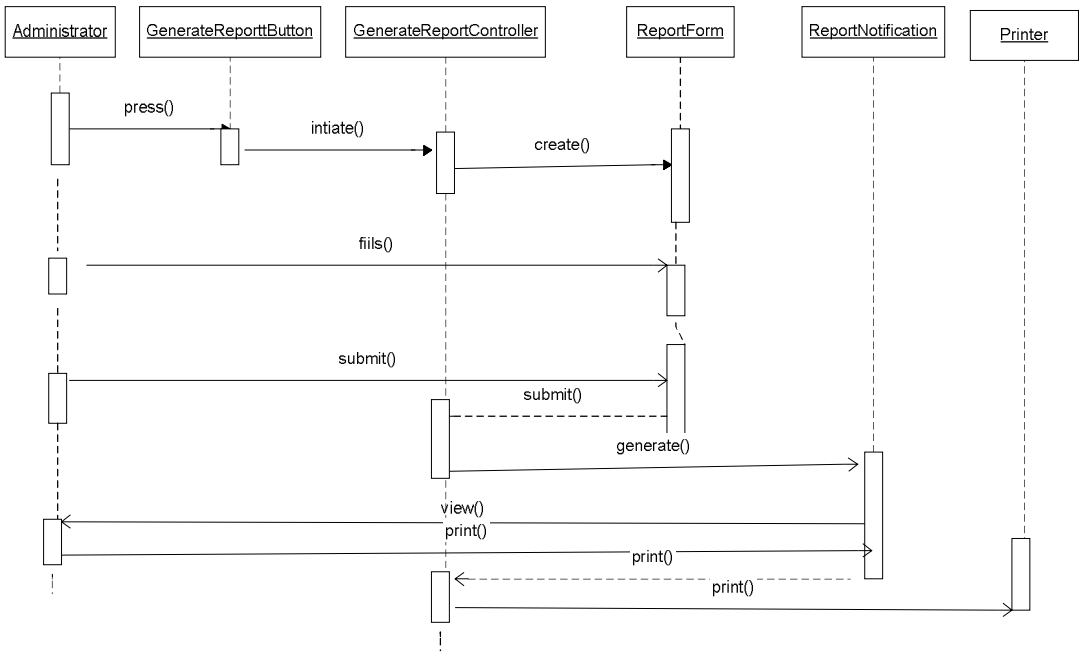

Figure 3.8 Sequence Diagram for Generate Report Use Case

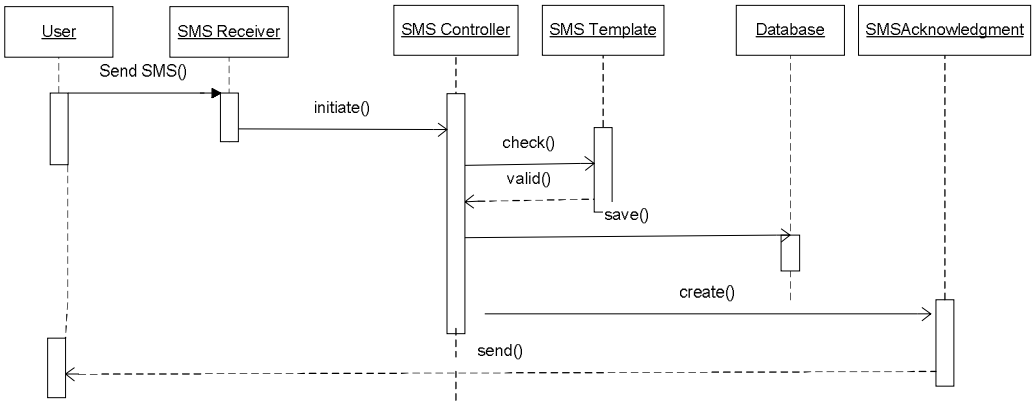

Figure 3.9 Sequence Diagram for Register through SMS Use Case

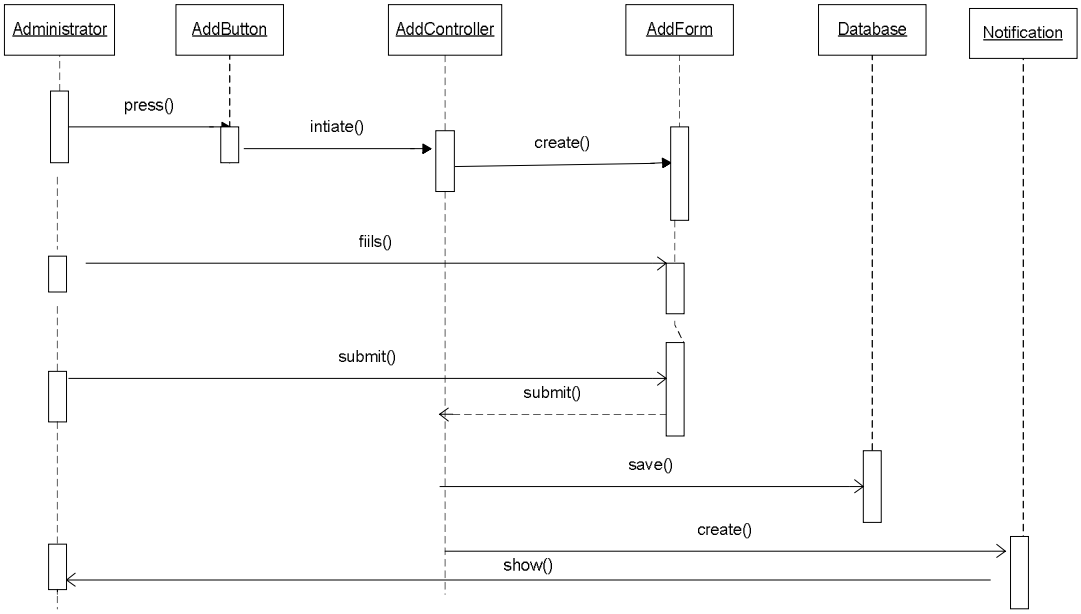

Figure 3.10 Sequence Diagram for Add User Use Case

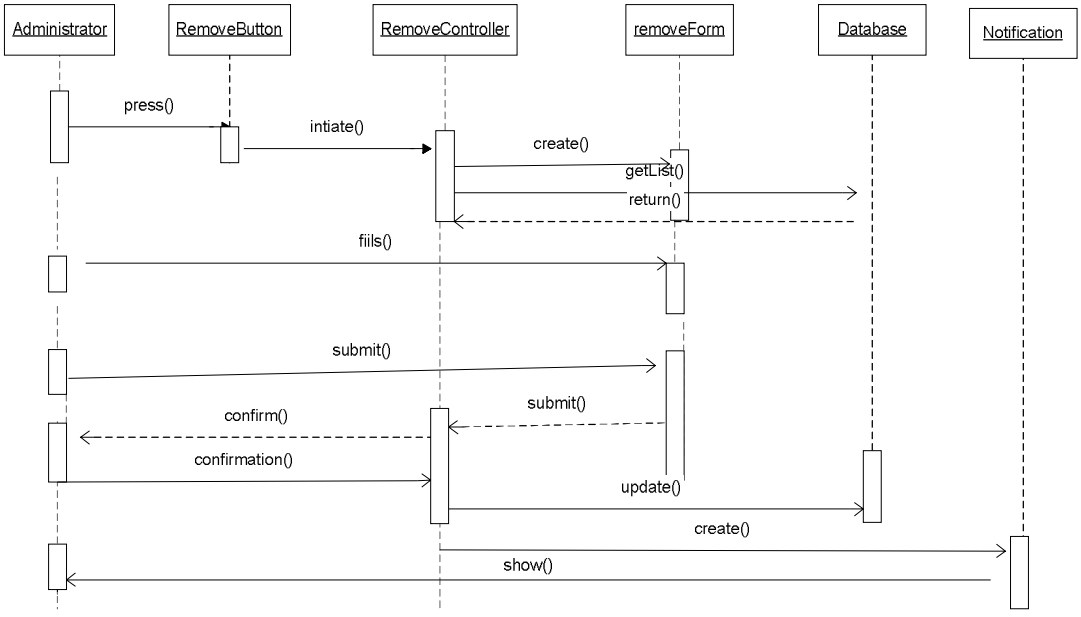

Figure 3.11 Sequence Diagram for Remove User Use Case

Chapter Four

Design of the System

In the first section of this chapter, a class diagram of the system is presented. On the second section, we defined the design goals of the system. Then, sub system decomposition and hardware/software mapping is presented. Finally, a persistence data management is given.

4.1 Class Diagram

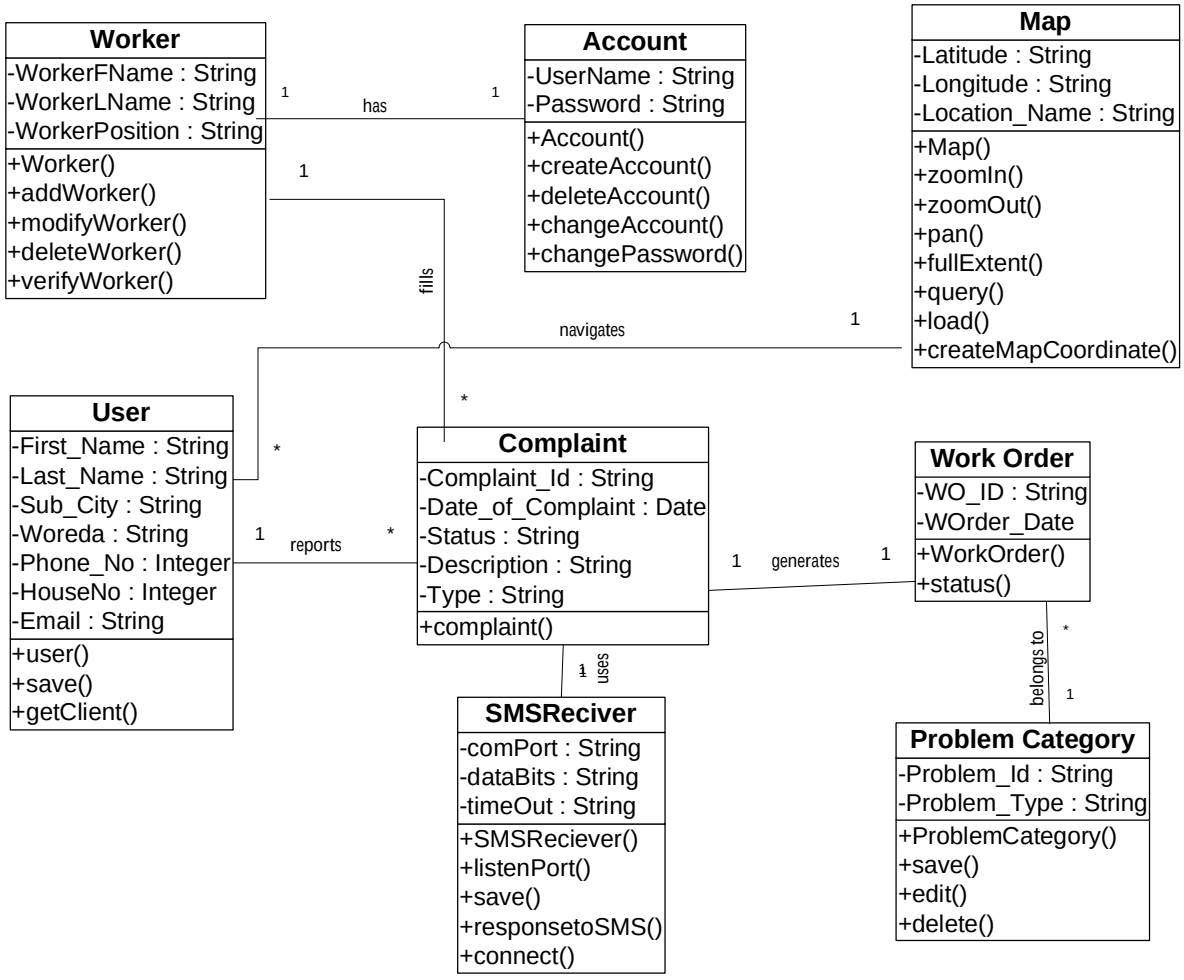

Figure 4.1 Class Diagram

4.2 Design Goals

The design goals represent the desired qualities of the system and provide a consistent set of criteria that must be considered when making design decisions. Design goals of the system are presented as follows:

- **User Interface**: User interface of the system should be attractive and simple so that the user of the system will easily interact with the system. No technical jargon is to be presented to the user at any time. The interface must be designed taking into consideration those who do not work with computers on a day-to-day basis.
- **Documentation**: A document which contains all features of the system should be provided for the users of the system.
- **Performance**: As the system is a web based application, it should be able to serve a number of users which are expected to access it concurrently.
- **Robustness**: The system should be designed in such a way that users cannot proceed having entered invalid input or data in all cases of interacting with the system.
- **Availability**: The system should be available 24 hours a day to enable registering complaints any time convenient for users of the system.
- **Security**: The system must prevent unauthorized users to access part of the system which is restricted for authorized users. Authorized users must be provided with user ids and passwords.
- **Modifiability**: Whenever any change needed to be made on the system it should be possible to easily modify the system. For this purpose, Object Oriented approach should be used so that modification to some part of the system could not affect other parts.
- **Portability: -** The system should be designed in such a way that users can access the server side being on various platforms like Windows, UNIX or Macintosh using common browsers.

4.3 System Decomposition

The System is an aggregate of different smaller components. Each of these components is represented by a subsystem. As shown in figure 4.2, the system is decomposed in to four

subsystems. Each of these subsystems is described followed by a diagram that shows the decomposition of the system in to its subsystems and the dependencies among the subsystems.

