Design and implementation of Crisis and Emergency Reporting and Response system using SMS

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2. ___________________ ___________________
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Effective and reliable communication plays a critical role in helping organization engaged in the area of crisis and emergency reporting and responding. Addis Ababa Police Commission is an organization working in the area of responding to crisis and emergency related incidents in Addis Ababa. When faced with crises and emergency situations, for the purpose of reporting different type of incident, the general public is limited to using phone calls. Being limited to using phone calls, the Police Commission is facing different difficulties mainly in the credibility of the report, since phone calls are mostly anonymous false and unreliable reports are being received. This affects the action taken to the incident in managing available resource effectively. Therefore there is a need to enhance the communication medium by using an additional means of reporting crises and emergency incidents.

The use of mobile technologies are so broadening that people are depending on this technology in their day to day activities to effectively communicate and collaborate with each other whether handling their personal or business activities. One of the features of mobile technologies that have come to be broadly used is SMS (Short messaging Service) which enables the user to send and receive text messages using mobile phones. Different SMS based applications are currently being developed globally by different organizations for different purposes in the business world, health, monitoring, supply chain management etc.

After conducting a survey on the current condition of crises and emergency reporting and responding at Addis Ababa Police Commission, and identifying the available current technologies, we have developed a system called MobiRep that can alleviate the problems that is more efficient and economical.

MobiRep is a system engaged in accepting reports from any mobile phones using the SMS. In addition to accepting reports, the system can also send SMS or broadcast bulk SMS to a group or multiple devices that can accept text messages. After accepting a report, the police can also use the broadcasting feature of the system to take necessary action to an incident by dispatching resources. Additionally, the system will also be able to send SMS alerts in warning subscribed users about a major incident or criminal activities that occurred or may occur near their neighborhood. Generally the system to be developed will play a good role in being an additional means of accepting real-time reports and also help by filling the communication gap in reporting and responding to a crisis, crime or an emergency.
1. Introduction

1.1 Overview

When faced with crisis or emergency situation effective, real time and reliable means of communication plays a very critical role in accepting and responding to an incident. One of the organizations engaged in responding to crisis and emergency related incidents in our city is the Addis Ababa Police Commission. For the purpose of handling crisis and emergency related incidents, the police commission, accepts reports from the general public and responds to the report by forwarding the information to the responsible party to take necessary action. The information may be passed to the fire departments to handle fire related reports, field police officers for crime related reports, traffic police for traffic related accident and hospitals for ambulance requests.

With a growing number of population here in Addis Ababa, the means of reporting crisis and emergency incidents is limited to making a phone call to a specified number or reporting in person. No other additional type of technology is used to accept or receive emergency or crisis reports from the population especially for people with hearing or speech disabilities. In addition to accepting reports, responding to an emergency like dispatching or allocating resources to a specified location is only done by using phone calls or radio based communication.

When a major disaster or crisis occurs in the country, organizations like NGOs, international organizations that are responsible for their employee’s safety [14] [15] [16] and even local tour agencies that are responsible for the safety of their tourists distributed thought out the country needs real time information to take necessary measures based on their company policy. They should not wait for the media like the radio or television to find out about a major incident. Not only that but the general public who are close to a major incident are entitled to be informed on a real time basis.

Nowadays, the use of mobile technologies are so broadening that people are depending on this technology in their day to day activities to effectively communicate and collaborate with each other whether handling their personal or business activities. Here in our country, the Ethiopian Telecommunication Corporation is working hard in expanding the mobile network coverage to increase the number of mobile users throughout the country.
One of the features of mobile technologies that have come to be broadly used is SMS (Short messaging Service) which enables the user to send and receive text messages using mobile phones. SMS technology is being broadly used from commercial applications to health applications. Here in our country, SMS messaging is being widely used for socializing purpose where people exchange text message for birthday wishes, holiday wishes, and making appointments etc.

Different SMS based applications are currently being developed globally by different organizations for different purposes in the business world, health, monitoring, supply chain management etc. One type of application that has come to our attention is an SMS application used for collecting qualitative and quantitative data collection from remote areas where frequent travelling and paper based reporting is not feasible. This application makes it possible for managers and coordinators of the host organization to make fast and better decision in allocating limited resources, handling surveys, monitoring ongoing projects, status report etc.

The idea of the system to be developed is to design and implement a web based SMS application where anyone with a mobile device with SMS capability can report or ask for assistance when faced with a crisis, crime or emergency situations. This system will especially be convenient to the population who are deaf, hard of hearing or with speech disabilities. This system will not be expected to replace the current means of accepting reports. Instead, by providing two-way communication, it will be expected to fill the communication gap in reporting and responding to a crisis or emergency related incidents on a real-time basis.

In addition to enhancing the means of communication, the system will enable users with proper credentials to monitor the overall communication process from any location where internet is available. This is possible by enabling them to view incoming data as it arrives and also be able to send text messages to users when necessary. In addition to monitoring, analysis can be made on the received reports in defining patterns of an incident making it possible to make reasonable predictions and preparedness.

Different organizations whether they are NGO’s (Local or international), Police, government security agencies, fire departments etc. will be able to use the system handling safety and security related tasks.
1.2 Problem Statement

It has been stated that communication plays a great role in helping organizations engaged in emergency response to take necessary measures within a limited amount of time. Currently, emergency reports are accepted mainly using phone calls. No other means of accepting a report is used for crisis and emergency reporting purposes in Ethiopia. Since phone calls can be anonymous, it increases the level of accepting false reports. This will waste the time and resource of the organizations that are required to respond to the emergency events.

In particular, in the Addis Ababa Police Commission, the reporting to emergency has several problems. First, those who report to a crisis and emergency using phone calls do not have a registered identity. Hence, it is difficult to trust their report. Second, it is difficult for the reporters to express the location where the crisis happened or the emergency need is required. Even reporting among the police personnel requires expensive radio devices which are scarce in number.

In this work, we try to address the problems with more efficient and economical solutions.

1.3 Objective

1.3.1 General objective
The main objective is to design and develop a system that enables the reporting and responding to a crisis and emergency situations using SMS technologies.

