



**ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF NATURAL SCIENCES
FACULTY OF COMPUTER AND MATHEMATICAL SCIENCES
DEPARTMENT OF COMPUTER SCIENCE**

A Web based Fire Accident Recording and Reporting System

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Table of Contents

CHAPTER ONE: INTRODUCTION.....	1
1.1 Background.....	1
1.2 Statement of the Problem.....	2
1.3 Objective.....	3
1.3.1 General Objective.....	3
1.3.2 Specific Objectives.....	3
1.4 Scope of the Project.....	3
1.5. Methodology.....	3
1.5.1 Data Collection.....	3
1.5.2 Development Tools.....	4
1.6 Application of the Project.....	4
1.7 Organization of the Document.....	4
CHAPTER TWO: LITERATURE REVIEW.....	5
2.1 Fire Accident Recording.....	5
2.2 GIS for Fire Accident Data Management.....	6
2.3 Fire Accident Data Management.....	7
2.3.1 Accident Recording.....	7
2.3.2 Accident Location Referencing.....	8
2.3.3 Analysis and Reporting.....	8
CHAPTER THREE: RELATED WORK.....	10
3.1 Web Based Emergency Management System.....	10
3.2 Emergency Response Management and Information System (ERMIS).....	10
3.3 Crime, Risk and Incident Management e-Service(CRIMe-S).....	11
CHAPTER FOUR: FIRE ACCIDENT RECORDING AND REPORTING SYSTEM IN ADDIS ABABA.....	13
4.1. Accident Data Recording.....	13
4.2. Accident Location Referencing.....	15
4.3 Data Storage.....	15

4.4 Analysis and Reporting.....	15
CHAPTER FIVE: REQUIREMENT ANALYSIS.....	16
5.1 Data fields for the Proposed System.....	16
5.2 Functional Requirements	18
5.3 Non-functional Requirements.....	18
5.4 The Analysis Model.....	19
5.4.1 Use case Models	19
5.4.2 Sequence Diagram	26
5.4.3 Class Diagram.....	33
CHAPTER SIX: SYSTEM DESIGN	35
6.1 Design Goals.....	35
6.1.1 Dependability Criteria.....	35
6.1.2 Maintenance Criteria.....	35
6.1.3 User Criteria.....	35
6.2 Subsystem Decomposition.....	36
6.3 Architecture of the System.....	37
6.4 Deployment Diagram.....	40
6.5 Persistent Data Management.....	41
CHAPTER SEVEN: IMPLEMENTATION OF THE SYSTEM.....	44
CHAPTER EIGHT: CONCLUSION AND FUTURE WORKS.....	53
8.1 Conclusion	53
8.2 Future Works	54
References.....	55
Appendix A: Structured Interview.....	57
Appendix B: Accident Recording Form	58
Appendix C: Accident Reporting Form.....	59

List of Tables

Table 4.1 Existing system data fields.....	13
Table 5.1 Data fields for the proposed system.....	16

List of Figures

Figure 5.1 Use case diagram of FARRS	20
Figure 5.2 Sequence diagram for Register Accident use case	27
Figure 5.3 Sequence diagram for View Report use case	28
Figure 5.4 Sequence diagram for Find Record use case	29
Figure 5.5 Sequence diagram for View Map use case	30
Figure 5.6 Sequence diagram for Create Account use case	31
Figure 5.7 Sequence diagram for Log in use case	32
Figure 5.8 Class diagram of FARRS	34
Figure 6.1 Subsystem decomposition of FARRS	36
Figure 6.2 Architecture of FARRS	39
Figure 6.3 Deployment diagram of FARRS	40
Figure 6.4 Mapping objects into tables	41
Figure 7.1 Home page of the system.....	44
Figure 7.2 Log in page	45
Figure 7.3 Create user account form	45
Figure 7.4 General accident information registration form	46
Figure 7.5 Human casualty registration form	47
Figure 7.6 Resource report.....	47
Figure 7.7 Periodic report	48
Figure 7.8 Yearly report.....	49
Figure 7.9 General report.....	50
Figure 7.10 Fire brigade stations on a map.....	51
Figure 7.11 The nearest fire brigade station to accident location on a map	52

Abbreviations and Acronyms

AAFAEPCA: Addis Ababa Fire Accident and Emergency Prevention and Control Agency

ADO.NET: ActiveX Data Object NET work

ASP: Active Server Page

FARRS: Fire Accident Recording and Reporting System

GIS: Geographic Information System

GPS: Global Positioning System

HTTP: Hyper Text Transfer Protocol

SQL: Structured Query Language

Abstract

The availability of fire accident data is crucial to effectively prevent and control fire accident and to produce fire safety management system. Reliable and relevant data can help identify the cause of the accident, to take precaution actions and to understand the degree of accident.