1. **Complaint Management Subsystem**

Responsibility of this subsystem is to handle classification of complaints and update of its status.

2. **SMS Management Subsystem**

This subsystem is responsible for accepting SMS text arrived to the system and sending SMS message when new message arrives.

3. **Account Management Subsystem**

This subsystem is responsible for managing the creation, modification and deletion of user accounts.

4. **Report Generation Subsystem**

This subsystem handles the task of generating different reports based on criteria set by the users.

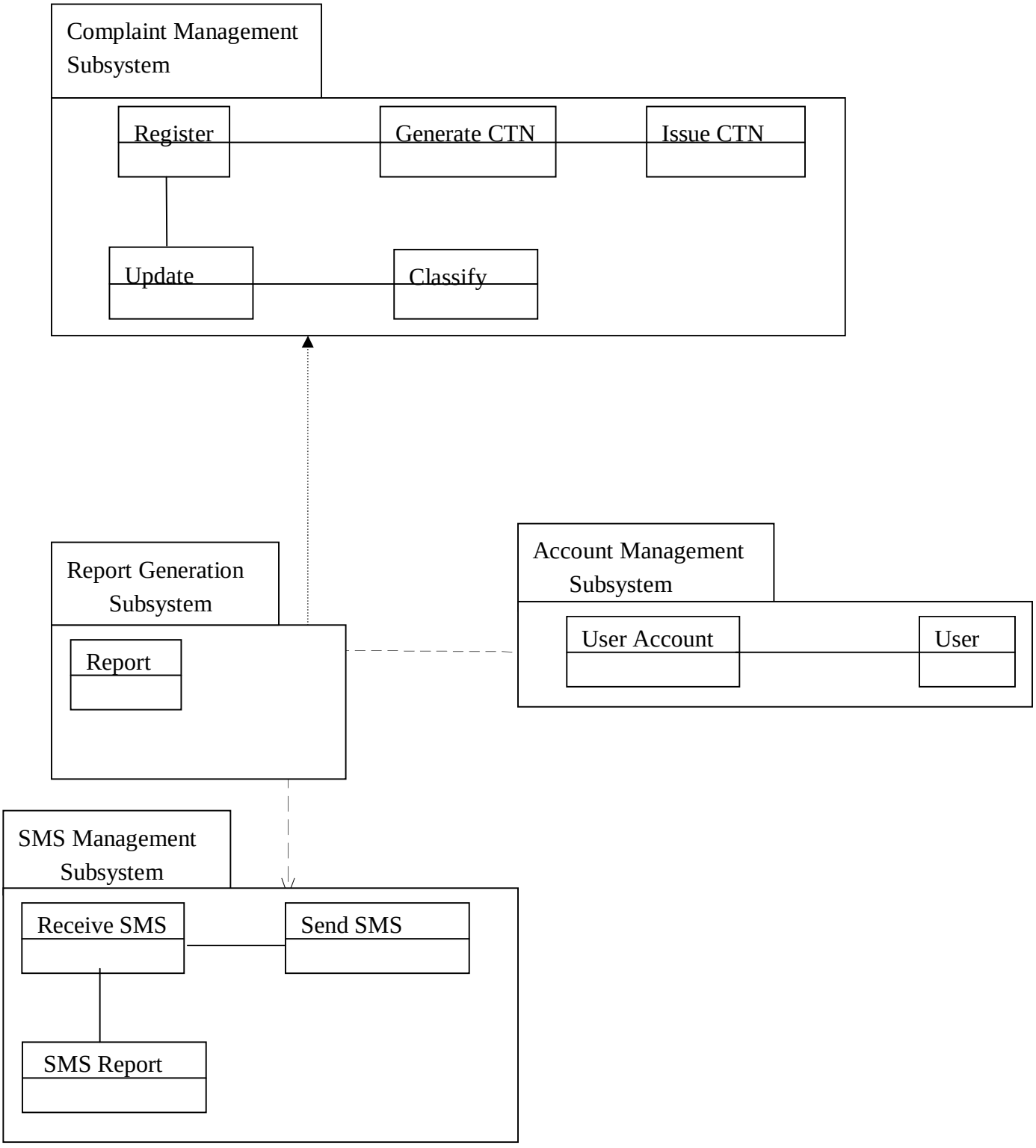

Figure 4.2 Sub System Decomposition

4.4 Hardware/Software Mapping

The system has three main components: the web client, web server and mobile client. User can access the system through a web client. The Web client component defines users of the system which access the system through Http protocol. The client send request using browser software found on a client machine and the system responses for request reaches to the system through Internet. The communication between the client and server is through Http protocol.

The second component of the system is a web server on which an application runs and communicates with database to provide responses for the user. The third component is mobile user which sends SMS message to the system. The message sent to the system reaches the system through GSM network. The system accepts and sends SMS message through GSM mobile attached with the computer or using GSM modem. Figure 4.3 shows the architecture of the system.