1.3.2 Specific objective
The specific objective of the project is to

- Analyze the situation to propose a better and a working system.
- Design a system that considers the current situation and technologies.
- Identify appropriate devices and technologies to implement the designed system.
- Implement the system based on the current requirements.
- Test and evaluate the developed system.
1.4 Scope

- The mobile application to be developed for the client will only work for mobile devices that support Java applications.
- The project to be developed will be limited to the Addis Ababa Police Commission.
- The system will not have a multi-lingual feature. The system will only support English language.
- For the purpose of accepting reports or data from mobile devices, MMS (Multimedia Messaging Service) will not be used, the system will only use SMS as a mean of accepting data from mobile devices.
2. Literature Review

2.1 SMS (Short Messaging Service)

SMS [8] also referred to as texting, sending text messages or text messaging, is a communication service that allows for short text messages (160 characters) to be sent between GSM mobile phones. This makes SMS a good means of mobile communication especially for deaf and hearing-impaired people.

SMS is a store-and-forward service, meaning that when a text message is sent to another phone, the message does not go directly to the receiving phone. The message is stored in the SMS service center (for days if necessary) until the receiving cell phone is switched on or moves into range, at which point the message is delivered. The message will remain stored on both phone’s SIM card until it is deleted.

The first SMS message was sent over the Vodafone GSM network in the United Kingdom on 3 December 1992, from Neil Papworth of the old Sema Group (now Airwide Solutions) using a personal computer to Richard Jarvis of Vodafone using an Orbitel 901 handset [1]. The text of the message was "Merry Christmas".

The first SMS typed on a GSM phone is claimed to have been sent by Riku Pihkonen, an engineering student at Nokia, in 1993. The first commercial deployment of a Short Message Service Centre (SMSC) was by Aldiscon (now Acision) with TeliaSonera in Sweden in 1993[1].

2.2 Related Works

In assess related works done in the area of crisis management here in Ethiopia, we have not come across to any application (to our knowledge) that developed an application that is using mobile phones in handling crisis situation. Many SMS based application are being developed especially in developing countries, some which are pilot projects. The next section will mention some of the projects related to our work.
One of the projects is the RapidSMS [12] platform currently in an alpha stage of development. RapidSMS is an SMS-based tool that allows for mobile data collection and bulk SMS messaging where users can collect both quantitative and qualitative data and SMS it to the central server [4].

To mention some of the projects implemented by RapidSMS, the first official release of the tool is the project implemented in Northern Uganda [4]. The system was used to monitor the condition of existing latrines to help determine how many latrines are needed or need to be rehabilitated. Community health workers are expected to use SMS to report latrine status summaries and report emergencies such as collapsed lavatories.

Next to Uganda RapidSMS was adapted for Ethiopia to improve UNICEF famine response logistics. The system was developed with UNICEF Ethiopia during October 2008 as a supply monitoring system for PlumpyNuts [12]. They used the system to;

- To monitor the field reporting activities,
- To view and analyze incoming supply reports immediately,
- Send custom messages to field monitors,
- Broadcast announcements and updates to all field monitors,
- Generate reports and visualize data (delivery status, number of new beneficiaries, stock levels, etc) on a map,
- Generate graphical summaries of activities.

Other project done abroad, a number of pilot project are being deployed. But one of the successful projects is the one developed for Kenya named Ushahidi [13]. This project was developed from the post-election violence that happened in the country. The project was used to map incidents of violence and peace efforts based on the reports submitted through the web and mobile phone by the citizens of the country. Another project includes FloodSMS [5], an early detection and warning of catastrophic flooding using SMS.

Having studied the related mobile based systems developed for the purpose of crisis and emergency reporting management, one of the limitations we have noticed is that there is only one way communication where only reporting of incidents or emergences are reported to the responsible authority. Two-way communication is not handled, where the responsible authority will be able to notify or communicate back with the people or organization to take necessary actions.
3. System Analysis

3.1 Current System

Hundreds of reports from the general public are received daily by the police. It is the responsibility of the police operators to accept and confirm the reported incident and respond to the incident as fast as possible. Basically the information required from the reporter depends on the type of incident. Emergency requests received by the police are generally classified into four. These include crime related reports, fire, traffic accidents and Ambulance requests.

After observing how reports are being received by the police, we have seen that around 10 telephone hotlines where the public can call a specified number (991) to report anything related to an emergency. To answer these phone calls, a number of police operators are assigned to take necessary information from the caller and take necessary action to the report.

When receiving the report, if the report is crime related, the type of crime committed is required since there are different types of crimes. This is necessary because different types of crimes require different types of resources. The other important information is the time of the incident or the crime. The time describes whether the incident is happening during the reporting period or has already happened or will happen in the future. The other information required is the location of the incident, which describes the exact location or the nearest possible area of the incident. To describe location generally the sub city, kebele and special or known location name is used. Special location names include known commercial buildings, hotels, banks, street names etc. will be described. In addition to the above information if the report is a traffic accident, information about the vehicles and victims involved is expected.

The operators who receive the information use different mechanisms to validate the report. Validation of the report is necessary because information accepted from the phone call is anonymous. This increases the probability of false or bogus reports obviously wasting time and resources of the organization.

After successful retrieval of the above information from the caller, the next task is responding to an incident. Response action could be dispatching the required resources (police officers, fire fighters, traffic officers, ambulances) to the specified location. For responding purpose, mainly radio based
communication is used, where selected number of officers carries around handheld radio communication system. Every sub city has its own a specific radio frequency, which is always open to receive reports. Therefore, the operators pass their information to the radio controller to inform the station nearest to the incident to take necessary action.

Every report received by the police follows the same routine to accept and respond to an incident. Later every police station from each sub city reports back to the central police station about the status of every incident and kept for later retrieval or analysis purposes. This will also help the central control to know of what is going on in the city every day.

3.2 Proposed System

3.2.1 Overview of the System

Basically the system to be developed (MobiRep) will have different features to manage the communication handled by the police. The first feature is receiving SMS messages from any phone. Using this feature the system will be able to receive crisis and emergency related reports from the general public or field officers.