This project work has designed and implemented a web based Fire Accident Recording and Reporting System (FARRS) with GIS enabled feature for Addis Ababa which will enable fire brigade fighters and other stakeholders to get reliable and summarized information about fire accident.

System requirements have been rigorously collected from Addis Ababa Fire Accident and Emergency Prevention and Control Agency information team analysis department and literature review and related works which are used in other countries are also considered.

The system has different subsystems to satisfy its main functionalities. The registration subsystem allows the fire fighter to record complete information about an accident. The report subsystem generates periodic reports which greatly reduce time and effort to prepare stakeholders specific reports. The system also allows interested users to view fire brigade stations on the map and other related information about them.

The prototype has been tested with the actual data from the agency and it is found to be promising.

Keywords: Fire Accident, Fire Accident Recording, Fire Accident Reporting

CHAPTER ONE: INTRODUCTION

1.1 Background

An accident is any unplanned incident that either leads to or has the potential to cause injury or death or property loss. It includes fire, road, marine, air or other incidents that bring physical or property damage to the society. Fire accidents can result in catastrophic personal injury and devastating damage. Every year, billions of dollars in property damage occurs as a result of fire. Victims of fire accidents can suffer serious harm, including burn injury to their entire body. Fires can be caused in a number of ways. Some fires are intentionally set. Others are accidental [1].

Fire accidents are worldwide problems affecting almost every thing and bring not easily determined economic loss in every fiscal year. According to the US Fire Department, in 2009, 3,010 American civilians died as a result of a fire while 17,050 American civilians were injured. Home fires caused eighty five percent of the civilian death. Property loss due directly to fires cost approximately \$12.5 billion [2]. According to the Australian Fire Safety Statistics, domestic home fires are one of the leading causes of death, injury and property damage. In 2007, there were 98 fire deaths and in 2009, there were 112022 genuine fire incidents attended to by the fire service organizations nationally in Australia and the cost to service the demand of the fire service organizations was greater than \$ 3.0 billion in 2008-09 [20]. In 2009-10, there were 328 fire fatalities in United Kingdom [21]. In 2009, a total of 647904 cases of unnatural accidents caused 334766 deaths and rendered in India. One of the major unnatural causes of accidental deaths was fire accidents and which accounted for 7% of deaths [22].

Fire accident is also one of the main problems in Ethiopia because most of the houses are connected to each other and built unplanned, they were also built with mud and wood or materials that are easily ignited and aggravate the problems. For instance, in January 2011 more than seven million birr worth of property was destroyed as a result of fire in Harar town [3]. In Addis Ababa, around three million birr worth of property was

damaged by fire accidents in three different areas of the city (Piazza, Bole, Kasanchis) in January 2011 [4].

Recording and tracking of fire incidents is important to understand the magnitude of the fire problems in any organization. The documentation and analysis of incidents can provide rationale for implementing prevention activities [5]. To do this an efficient and effective system is needed.

1.2 Statement of the Problem

The current method or technique used to recording and reporting fire accident by Addis Ababa Fire Accident and Emergency Prevention and Control Agency (AAFAEPCA) is manual. When the accident occurs, fire brigade fighter, who observes the accident, records it on a form and reports to his or her leaders. After the authorities check and validate the accident form, they store it in the appropriate place. The current data recording and reporting of the fire accident from different fire brigade stations (Addis Ketema, Akaki Kality, Arada, Bole, Kirkos and Nifas Silk Lafto) to the AAFAEPCA (head office) is time consuming and prone to error. This also becomes hindrance for other stakeholders (police, insurances, court) from taking measures.

AAFAEPCA also uses different mass media to create awareness in the society and reduce fire accident casualty and property damage. In order to achieve their aims, they should be supported by up-to-date information about fire accident from any part of the city or surrounding districts. Web based Fire Accident Recording and Reporting system would provide up to date accident information which will assist the fire brigade fighters, society, police and other government to effectively prevent and control the accident.