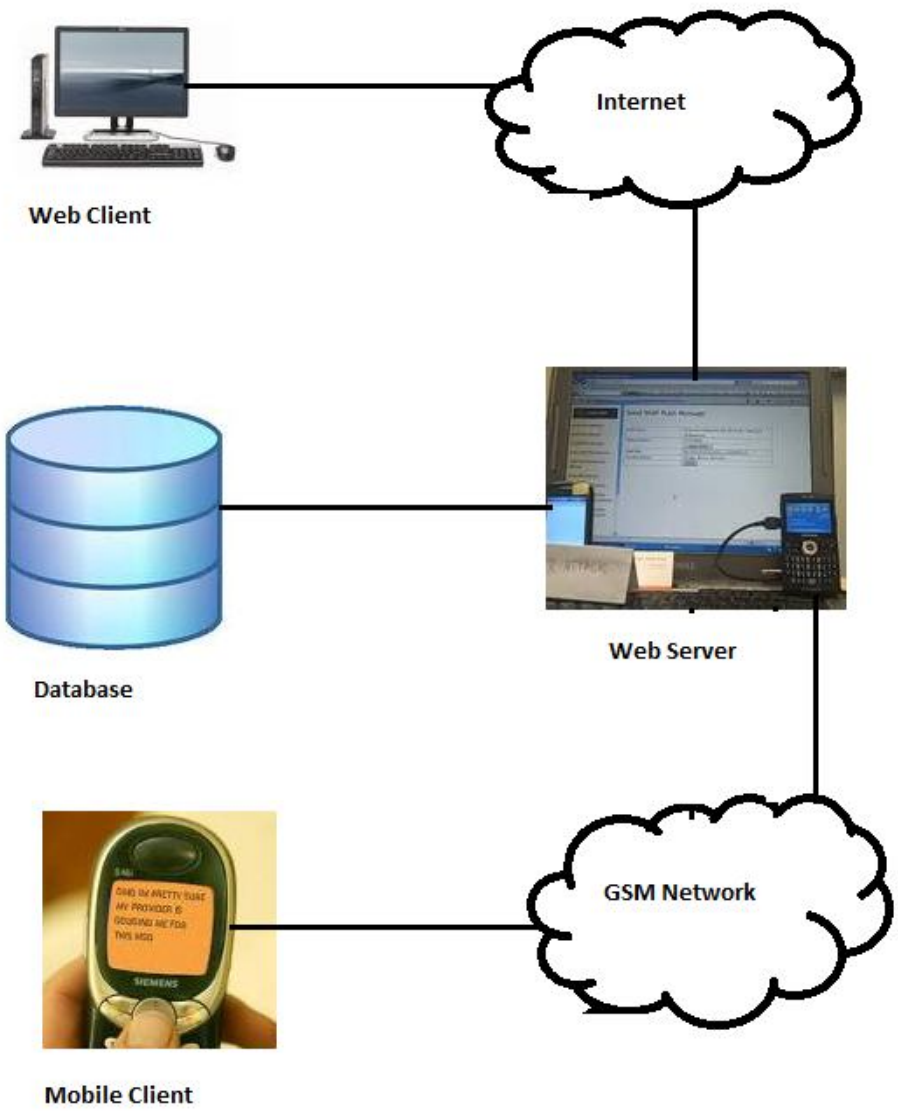

Figure 4.3 System Architecture Design

Deployment diagram, which consists of nodes and their relationships, is used to visualize the topology of the physical components of a system where the software components are deployed. The deployment diagram of ECoMS is shown in figure 4.4.

Browser component, in the client node, is responsible for browsing applications which found on a web server. The components on a web server node are a web application developed using Visual Studio C# programming language and Active Server Pages (ASP.Net), and an

application developed using C# to accept and send SMS message. The database server contains the ECoMS database. MySQL 5.5 is used to maintain the database. ADO.Net is responsible to create a connection to the ECoMS database, manage communication between the application and the ECoMS database.

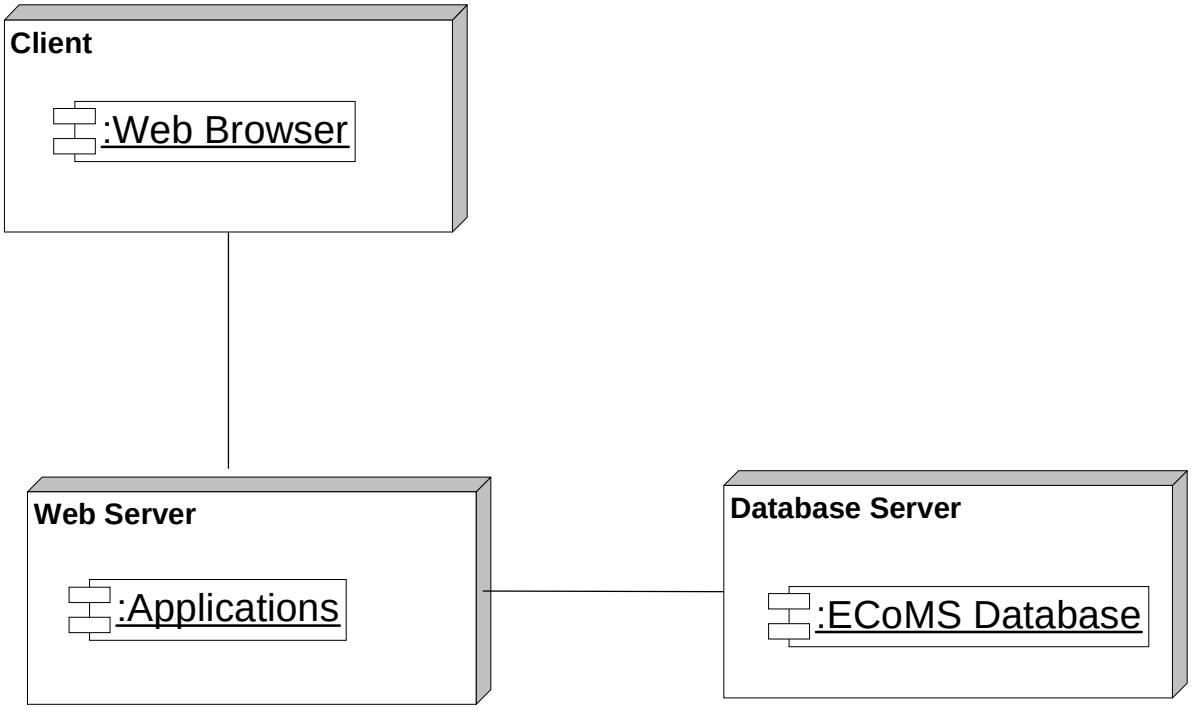

Figure 4.4 Hardware/Software Mapping

4.5 Persistent Data Management

ECoMS has got several objects that need persistence data storage. The objects have links between them that means they happen to share attributes. Considering the number of times it is needed to make complex queries on the database, a relational database system is chosen to effectively manage large dataset the system has to store. The relational database design of the system is shown in figure 4.5.

The user account information, which keeps data of the user name, pass keys and user levels, is the one that will enable the system to provide the access rights according the user level.