To accept a report from clients two options are used, from applications installed on mobile phones or using plain SMS message. To use the former option, a Java Micro Edition Platform (J2ME) [2] application will be loaded onto the phone over Bluetooth or by downloading the application from the website. To use the mobile application, the reporter navigates through questions in an application on the phone, which collects the answers and submits the completed form to a server using SMS. In using the latter option provides two types of messages, the user can either send just a plain message where there are no rules in the format of the message. The second type of message is where the user will be given a specific message format to send their report. Specific codes or keywords and sequence will be provided to represent a message. This option needs a better training and carefulness since it is error prone. The last option can also be used to pass commands to the system. Table 1 describes the possible SMS messages to be sent by the user to report a house breaking and entry and registration to the system.
The Message | Possible plain SMS with Rules | Possible SMS message with keyword (rule based)
---|---|---
To report House breaking and entry (burglary report) | A **burglar** has broken in to my house I live at **bole** sub city kebele **03** house no **067** please hurry | BUR BL 05 067

| User Registration | - | REG Abebe Kebede BL 05 067 |

**Table 3-1: Possible SMS message formats**

After the report has been accepted by the system using the available formats, the system is expected to process and convert the received message to an understandable format. To start with, the system classifies the message according the type or format of the message. The messages accepted from the different types methods are processed differently.

If the message received is recognized to be from the mobile application, the system automatically parses the message and stores the message in the database to their relative fields. There is no possibility of error to be experienced from the accepted report. This is because the application to be installed on the device will be responsible in handling possible errors; in addition to that, it will organize the data received from its form according to the format understandable by the system. The system will automatically break up the message accordingly to store it to the database. If the message is recognized to be plain SMS message, it checks if the message is keyword based message (SMS form). If the message is based on an SMS form, the system checks the format of the message for possible errors and if there is no problem the message is broken to understandable form and stored to their database fields accordingly. If a problem is experienced with the format or type of message, it will be classified to be an unresolved message. Finally if the message is none of the above types, the message is automatically classified as unresolved message or just plain message. Unresolved or plain message will just be displayed to the user as they are. On the other hand, messages that are understandable by the system will be displayed as reports.
Based on the preference set by the operator the system will automatically send confirmation message to the person who reported the message by notifying the client that the message has been received by the system. The confirmation message may include the detail of the received message, a unique acknowledge number or identification number to the accepted report and the subscribed user information. Later the client or the reporter can check or follow up his report by messaging his request using their specified acknowledge number.

After successfully storing the message as either a report or unresolved and plain message, the next task is displaying the information to the police operators in a more understandable, readable and summarized format for fast response to an incident. To display the report, every type of crime related reports will be grouped in one category and displayed to the operator in a grid displaying the necessary information. The same thing will be done for fire emergency, traffic accident report and ambulance requests.

The police operator will be able to view every incoming report and respond to the report or request by opening it on a different page. The response can be by further communicating with the reporter or dispatching police force to the location of an incident by broadcasting bulk SMS to the police officers located at the station nearest to the incident. Since the reporter or the person sending the request is a subscribed user, it would not be necessary to check the credibility of the report. This reduces unnecessary communication with the client.

One example can be, if the report is concerning a vehicle theft, action to be taken will be to broadcast SMS message describing the stolen vehicle to all the field traffic officers.

At this point we are assuming that available resources (human power, vehicles armed officers etc.) and also every known location (house number, kebele, commonly known locations like buildings etc) is fed to the system

In addition to the above features of the system, based on the location of the crime, the system will be able to broadcast warnings or alerts to subscribed users using SMS message. A client (as an individual or organization) will be able to register using their sub city information and sending SMS message to the system to receive alerts for incidents that happen within his/her neighborhood. To receive alerts, registration can be done by providing sub city and kebele
information. For example, if there is or was an incident (riots, violence, robbery, vehicle theft etc.) at a certain location, subscribed clients near that location will get a warning message to watch out and secure their properties or take safety measures depending on the type of alert sent.

Generally this application will make it easier for the operators at the receiving post to automate most of their management and communication process in such a way that most of the unnecessary and tiresome process in accepting and responding will be handled by the system.

3.2.2 Functional Requirements

Possible Actors of the system,

- Operator/Monitor
- System Timer
- Field Officers
- Client
- System Administrator

Main Functional Requirements of the system include

I. Situation Dashboard
II. SMS Management Module
III. Alert Management Module
IV. Contact Management Module
V. Utility Module

**Situation Dashboard**

This module handles the communication of the overall issues from all the different modules to the users of the system.
a) Summarized view of the current day’s entries
b) Summarized view of recent SMS transactions
c) View of Unresolved notifications.
d) Organized view of contact lists to Send quick SMS
e) Navigation options throughout the system

**SMS management module**

This module handles the automatic accepting of SMS messages from the public or field officers.

a) Accept and send SMS messages.
b) Generate acknowledgment number and confirmation message.
c) Processing the received SMS message – automatically process the SMS message received and convert it to a meaningful and required report.
d) Broadcast SMS – Send bulk SMS to a group or multiple users.
e) Generate SMS templates for automatic message creation when necessary.
f) Search/filter SMS messages, Templates, Incident reports.

**Alert management module**

This module will be responsible to send alert SMS message to subscribed or registered users based on their requirements

a) Add/Edit/Delete Subscribed users
b) Send/broadcast Alert SMS

c) Add/Edit/remove Client
b) Add/Edit/remove Officer
c) Add/Edit/remove Station
d) Add/Edit/remove Resources
e) Search/filter clients, officers, station
**Utility module**

This module handles the utilizing the system.

- a) Add/Edit/Delete System users
- b) Login and Logout of system users
- c) Generate reports and printing

### 3.2.3 Non-Functional Requirements

Non-Functional requirements describe user visible aspects of the system that are not designated to the functional behavior of the system. The requirement includes from user interface to security issues. Generally, Non-Functional requirements of the system can be viewed as follows;

**User interface and Human factors**

Two types of interfaces should be considered when talking about the human factor since users of the system will interface with the software to be deployed on a personal computer and a mobile phone. When we consider the user interface on the personal computer since there is going to be different type of users, it will have different type of user interfaces. Generally it will include the necessary features for each user with a user friendly interface. When we come to the mobile phone, since pure SMS will be used, a short and understandable template for urgent reporting of incidents will be generated and trained to the user.