Web based Fire Accident Recording and Reporting System can provide a number of advantages over the current existing system to Addis Ababa Fire Accident and Emergency Prevention and Control Agency such as reducing cost of communication between fire brigade stations, centralized control of the system and reducing cost of report preparation.

1.3 Objective

1.3.1 General Objective

The general objective of this project is to design and develop a web based Fire Accident Recording and Reporting System (FARRS) that would permit fire brigade fighters and other stakeholders to get reliable and summarized information about fire accident.

1.3.2 Specific Objectives

The specific objectives of the project are:

- To conduct literature review
- To design web based Fire Accident Recording and Reporting System
- To develop a prototype of the system

1.4 Scope of the Project

The system is limited to the development of a web based Fire Accident Recording and Reporting System for the city of Addis Ababa.

The limitations of the FARRS are:

- The system works in English language only
- The system does not identify the shortest route from fire brigade station to the accident occurring place

1.5. Methodology

1.5.1 Data Collection

For the purpose of requirement elicitation for the new system, primary data from Addis Ababa Fire Accident and Emergency Prevention and Control Agency has been collected and analyzed through structured interview, Appendix A. Structured interview has been conducted with two information team analysis department workers of the Agency.

1.5.2 Development Tools

Different tools were used to accomplish this project. They include ASP.NET 3.5 for developing the web applications, C# language for writing the application code, Microsoft SQL server 2005 for developing the backend of the database, Global Positioning System (GPS) for collecting geographic coordinates, AspMap 4.6 for controlling and adding maps into web applications and ArcGIS 9.3 for managing spatial and non spatial data.

1.6 Application of the Project

The result of the project can be used by fire brigade fighters to record the accident data, to recognize the major cause of the accident and to identify the place and season which is frequently affected by the fire accident. Fire brigade fighters are also capable of identifying the location of the accident and nearest fire brigade station to the accident occurring place. Information team analyst and agency's manager can get various reports and accident statistics easily that will help to take appropriate measures. Addis Ababa residents can easily identify the location of fire brigade stations and get information about them. Other stakeholders like police commissioner, insurance workers can also access different information about accident online.

1.7 Organization of the Document

The project report is organized into eight chapters including the current one. The second chapter presents a review of literature related to Fire Accident Recording and Reporting System. The third chapter reviews related works in different countries. The fourth chapter describes the existing fire accident recording and reporting system in Addis Ababa. The fifth chapter describes functional requirements, non-functional requirements and analysis model of the system. The sixth chapter describes architecture, subsystems and persistent data management of the system. The seventh chapter presents the prototype of the system and the last chapter presents conclusion and future work of the system.

CHAPTER TWO: LITERATURE REVIEW

2.1 Fire Accident Recording

In order to effectively fight against fires and to potentially prevent or minimize the impact of fire accidents, a large amount of data needs to be collected and to store data in a system that allows analysis to be undertaken when it is required. Through the analysis of the data, different statistics can be produced that are used to monitor the number and the characteristics of fires attended by fire fighters, including the cause and consequence of fires so that appropriate measures can be taken to bring down financial cost of fire. Fire brigades and other concerned organizations can use this fire statistics in making operational decisions, policy development and in promoting public awareness about the dangers of fire [8].

The availability of fire accident data is crucial to effectively prevent and control fire accident and to produce fire safety management system. Reliable and relevant data can help identify the cause of the accident, to take precaution actions and to understand the degree of accident.

Data collected about fires include [8]:

- Time and date of call
- Brigade or other geographical area
- Type of building or vehicle
- Most likely motive (accidental or malicious)
- Cause of fire
- Materials (furniture, etc)
- Spread of fire (beyond room of origin, etc.)
- Nature of fire casualties
- Rescue information and method of extinction

Fire incident data is used at all levels of government. At the local level, incident and casualty information is used for setting priorities and targeting resources. The data being collected are particularly useful for designing fire prevention and educational programs

and emergency medical service related activities specifically suited to the real emergency problems the local community faces. At the regional level, fire incident data is used in many capacities. One valuable contribution is that data is used by region legislatures to justify budgets and to pass important things on fire-related issues. Nationally, it is used by various private industries, including national associations for home appliance product manufacturers, the hotel and motel industry, insurance companies and lawyers [6].