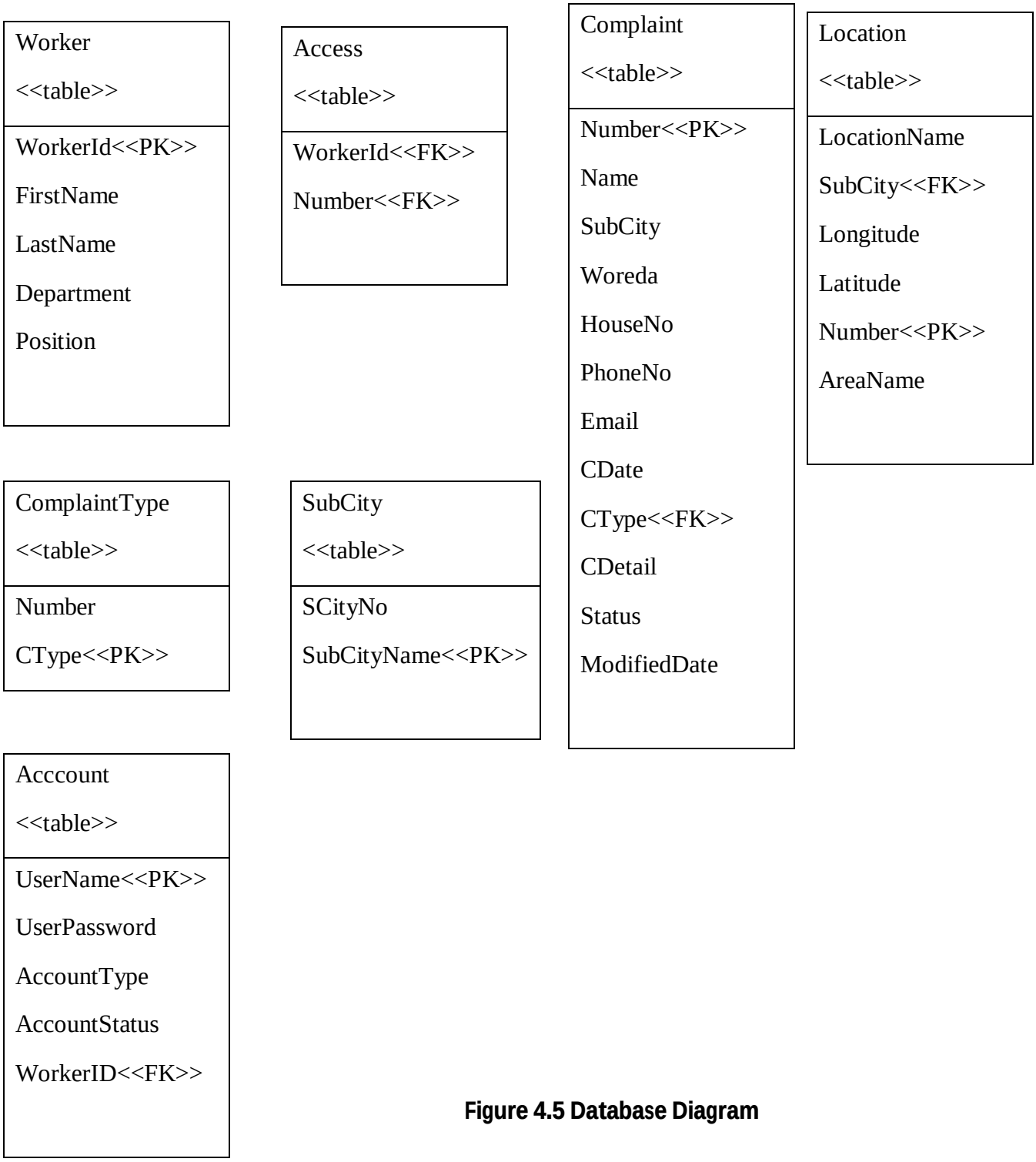

Figure 4.5 Database Diagram

Chapter Five

Prototype Development

In this chapter, tools that have been used for the implementation are described and prototype of the system is presented.

5.1 Programming Tools

The project is composed of three main applications. The first one is a web application, the second application is an application which handles SMS messages and the other one is a GIS application which presents data on a map. To achieve the objective of the project, several tools and technologies were used. The tools used to develop the system are described as follows.

ASP.NET

ASP.NET is a web application framework developed by Microsoft that can be used to create dynamic and interactive web applications using a visual interface [26]. It allows using a full featured programming language such as C# or VB.NET to build web applications easily, and it features server controls that can separate the code from the content. ASP.Net is used to develop the web application.

ArcGIS 9.3

ArcGIS is used in this project to view spatial data, to create layered maps, and to perform basic spatial analysis.

AspMap

AspMap is a set of high-performance, mapping component for embedding spatial data access, display and analysis capabilities in ASP.NET [19]. To integrate the map created using ArcGIS with the web application developed using ASP.Net we used AspMap.

C# Visual Studio 2008

C# is an object-oriented programming language developed by Microsoft Corporation designed for the Microsoft .NET framework [25]. In this project, the language is used for developing the server side of the web application and for development of an application which accepts and sends SMS message using mobile phone which connected with computer.

Internet Information Service (IIS)

Microsoft's IIS web server (which is used to make a computer a web server) is by far the most common platform for ASP.NET websites in order for an ASP.NET website to function correctly [26]. For the project IIS has been used.

MySQL Database Management System (DBMS)

MySQL is a freely available open source relational database management system that uses Structured Query Language [7]. To store the persistent data of the system, MySQL 5.5 database management system is used.

5.2 The Prototype

The system is composed of a web application which handles the business logic of the system and a desktop application which accepts and sends SMS message. In this section, screen shots of the major components along with their description are given.

5.2.1 Home Page

When user accesses the website hosting the application, the system displays home page of the website. The home page of the website is shown in figure 5.1. The home page consists of hyperlinks to open different pages, options for searching, and GIS map of Addis Ababa City along with complaint information. Detail information of the registered complaint is displayed on the map when user clicks the symbols found on the map. This simplifies obtaining information of registered complaint along with the location of registered complaint.

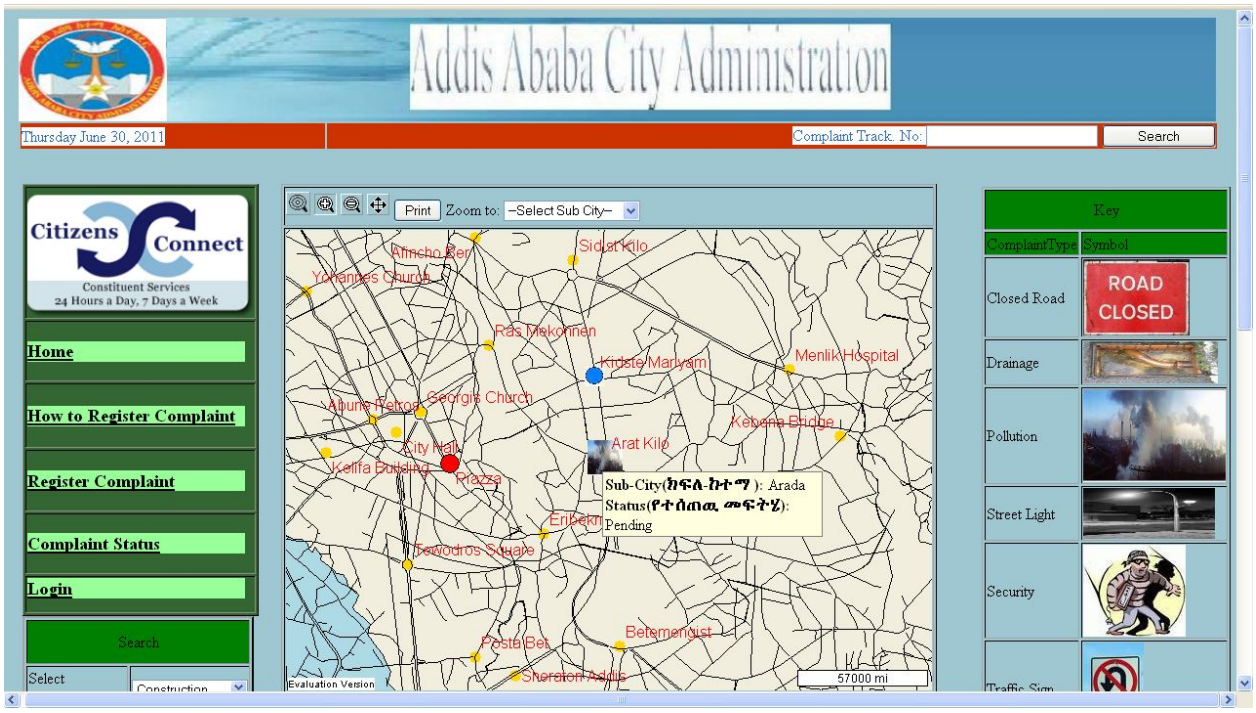

Figure 5.1 Home Page

5.2.2 Complaint Registration Page

The user can register a complaint using a page displayed when “Complaint Registration Page” is opened. The page is shown in figure 5.2. The user can use a Google map integrated with the system to identify exact location of the complaint when fills the form or can choose one of the locations listed on “Area Combo Box” to specify location of the complaint. After filling the form when the user submits the complaint, the system generates CTN and displays the CTN with acknowledgment. This shows that those users who have Internet access can easily register complaint using the website.