**Documentation**

System users and the general public benefiting from the system will receive short and properly prepared documentation on how to use the system. System administrators will receive documentation about the database schema, and documentation on the code of the system. On the occurrence of problems, the documentation will help the system administrators to understand the system’s structure and to facilitate maintenance of the so easily.
**Hardware and software consideration**

The Software product to be developed should run seamlessly on existing Pentium IV computers. Also any mobile phones with SMS capability can be used.

**Performance Characteristics**

Since the system is going to be accessed by different users with different needs, it should be capable of handling and processing their queries quickly. Since the system is an online system, it is difficult to tell exactly how many users will be using the system at a time. However, if the system is being accessed by many, all the users must feel that they are the only one using the system. Besides the software, Hardware will also be a great factor in the systems’ performance. Generally, the system should be able to handle many users and it should be responsive.

**Error Handling and Extreme Conditions**

The system is expected to handle errors encountered during run time. Errors could rise from users and from the system. Errors that occurred from the wrong doing of users will be handled by appropriate exception handling mechanisms. Moreover, in case of the system’s database failure, back up database will be used to resume normal operation. Generally, if an error occurs, the system will identify the error and notify the user so that he/she can take the appropriate corrections. When we say this, we are not saying that all errors will be handled with notifications on how to correct them.

**Quality Issues**

Since the system is used for emergency reporting, it should be robust and reliable to a certain level. Generally, the system will be reliable and accurate in providing information to the users.

**System Modifications**

System modification is based on the interest and the need of the clients as well as the developers. As of the users’ comment (feedback), the system will be modified to meet their requirement. In fact, the developers or any trained person that knows the code behind the system does this modification. Moreover, modifications can be achieved without a problem since the system is going to be designed using an object oriented approach.
**Physical environment**

The server must be put on a place that has high security and little physical access.

**Security Issues**

The system should be protected with different security features (techniques) on both the software and hardware part. On the software part, any user who wants to login to the system must have a user name and password. This protects the system from any unauthorized access. A user in any section will be given the right to access and/or modify the data related to that section. In addition, the system allows only one user to use a single user name at a time. Generally, the system should be secure to a level that, even when it is available online, critical information should not be available to non-authorized users.

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

**Resource Issues**

The system is supported by a server with the best-secured operating system installed on it. As the machine is envisioned to be stationed in a controlled machine room, procedures should be placed for the backup of important data.
3.3 Analysis Model

3.3.1 Use Case Diagram

Figure 3-1: Use case for SMS Management Module
<table>
<thead>
<tr>
<th>Use case Name</th>
<th>Add templates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating Actors</td>
<td>Operator</td>
</tr>
<tr>
<td>Description</td>
<td>The Operator wants to Send SMS message or notification or any other message, so he/she can use it in future communications.</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The Operator is logged in</td>
</tr>
</tbody>
</table>
| Flow of events | 1. The Operator Selects on “Add Template”.  
2. The system displays the “Add template” wizard.  
3. The Operator selects the type/subject of template he is creating and clicks next.  
4. The system displays the template editing form.  
5. The Operator Edits the template and clicks NEXT.  
6. The system Previews the template to the Operator.  
7. The user clicks Finish.  
8. The system stores the new template.  
9. The system displays an acknowledgment of successful creation of the template. |
| Exit conditions | A new template is added |
| special requirements | |

<table>
<thead>
<tr>
<th>Use case Name</th>
<th>Edit Template</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating Actors</td>
<td>Operator</td>
</tr>
<tr>
<td>Description</td>
<td>The Operator may want to edit the templates.</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The Operator is logged in, The Template is stored or exists</td>
</tr>
</tbody>
</table>
| Flow of events | 1. The Operator clicks on Templates Link  
2. The system displays the available templates  
3. The Operator selects a template and clicks on Edit Template  
4. The system displays Edit Template Form  
5. The Operator makes necessary modifications and clicks on preview |
6. The system displays the preview of that specific template
7. The Operator clicks on Save
8. The system saves the changes to that Template
9. The system displays an acknowledgment

Exit conditions | Save the changes to the templates
---|---
special requirements
Use case Name | Delete Template
Participating Actors | Operator
Description | The Operator may decide to delete template if it no more necessary, clears unnecessary templates.
Entry condition | The Operator is logged in, the template exists
Flow of events | 1. The Operator clicks on the Templates link
2. The system displays the list of templates
3. The Operator selects the subject template and clicks delete
4. The system asks for confirmation
5. The Operator clicks OK
6. The system deletes the template
7. The system sends an acknowledgment to the Operator
Exit conditions | The Template is deleted

Use case Name | Search
Participating Actors | Operator
Description | The user should be able to search and filter the SMS message or Incident Reports generated or Templates using different criteria.
Entry condition | The Operator is logged in to the system
Flow of events | 1. The Operator clicks on Search link.
<table>
<thead>
<tr>
<th>Use case Name</th>
<th>View Report Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating Actors</td>
<td>Operator</td>
</tr>
<tr>
<td>Description</td>
<td>The Operator should be able to view Report Detail under a certain client, including the SMS transaction between the Operator and the Client, if there are Incident Reports. Generally the Clients history will be displayed.</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The Operator must be logged in, The Client must exist in the system</td>
</tr>
</tbody>
</table>
| Flow of events | 1. The Operator clicks on Client Detail button  
2. The system responds by displaying a Client detail form and prompts the Operator to select the specific Client.  
3. The Operator or Billing Officer selects the Client and clicks Show Detail  
4. The system responds by displaying the detail of the selected Client. |
| Exit conditions | The Operator views the Report Detail. |
| special requirements | |
Figure 3-2: Use Case for Contact Management Module
<table>
<thead>
<tr>
<th>Use case Name</th>
<th>Register Client</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating Actors</td>
<td>Operator</td>
</tr>
<tr>
<td>Description</td>
<td>The Operator wants to add a new Client.</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The Operator is logged in</td>
</tr>
</tbody>
</table>
| Flow of events  | 1. The Operator clicks on Register Client  
|                 | 2. The system displays the Register Client Form, which prompts the Operator for filling the Client’s detail.  
|                 | 3. The Operator fills the necessary Client details and clicks save.  
|                 | 4. The system saves the Client details.  
|                 | 5. The system displays an acknowledgment for the Operator.  |