The database should be designed to capture the data in the same order and format as paper forms used by firefighters, so this guide is relevant to anyone who must collect and report incident data. According to [6] each accident must have incident number to uniquely identify the accident and permits all properties involved in a fire incident to be related together.

2.2 GIS for Fire Accident Data Management

Geographic Information System (GIS) is one of the most important technologies used in different fields. A GIS is a dynamic and versatile technology capable of providing information to users and decision-makers for efficient planning and implementation. The unique feature of GIS is its ability to provide answers to the queries through rational and systematic analysis of the situation and users to take quick decision [12, 13].

GIS technology is being utilized in fire accidents, industrial accidents and road accidents [13]. Geographic information system (GIS) can be used to reduce the consequences of the accidents and provide appropriate response to the situation. Information gleaned from GIS software helps workers make better decisions. GIS is used to map incidents by type, location, and response time so that analysis can be done to understand severity of the accident [14].

For effective fire management, conventional fire records must be supported with maps and there should be dynamic integral spatial data such as the location of fire stations, access routes and information on risk areas. GIS can help to determine the optimum location of fire stations, classification of fire regions according to some criteria and the creation of region specific for prevention plans [15]. GIS by matching address

information with coordinate information directly helps in the determination of places of fires or accidents. Integration of all data within a GIS framework therefore represents a useful approach for performing more accident analyses that can support the decision-making processes of accidental management [16].

2.3 Fire Accident Data Management

2.3.1 Accident Recording

Many countries or states or cities use accident data management systems and practices in order to understand the magnitude of the problems and take appropriate measures. Management of fire records is critical to meeting its core business needs. Effective record keeping is also required to meet the needs of the fire fighters. Fire records are contained in written documents, computer systems and other formats. Proper records management supports the business function of the fire department. The records maintained by the fire department must be [10]

- Complete
- Accurate
- Relevant
- Authentic
- Reliable

The fire department personnel collect and record information about the accident where it occurred, the resources used to mitigate it and other information designed specifically to understand the nature and causes of fire. Information is also collected on the number of civilian or fire fighter casualties and an estimate of property loss.

Data elements collected, identified and recorded in various countries are uniform; however, there are some differences in the descriptions about data fields. The basic accident data fields appearing on accident report forms are categorized under different conditions or circumstances such as general accident information, location of the

accident, human casualty, property damage, resources use to extinguished fire, animal casualty and fire station [6, 7, 11].

2.3.2 Accident Location Referencing

In most accident recording forms different information is used to locate the accident place. This includes street or highway, intersection, direction, site, city or town information [6].

In order to efficiently and effectively control and analyze the accident, it is important to record and store the details of an accident on site and accurately reference the location of the accident. The use of geographic coordinate of the accident location is practiced in most countries. Global positioning system (GPS) is used to record the coordinates of accident locations. GIS mapping together with GPS provides pin point locations [9].

2.3.3 Analysis and Reporting

The analysis of information about accident may permit an understanding of the condition causing the injury and a means of planning suitable preventive techniques. On the basis of data items collected, it is possible to derive the location of fire, most likely cause, source of ignition, spread of fire, method of fire fighting, time and day of call to brigade, risk to life, rescue information, the details of casualties and many other variables [8]. It is also possible to create user-defined tables and charts based on the fire data collected by the fire worker to show the trend of the occurrences of fires and causality figures.

Each fire department is responsible for planning and managing its operations so that fire fighters can perform their roles of fire control and fire prevention most effectively and efficiently. The availability of accurate information about fires and other incidents is vital in achieving maximum performance. Patterns that emerge from the analysis of incident data can help departments focus on current problems, predict future problems in their communities, and measure their programs' performance. The data can be presented in a variety of ways, such as summaries, comparisons and reports [6]. GIS can analyze

intensive data volumes and it is highly effective in responding to spatial queries that can be used in the analysis data concerning fires [15].

CHAPTER THREE: RELATED WORK

The fire accident reporting systems generally appear in two forms as desktop applications and web-based applications. Both types of applications recently incorporate Geographical Information System (GIS) for better visualization of accident locations and capable of deeply analyze the accidents. This chapter reviews some of the available accident reporting systems.

3.1 Web Based Emergency Management System

The Virginia Department of Emergency Management (VDEM) recently launched an emergency management system called the Virginia Picture for Emergency Response (VIPER) that has transformed how it prepares for emergencies and responds to disasters. The GIS-based enterprise platform integrates with numerous information systems and links with approximately 250 data fields. It supplies a Web-based common operating picture and numerous analysis tools. Emergency commanders: police, fire, and government officials can exploit information about accident [17].