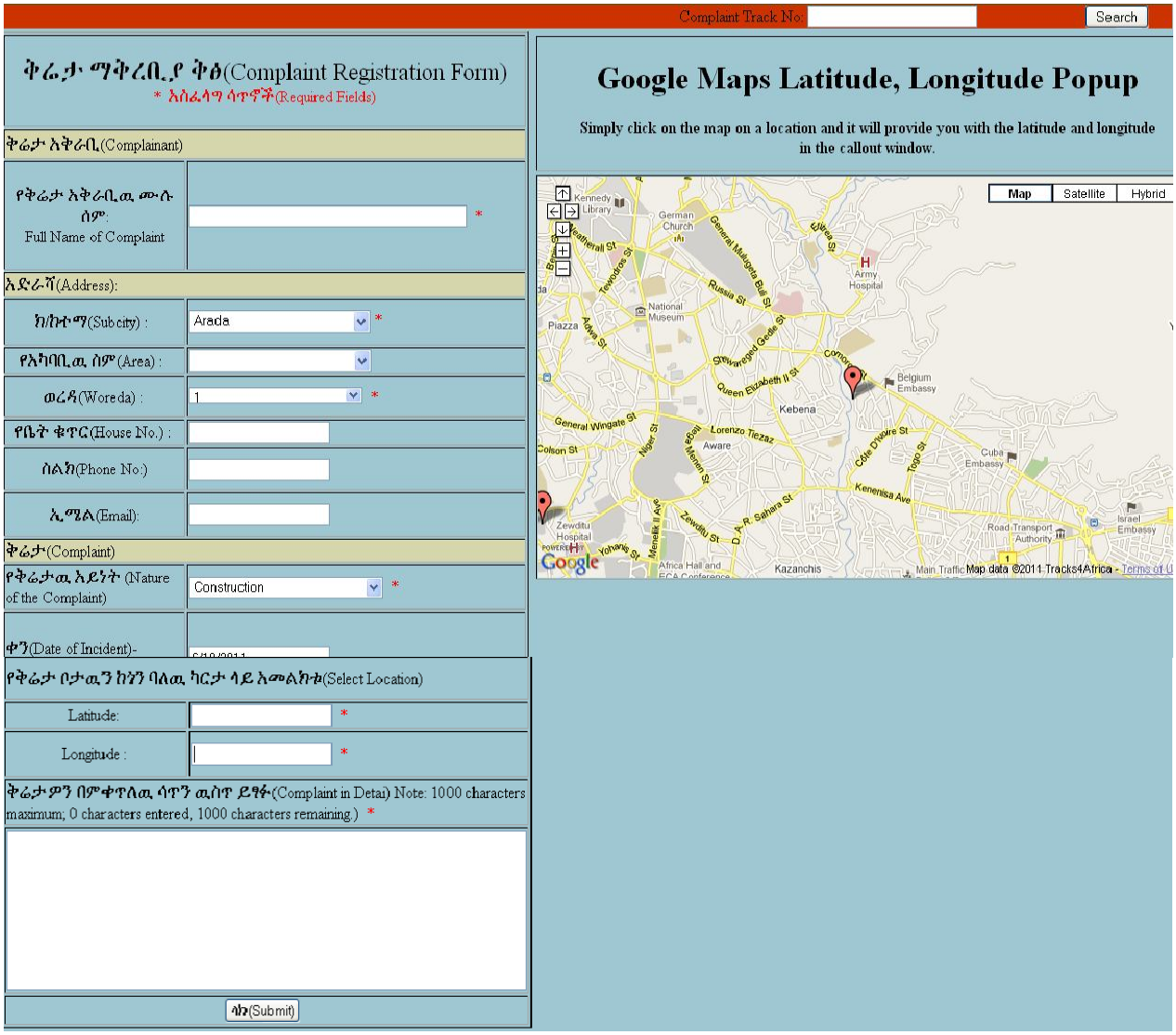

Figure 5.2 Complaint Registration Page

5.2.3 Complaint Searching Page

To follow status of the complaint, the user can use the website. This avoids necessity of going to office to know the status of the complaint. On most of the pages there is a text box which is prepared for searching status of complaint. In addition to this, a separate page that can be used for checking status of complaint is prepared. The user can use either of them to know status of registered complaint. The screen shot of the page is shown in figure 5.3.