| A1                  | 1. The system displays an error message, prompts the user to correct the problem  
|                     | 2. Go to number 3. |

| Exit conditions   | A new Client is added or registered. |

<table>
<thead>
<tr>
<th>Use case Name</th>
<th>Edit Client</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating Actors</td>
<td>Operator</td>
</tr>
<tr>
<td>Description</td>
<td>The Operator wants to edit or modify Client detail</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The Operator is logged in, a Client must exist.</td>
</tr>
</tbody>
</table>
| Flow of events  | 1. The Operator clicks on Clients Button  
|                 | 2. The system displays a Clients Form which lists the available Clients  
|                 | 3. The Operator selects a Client and clicks on Edit Client button  
|                 | 4. The system displays Edit Client Form and prompts the Operator to edit the details  
|                 | 5. The Operator makes the modifications and clicks on Update button  |
6. The system displays the preview of the Client for the Operator. The Operator confirms by clicking ok.

7. The system saves the changes to that Client.

8. The system displays an acknowledgment.

<table>
<thead>
<tr>
<th>Exit conditions</th>
<th>Save the changes to the Client</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use case Name</strong></td>
<td><strong>Delete Client</strong></td>
</tr>
<tr>
<td><strong>Participating Actors</strong></td>
<td>Operator</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>The Operator wants to delete a Client</td>
</tr>
<tr>
<td><strong>Entry condition</strong></td>
<td>The Operator is logged in, a Client must exist, no SMS transactions or Incident reports must exist under the Client.</td>
</tr>
</tbody>
</table>
| **Flow of events** | 1. The Operator clicks on Clients Button.  
2. The system displays a Clients Form which lists the available Clients and prompts the Operator to select from the list.  
3. The Operator selects a Client and clicks on Delete Client button.  
4. The system checks for SMS transactions or Incident reports under the selected Client.  
5. The system asks for confirmation.  
6. The Operator confirms by clicking yes.  
7. The system deletes the Client.  
8. The system sends an acknowledgment to the Operator.  

A1 If the system finds out that there are SMS transactions or Incident reports under the Client, the system displays cannot delete.  

A2 If the Operator clicks No, the Client will not be deleted. |
<p>| <strong>Exit conditions</strong> | The Client is deleted from the system. |
| <strong>special requirements</strong> | |</p>
<table>
<thead>
<tr>
<th>Use case Name</th>
<th>Search</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating Actors</td>
<td>Operator</td>
</tr>
<tr>
<td>Description</td>
<td>The user should be able to search and filter the <strong>client’s information, resource information, and officer’s detail</strong> using different criteria.</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The Operator is logged in to the system.</td>
</tr>
</tbody>
</table>
| Flow of events | 1. The Operator clicks on Search link.  
2. The system displays a search and Filter Form.  
3. The user enters his/her search type (this could be client search, resource search, officer search)  
4. The Operator enters filter criteria required.  
5. The user clicks search \(^\text{A1}\)  
6. The system displays a resulting list |
| A1 | 1. The system displays a result not found dialog box |
| Exit conditions | Properties and Clients matching the criteria are displayed in a list |
### Use Case Diagram for Alert Management Module

#### Use Case Name
Subscribe Client

#### Participating Actors
Operator

#### Description
To register a client who wants to receive SMS alerts

#### Entry condition
The operator is logged in. The client must be registered already.

#### Flow of events
1. Operator selects Alert button
2. The system displays a Alert Subscription form
3. Operator selects Subscribe client option
4. System displays list of clients to be selected
5. Operator selects a client, and selects Subscribe button
6. The system registers the client to receive alerts

#### Exit conditions
The user is logged in.

#### special requirements

---

Figure 3-3: Use Case Diagram for Alert Management Module
<table>
<thead>
<tr>
<th>Use case Name</th>
<th>Unsubscribe Client</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating Actors</td>
<td>Operator</td>
</tr>
<tr>
<td>Description</td>
<td>Used to unsubscribe client from receiving SMS alerts.</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The Operator is logged in to the system, The selected client must already be subscribed</td>
</tr>
<tr>
<td>Flow of events</td>
<td>1. Operator selects Alert button.</td>
</tr>
<tr>
<td></td>
<td>2. The system displays a Alert Subscription form.</td>
</tr>
<tr>
<td></td>
<td>3. Operator selects Unsubscribe client option.</td>
</tr>
<tr>
<td></td>
<td>4. System displays list of clients to be selected.</td>
</tr>
<tr>
<td></td>
<td>5. Operator selects a client, and selects Unsubscribe button.</td>
</tr>
<tr>
<td></td>
<td>6. The system removes the client from the alerting feature.</td>
</tr>
<tr>
<td>Exit conditions</td>
<td>The client is Unsubscribed from the Alerting feature</td>
</tr>
<tr>
<td>special requirements</td>
<td></td>
</tr>
<tr>
<td>Use case Name</td>
<td>Edit Alert Setting</td>
</tr>
<tr>
<td>Participating Actors</td>
<td>Operator</td>
</tr>
<tr>
<td>Description</td>
<td>Used to set the alerting feature of the system for the client</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The Operator is logged in to the system, The client is subscribed to receive alert</td>
</tr>
<tr>
<td>Flow of events</td>
<td>1. Operator selects Alert button</td>
</tr>
<tr>
<td></td>
<td>2. The system displays a Alert Subscription form</td>
</tr>
<tr>
<td></td>
<td>3. Operator selects Edit Alert Setting option</td>
</tr>
<tr>
<td></td>
<td>4. System displays list of clients to be selected</td>
</tr>
<tr>
<td></td>
<td>5. Operator selects a client, and fills the detail of the alerting feature like location preferences and reporting period and selects save button</td>
</tr>
<tr>
<td></td>
<td>6. The system saves the Alert setting of the client.</td>
</tr>
<tr>
<td>Exit conditions</td>
<td>New alert setting is updated to the system.</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Use case Name</td>
<td>Generate Alert</td>
</tr>
<tr>
<td>Participating Actors</td>
<td>System</td>
</tr>
<tr>
<td>Description</td>
<td>The system will automatically generate alerting message based on the alert setting of the client.</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The system user is logged in to the system, the client is subscribed to receive alerts</td>
</tr>
</tbody>
</table>
| Flow of events  | 1. System periodically checks the alert setting of the clients that are subscribed to receive alert SMS messages  
2. According to the alert setting, if the system finds out that the alerting time has reached, automatically the alert message is generated.  
3. The generated alert message is ready to be sent.  
4. The System sends the message to the client. |
| Exit conditions | Alert message is sent.                 |
| special requirements |                                      |


Use case Name | Login  
---|---  
Participating Actors | All system users  
Description | Any user who wants to access the system’s functionalities should be able to login to the system  
Entry condition | The user needs to be already registered.  
Flow of events | 1. The system displays a login form  
  2. The user enters his/her credentials  
  3. The user clicks on login button A1  
  4. The system takes the user to his/her dashboard.  

A1 | 1. The system displays an error message  
  2. Got to step 1.  

**Figure 3-4: Use case diagram for Utility Module**
<table>
<thead>
<tr>
<th>Exit conditions</th>
<th>The user is logged in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>special requirements</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Use case Name</th>
<th>Add System users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating Actors</td>
<td>System Administrator</td>
</tr>
<tr>
<td>Description</td>
<td>As the system is designed to be operated by more than one user, the System administrator should be able to add System users.</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The Operator is logged in to the system</td>
</tr>
</tbody>
</table>
| Flow of events      | 1. The Administrator clicks on add user button  
|                     | 2. The system displays the add user form  
|                     | 3. The administrator enters the user details and selects the job title  
|                     | 4. The administrator clicks save button  
|                     | 5. The system adds the user to the system  
|                     | 6. The system displays an acknowledgment |
| Exit conditions     | A new user is added. |
| special requirements|                       |

<table>
<thead>
<tr>
<th>Use case Name</th>
<th>Edit system user profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating Actors</td>
<td>System Administrator</td>
</tr>
<tr>
<td>Description</td>
<td>The administrator may want to change the profile of the system user. These profiles may be the user name, password and roles.</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The system user or the administrator is logged in to the system</td>
</tr>
</tbody>
</table>
| Flow of events      | 1. The administrator clicks on users menu  
|                     | 2. The system displays a list of users  
|                     | 3. The administrator selects a single user and clicks on change profile  
|                     | 4. The system displays change profile form  
|                     | 5. The administrator changes the users profile  
|                     | 6. The administrator clicks on save  
|                     | 7. The system saves the changed profile |
8. The system displays an acknowledgement

<table>
<thead>
<tr>
<th>Exit conditions</th>
<th>The profile of the user is changed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use case Name</td>
<td>Change password</td>
</tr>
<tr>
<td>Participating Actors</td>
<td>System user</td>
</tr>
<tr>
<td>Description</td>
<td>The system users in their own behalf can change their own passwords.</td>
</tr>
<tr>
<td>Entry condition</td>
<td>The system user is logged in to the system</td>
</tr>
</tbody>
</table>
| Flow of events  | 1. The user clicks on change password menu  
|                 | 2. The system displays change password form  
|                 | 3. The user enters his/her previous password and the new password  
|                 | 4. The user clicks change  
|                 | 5. The system stores the new password  
|                 | 6. The system displays an acknowledgement |
| Exit conditions | The new password is stored |
| special requirements |                                      |
3.3.2 Class Diagram

Figure 3-5 Class diagram
3.3.3 Sequence Diagram

Figure 3-6: Sequence Diagram to Add System User

Figure 3-7: Sequence Diagram to edit password
Figure 3-8: Sequence Diagram for Subscribing Client for Alert

Figure 3-9: Sequence Diagram for editing Client Alert
Figure 3-10: Sequence Diagram for Unsubscribing user from Alerts

Figure 3-11: Sequence Diagram for registering new Client
Figure 3-12: Sequence Diagram for editing existing client information

Figure 3-13: Sequence Diagram for removing a client
Figure 3-14: Sequence diagram for adding new SMS Template

Figure 3-15: Sequence diagram for editing an existing template
Figure 3-16: Sequence diagram for removing a template

Figure 3-17: Sequence Diagram for processing SMS messages
Figure 3-18: Sequence Diagram for sending SMS message
4. Design of the System

This section consists of the design goals and proposed system model. Functional requirements are grouped in such a way that they could be constructed as sub systems and the non functional requirements defined in the analysis are transformed into design goals.

4.1 Design Goals

The new system is considered to be successful if it meets the following sets of criteria’s.

1. User Interface: The user interface of the system should be easy to use by each user of the system with little training.
2. Documentation: System administrators and other users are provided with proper documentation about the software’s features.
3. Hardware Consideration: The system should be able to work on Pentium IV computers.
4. Performance: The system should be able to serve a number of users which are expected to access it concurrently.
5. Error Handling and Extreme conditions: The system should be robust enough to handle error conditions and continue with normal operations.
6. Availability: The system availability should be available most of the time since it is handling emergency situations.
7. Security: The system should prevent the sensitive data from unauthorized access.
8. Modifiable: The system should be designed in Object Oriented language so that modification to some part of the system could not affect other parts.

4.2 Proposed New System Model

This section represents the system decomposition and other implementation designs necessary to achieve both the design goals and the functional requirements.
4.2.1 General Architecture

Figure 4-1 describes the general architecture of the system.

At the top of the architecture we have the Mobile Phone Devices. This layer defines any mobile device with SMS functionality will be able send SMS reports. Within the Mobile Phone Devices layer we have the Mobile Application. In addition to sending plain SMS messages, a mobile application is developed to be installed on the mobile devices. Using the mobile application the reporter will be able to send his message just by filling the forms provided with the application. Later upon submission the mobile application organizes the filled information and sends or passes the data using SMS.