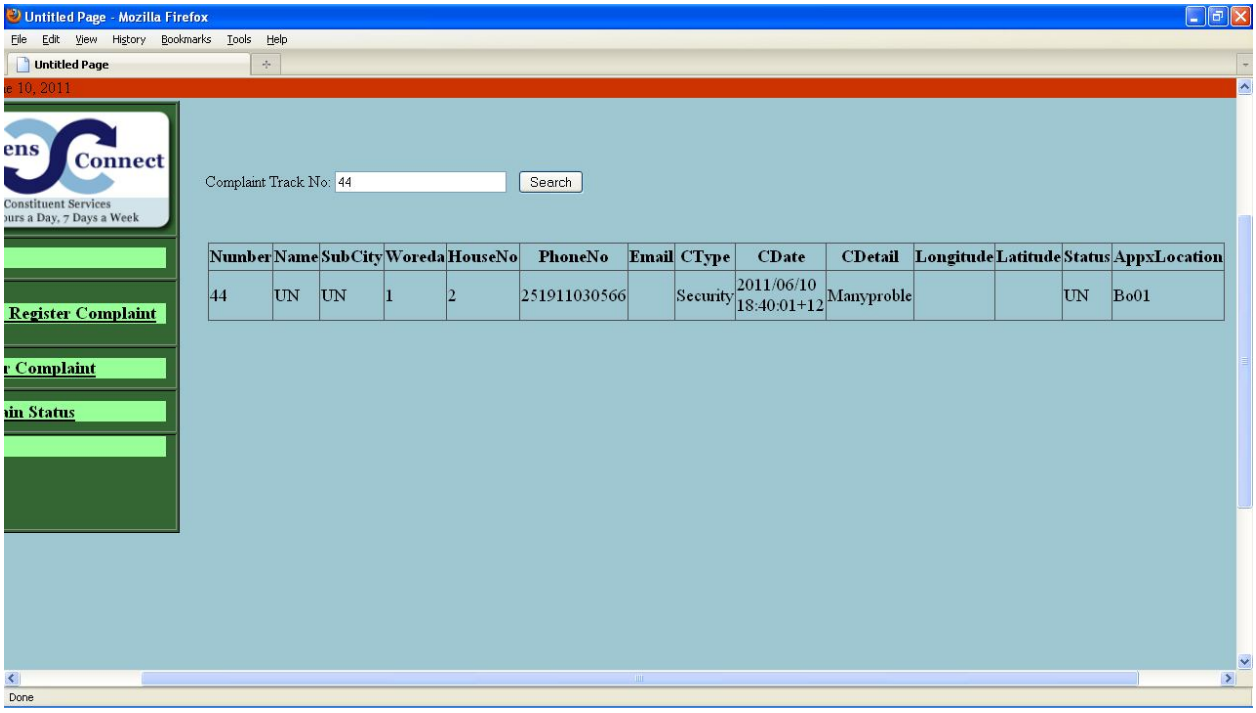

Figure 5.3 Complaint Searching Page Screen Shot

5.2.4 Administrator Page

When user with administrative privillage logged to the system and chooses “Update” from “Complaint” menu, a page shown in figure 5.4 is displayed. The administrator can easily modify staus of the complaint by choosing “Edit” button found on the first column of the displayed form. For other users, when they logged on to the system, the system checks the department of the worker and dispalys a page which contains a complaint information related within that deparment and they can update the displayed complaint using “Edit” button found in the first column of the form.

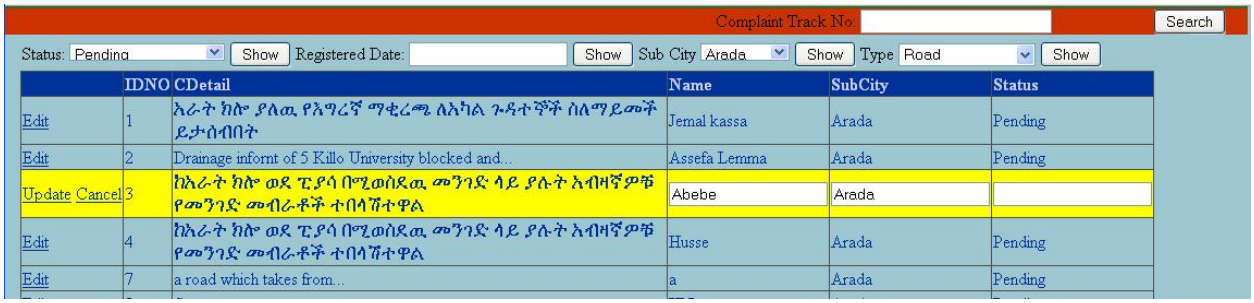

Figure 5.4 A Page Displayed When User Logged on With Administrator Privillage

5.2.5 Add Location Page

The page shown in figure 5.5 allows the administrator to add detail information of locations.

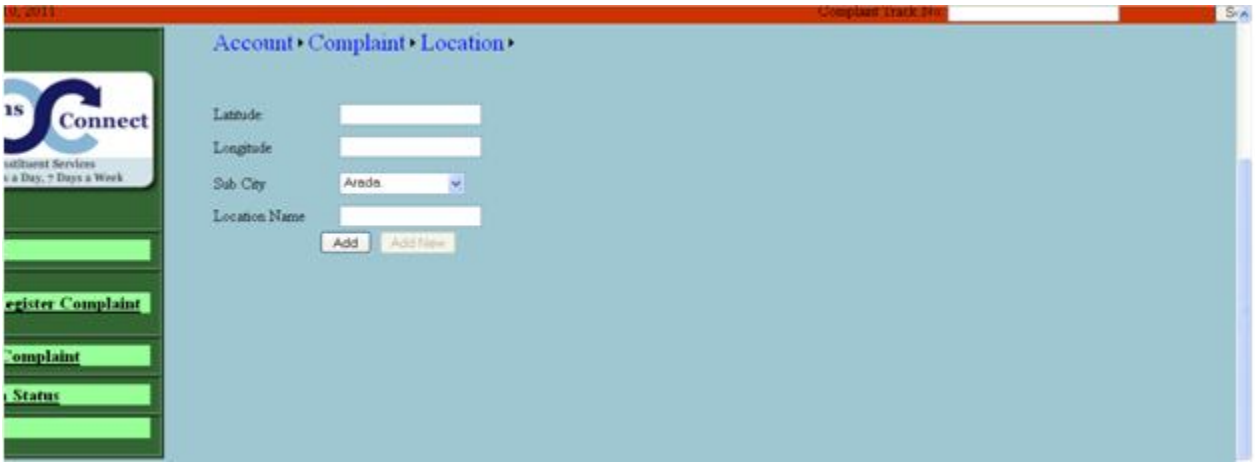

Figure 5.5 Add Location Screen Shot

5.2.6 Report Generation Page

The system simplifies generation of different types of reports. For example, if a report of complaints registered on a specific sub city along with the type and status of complaint is needed, it can be easily generated using "ReportbySubCity" page. The page, as shown in figure 5.6, contains an option to select sub city and date. After selecting the report criteria when the user presses "Generate Report", the system generates the report. Other pages which use different criteria to generate a report also prepared.