At the next layer, we have the SMS center which is provided by the SMS service provider, when SMS is sent from the client it passes through this layer. This layer stores the message and forwards it to the recipient phone. This is necessary the receiver’s phone is not reached, out of service or switched off. The
message could be stored at the SMS center until the receiving cell phone is switched on or moves into range of the network coverage. This guarantees the submission of messages.

The next layer, the Application Server, accepts the SMS message from the SMS center either a wireless GSM modem is used or a GSM mobile device with a serial port cable to connected to the application server. The application server automatically receives the message and stores it to the Database taking necessary action. In storing the message to the Database, more detail about the process is explained in chapter three. The received message is then retrieved by the web server where anyone with proper credentials will be able to use the basic functionalities of the. The web server can be accessed internally within the organization or using the internet for users who wants to use the application remotely.

4.2.2 System decomposition

The system will be built on a layered architecture. A layered architecture makes it easier to maintain or modify one part of the system without affecting the others. If for example the users need a modification on the User interface, they could get it without affecting the whole or the rest of the system. All layers will be interacting only with the layer right next to them. No layer will be interacting with a layer it doesn’t have direct access to. This policy shall make the code readable and maintainable.

The following diagram shows the layers that the system will be constructed on.

![Layered Architecture of the system](Figure 4-2: Layered Architecture of the system)
As shown in figure 4-2, the system will have four logical layers to achieve its design goals. The next section will describe the layers in detail.

**The UI layer:** the user interface layer is the layer on which all the user interface codes are implemented. This makes the whole implementation easier to modify because a change in one layer will not affect other layers.

**Business Logic Layer:** this layer is a layer that really implements the business requirements and constraints. The business logic layer implements all the functional requirements without the User interface.

On the business logic layer, the system should have the following sub systems. These sub systems interact to achieve the final goal. Details of the sub system can be found at the functional requirement section

- SMS management sub system
- Alert management sub system
- Contact management sub system
- Utility sub system
Figure 4-3: Layers relationship

Figure 4-4: SMS Management Sub system
**Object Relational Mapping Layer:** Next to the database we have an **Object Relational Mapping** layer. This layer shall be responsible for connecting the database with the business layer. This layer shall support basic database operations like creating new rows, deleting, updating etc. in the Object oriented name space. The object relational mapping is code that can be generated by some software so it could later be considered as a component that we take from shelf.

**Database Layer:** The system will be using a relational database for its persistent data storage. The layer at the bottom of the architecture will be a database system.

### 4.2.3 Hardware/software mapping

The hardware software/mapping of system shows the relationship between nodes and independent software components. In line with that the following diagram shows the nodes and components used in PMS. Since the system is web-based client nodes should have browser components, whereas the web-server machine will have IIS. The same web-server or an independent machine, will host MySQL server DBMS component. Figure 4-8 shows the deployment diagram which includes the mobile application deployed on the mobile device of the user, the application server where all the business logic functionalities are deployed on and the database server.

The system will be using client/server architecture
Figure 4-8: System Deployment Diagram
4.2.4 Data Management

The system will use a relational database to keep its persistent data. The relational database design is as shown on figure 4-9.
5. Prototype Development

This chapter will define the development tools used to implement the system and the prototype of the system.

5.1 Programming Tools

This project consists of different types of application. The web application used to develop the business logic of the system, the desktop application which handles the communication with the modem and the mobile application which facilitates the interface for sending SMS message. Therefore different tools and technologies were used based on the requirement of the type of application.

**ASP.NET**

ASP.NET is a web application framework developed by Microsoft to build dynamic web sites, web applications and web services [7]. ASP.NET is built on the Common Language Runtime (CLR), allowing programmers to write ASP.NET code using any supported .NET language where in this case C# is used. Basically this web application framework is used to develop the web application.

**C# Visual Studio 2008**

In addition to using this programming language for developing the web application, C# programming language is used to develop the desktop SMS application where it is engaged in accepting and send SMS message communication directly with the modem or mobile phone connected to the ports.

**Java 2 Micro Edition (J2ME)**

To develop the mobile application, the J2ME version of Java is used. J2ME provides the necessary APIs to develop mobile applications [2]. Netbeans 6.5.1 was used as the Integrated Development Environments (IDE) to facilitate the development process of the mobile application. Since this version of Netbeans supports the J2ME edition of java by providing the necessary features making it possible to develop and test the mobile application before deploying it on a mobile device.

**Internet Information Service (IIS)**

Since ASP.NET has been used to develop the web application, IIS [9] was used. IIS is a set of Internet-based services for servers created by Microsoft for use with Microsoft Windows. The IIS provides
different services including Network News Transfer Protocol (NNTP), File Transfer Protocol (FTP), and Simple Mail Transfer Protocol (SMTP)

**MySQL Database Management System (DBMS)**

To store the persistent data of the system, the MySQL database management system is used. MySQL is an open source relational database management system (DBMS).

### 5.2 The Prototype

The System is composed of web application handling the business logic of the system, the desktop application handling communication with the GSM modem or GSM mobile phone connected to the server, and a client mobile application facilitating an interface in sending SMS data to the server. This section, a brief overview is given regarding the basic component of the system.

![Figure 5-1: Login Screenshot](image-url)
The first page that the users will face is the log in interface shown on figure 5-1; every user will have a user name and password to log in to the system. After successful login to the system every user will be to his/her dashboard.

![Send SMS Screen shot](image)

**Figure 5-2 : Send SMS Screen shot**

At any point when the user wants to contact or pass notification to field officers, figure 5-2 shows the interface where the user selects the registered filed officers throughout the police stations. The user will have the possibility to choose the users by group or individually depending on the type notification. To send a message, after selecting the contacts to whom the message is to be sent, the message will written in the message text box and press send button.
Figure 5-3 shows the interface where the system has automatically processed incoming SMS messages and converted to meaningful information where the reports are classified into different types of reports. The operator who is using the system can open each report for further and detailed information of the report.
If the received SMS message is not understandable by the system, the possibilities are that the user is trying to send a plain message or the intended message has format errors. Either ways these messages will be classified into plain or unresolved messages where the operator can view the messages as they are shown on figure 5-4.
The mobile application provides the interface where the user is expected to fill the forms provided. After successful filling forms, the application organizes the data and sends it using SMS to a specified number.

As shown in figure 5-5, depending on the report type selected, the mobile application will follow different streams. Primarily the system will ask if the user wants to register or report. If the user wants to register, the registration form with its follow stream is presented. If the user wants to report crisis or emergency situation, a list of possible reports is presented. Since different reports require different information the diagram clearly describes the flow of pages clearly.
6. Conclusion and Future Work

The Addis Ababa Police Commission is an organization engaged in responding to crisis and emergency situations here in Addis Ababa. During these situations, effective and reliable means of communication plays a critical role in handling the reporting and responding process.

In the project we have tried to analyze the current means of how communication of how crisis and emergency related reporting is made between the Addis Ababa Police and the general public and also internally within the organization. Using the information we have gathered we tried to design a system that considers the current situation and available technologies. In designing the system we have considered of how data is to be communicated and how the system will best fit with the workflow of the current means of communication. After designing the system we have tried to use appropriate and easily available devices and technologies to implement the designed system based on the current requirements identified. After implementing the system we have tried to test and evaluate the developed system.

In identifying problems of the Addis Ababa Police commission during our survey, we have found that the current means of receiving or accepting crises and emergency reports which is limited to only using phone calls made the communication process difficult in receiving valuable information to the incident. In receiving the report using phone call one of the main problems faced is that since the phone call reporters are anonymous false reports are being received and waste time and resource of the organization which could have been used for actual incidents. We also found out that it is difficult for the reporters to express the location of where the crisis has happened or where the emergency is needed.

Due to the increasing number of mobile phones and their pervasiveness nature, we proposed a system which uses SMS messaging as a means of communication when faced with crises and emergency situation. We believed that increasing the means of accepting reports will only increase valuable information. Therefore in addition to using phone calls, the general public can use SMS feature of their mobile phones to report incidents to the police. In addition to accepting reports, makes it possible for the police to use SMS for internal communication and externally to respond to a report.

In accepting report from the public, we have identified two means of accepting SMS reports. The first one is installing an application on the mobile devices of the clients which can support Java application.
To use this method, the client is expected to filling and submitting the necessary information on the forms required. This way the application will organize the information collected from the form and send it using SMS messaging service. The other means of sending the report is using plain SMS message. In addition to using plain SMS messages, the user will be given a standard format which includes specific keywords and numbers to send their reports. The last option if appropriately used, unlike normal or plain SMS messages, the keyword based message will be automatically processed by the system and converted to a meaningful incident report.

In implementing the system, the core feature of the system is where SMS message is accepted by the system. To accept SMS messages, by connecting wireless GSM modems or using GSM mobile phones, the system is able to retrieve and process the received messages to an understandable format making it possible to automatically store to the appropriate fields of the database storage. In implementing this project we believe that we have developed a system that can act as an additional means of communication which automated the accepting and responding process by avoiding unnecessary communications.

To mention the possible future works, one major work could be for the system to support multi-language support. Since different languages are being spoken here in our country, it would be a good advantage to the hosting organization that would be deploying the system.

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

Appendix: Interview Results

1. How many reports do you receive from the public for emergency purposes?
2. What type of reports do you receive?
3. What is your minimum response time when responding?
4. What are your means of accepting reports from the public?
5. What information is expected from the reporter when receiving a report by your operators?
6. How do you validate a report that you have accepted?
7. How often do you receive false reports?
8. After successfully receiving the required report, how do you respond or take action to a report?
9. Does your organization use SMS for communication purposes?
10. How do you communicate internally within your organization and with field officers throughout the city?
11. How does the reporter follow up the status of the report?
12. How is the overall information stored or archived coming from all the sub cities?
13. What type of report is expected from the department for the purpose of analysis?
14. Does your organization use any type of software for the purpose of accepting or analyzing reports accepted from the public?

The summarized report of the response to these questions is presented below:

Addis Ababa police Commission is responsible in responding to crisis and emergency related incidents. Many reports from the general public are received daily by the police. It is the responsibility of the police operators to accept and confirm the reported incident and respond to the incident as fast as possible. Basically the information required from the reporter depends on the type of incident. Emergency requests received by the police are generally classified in to four. These include crime related reports, fire, traffic accidents and Ambulance requests.

After observing how reports are being received by the police, we have seen that around 10 telephone hotlines where the public can call a specified number (991) to report anything related to an emergency. To answer these phone calls, a number of police operators are assigned to take necessary information from the caller and take necessary action to the report.

When receiving the report, if the report is crime related, the type of crime committed is required since there are different types of crimes. This is necessary because different types of crimes require different types of resources. The other important information is the time of the incident or the crime. The time...
describes whether the incident is happening during the reporting period or has already happened or will happen in the future. The other information required is the location of the incident, which describes the exact location or the nearest possible area of the incident. To describe location generally the sub city, kebele and special or known location name is used. Special location names include known commercial buildings, hotels, banks, street names etc. will be described. In addition to the above information if the report is a traffic accident, information about the vehicles and victims involved is expected.

The operators who receive the information use different mechanisms to validate the report. Validation of the report is necessary because information accepted from the phone call is anonymous. This increases the probability of false or bogus reports obviously wasting time and resources of the organization.

After successful retrieval of the above information from the caller, the next task is responding to an incident. Response action could be dispatching the required resources (police officers, fire fighters, traffic officers, ambulances) to the specified location. For responding purpose, mainly radio based communication is used, where selected number of officers carries around handheld radio communication system. Every sub city has its own a specific radio frequency, which is always open to receive reports. Therefore, the operators pass their information to the radio controller to inform the station nearest to the incident to take necessary action.

Every report received by the police follows the same routine to accept and respond to an incident. Later every police station from each sub city reports back to the central police station about the status of every incident and kept for later retrieval or analysis purposes. This will also help the central control to know of what is going on in the city every day.
Declaration

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

Declared by:

Name: ______________________________________
Signature: ______________________________________
Date: ______________________________________

Confirmed by advisor:

Name: ______________________________________
Signature: ______________________________________
Date: ______________________________________

Place and date of submission: Addis Ababa, June 2009.