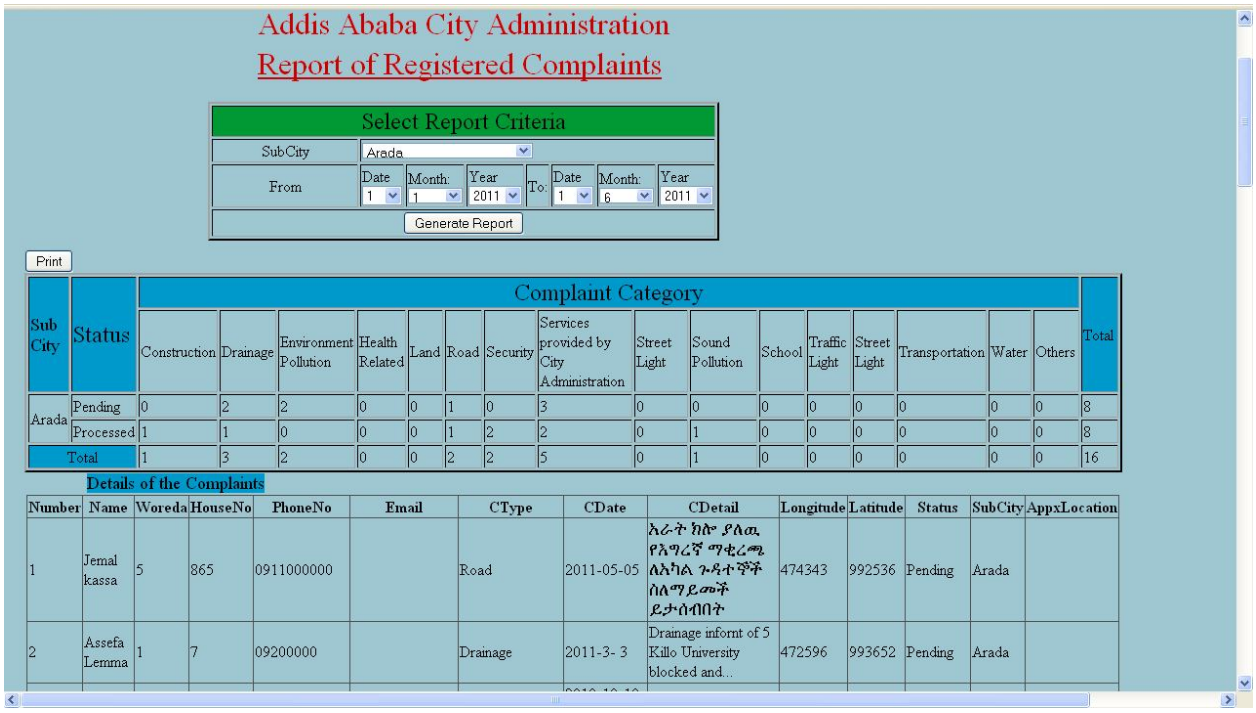

Figure 5.6 Generate Report Screen Shot

5.2.7 SMS Message Receiver Window

When user opens the SMS receiver application, a form shown in figure 5.7 is displayed. The system starts receiving SMS message when a user connects mobile phone with a computer hosting the application, then selecting port of the mobile phone when presses “Connect” button. Once the system connected with the GSM modem, when new SMS messages arrives it automatically stores it to database and sends acknowledgment message to the sender or sends appropriate message for the sender if the message does not match with the defined pattern. The user can also use option found on top right hand side of the application to send SMS message whenever it needed to send SMS message.

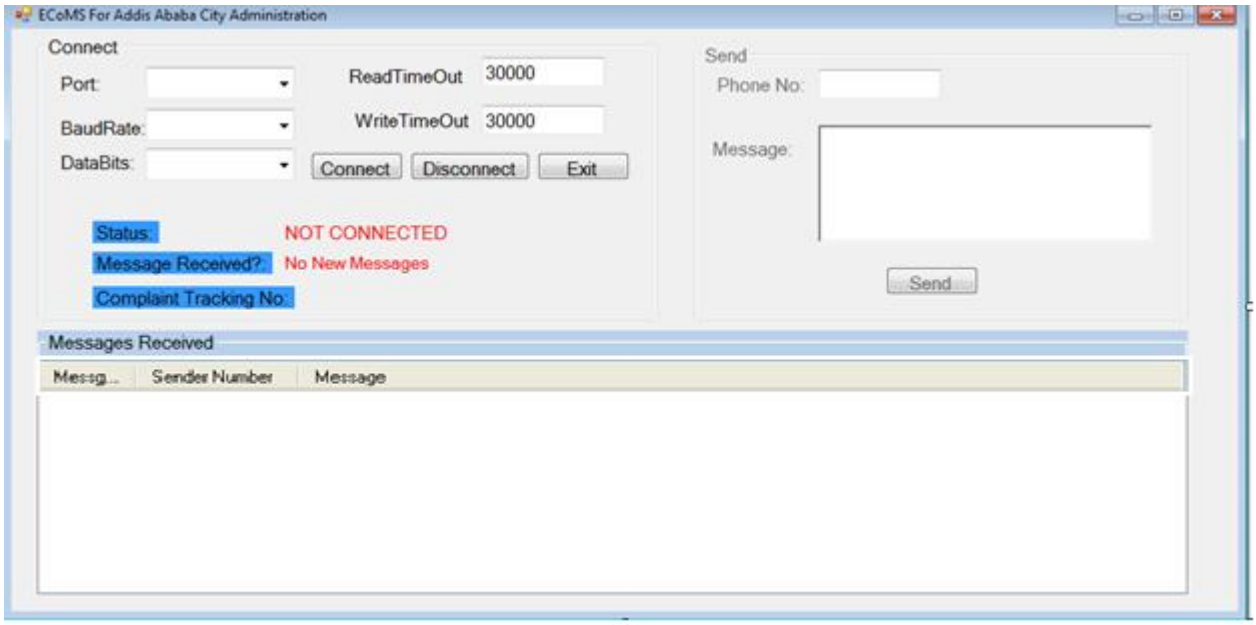

Figure 5.7 SMS Message Reader Window

Chapter Six

Conclusion and Future Work

6.1 Conclusion

Reaching large group of people and colleting complaints from them then giving a solution for the collected complaints is not an easy task. The problem becomes worst when collection and processing of complaints is done manually. Addis Ababa City Administration currently uses manual data collection and processing to handle complaints. As seen in different parts of world, use of ICT in government system improves services provided for citizens. To alleviate the problems observed in the current complaint management of the city administration, a web based complaint management system is developed for the city administration.

In this project, we first study the current system to get necessary information to have a clear view of the existing system. This is done using observation, interview and revision of documents that the city administrator currently uses to handle complaint. We interviewed workers of the city administration and residents of the city. Clear view of the current system is obtained from gathered data. Based on requirements gathered, analysis and design documents are prepared. Then we used appropriate tools to implement the system.

The system shall ensure the city residents to register and follow complaint status using website or by sending SMS message and view the registered complaints on a GIS map. This enables to collect complaints from large group of people. Moreover, the system reduces the time needed to collect and process complaints.

6.2 Future work

Some features can be added to the system to enhance functionality of the system. One of the major features that can be added to the system is incorporation of natural language processing techniques to the system to enable understanding of SMS messages reaches to the system so that it is possible to identify nature of complaint, its location and name of complainant from plain text reached to the system without setting pattern.

Currently, the system accepts only SMS messages. The other major work can be adding a feature to the system so that it is possible to accept multimedia message in addition to SMS text message.

With the increasing wider acceptance and usage of smart phones worldwide, it is expected that the number of smart phone users in the country will increase. The other major work can be developing an application which can be installed on smart phones and has a complaint registration form and GIS map to simplify identification of complaint location.

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Appendix

Interview Questions

The following interview questions were used to understand the current complaint collection and management method used by the city administration.

1. In a day how many complaints reaches to your office?
2. Which types of complaints are frequently reaches to your office?
3. How complaint is collected from complainant?
4. Is there any precondition to register complaints?
5. How you verify the appropriateness of registered complaint?
6. What kind of complaints you collect?
7. At a time how many complaints can be registered by a person?
8. What are the steps to give a solution for registered complaint?
9. In average how many days it takes to give a solution for registered complaint?
10. How the registered complaint is stored?
11. Does your organization use any type of software for the purpose of accepting or analyzing reports accepted from the public?

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

Declared by: Name: Abdi Mulatu

Signature: _____

Date: _____

Confirmed by advisor: Name: Dr. Fitsum Admasu

Signature: _____

Date: _____