The goal of the system was to enhance information sharing, communication, and analysis. It would provide a new level of connectivity and fully integrate multiple systems. The system was built using ArcGIS9.3, including ArcGIS Server and ArcGIS Desktop software. VIPER offers instant access to essential information and maps. VIPER also provides information about nearby hospitals, fire stations in the case of an emergency and performs an analysis based on available information [17].

The VIPER system is available not only to local, state, and federal agencies but also to the public [17].

3.2 Emergency Response Management and Information System (ERMIS)

Emergency Response Management and Information System (ERMIS) was designed by analyzing the ground situation of Madurai city which is the third largest city in Tamil Nadu, state in southeastern India. The main objective of the ERMIS is to determine the

existing emergency risk zones by employing a GIS analysis on the history of fire accidents records, to locate the nearest emergency responder (ambulance, hospital, fire and rescue) and to provide all the available information regarding emergency care situation through ERMIS [18].

Emergency Response Management and Information System (ERMIS) was also planned to supply information to the user to make proper decisions at the time of emergencies. ERMIS also helps to solve routing problems effectively. Route map and directions output supply a substantial assistance to enable service providers to giving their service in a minimum of time. ERMIS database was designed to carry wide range of information including record of accidents and details of existing emergency services of the city. ERMIS does not require the user to be proficient in GIS techniques. It creates the displayed message of the spatial data and allows these data elements to be combined without a user having knowledge of the GIS software [18].

To make the ERMIS more user friendly, menu bars are added to user interface. Menu bar contains different menus with common commands to perform different functionalities on spatial data. ERMIS also contains map toolbar for display different maps [18].

3.3 Crime, Risk and Incident Management e-Service(CRIME-S)

CRIME-S is a web based Incident Reporting, Tracking, Investigation and Risk Management System. It enables the users to capture, track, investigate, manage risk and generate analytical reports on all possible and critical workplace incidents relating to arson, car or vehicle, electric and fire. An Internet connection and Internet browser is required to access the service and data [19].

The objective of the CRIME-S is to improve and establish effective and efficient communication. It provides a number of functions such as views or finds information on demand, accesses the service anytime, anywhere with the online-based web hosted service, accelerates incident reporting and GIS incident mapping with digital maps [19].

Summary

Different incident reporting systems have been used in many countries. Most of them handle a number of accidents such as fire, road, marine, air and other incidents. The situations of accident reporting in those countries are different from our country. For instance, there is fire sensor in almost every building and a lot of fire brigade stations are found a short distance apart. However, in our country few buildings (Bole Terminal, ECA, Sheraton Addis and Hilton Hotel) have fire sensors and a few fire brigade stations are found. Due to the above reasons and geography structure of our country differs to those countries so the GIS part is difficult to adapt it.

Most of the accidents, which are responded by Addis Ababa Fire Accident and Emergency Prevention and Control Agency (AAFAEPCA), are fire. The agency also responds to other accidents or problems like electric, river, lift and so on. It requires long time, capital and effort to tailor those incidents reporting systems in Ethiopia context.

CHAPTER FOUR: FIRE ACCIDENT RECORDING AND REPORTING SYSTEM IN ADDIS ABABA

Fire fighters, who work in Addis Ababa Fire Accident and Emergency Prevention and Control Agency, are responsible for recording and reporting of fire accidents data that happen in the city and surrounding districts. The fire accident recording and reporting system that is used in the agency is categorized into four main areas: accident data recording, accident location referencing, data storage and analysis and reporting.

4.1. Accident Data Recording

Fire fighters currently use pen and paper to record fire accidents. Fire departments use the forms to report fires and other incidents to which fire departments respond and to maintain records of these incidents in a uniform manner. After responding to an accident, fire fighters record the accident into forms, Appendix B. The information in these forms describe the kind of accident responded to, where it occurred, the resources used to control and extinguish the accident and other information designed specifically to understand the nature and causes of fire. Information is also collected on the number of civilian or fire fighter casualties, an estimate of property loss, offices or organizations which assist to control the accident, suggestion from the people who participated to turn off the fire and from owner of the property that is affected by fire accident.

The detail data fields and their expected values are shown in Table 4.1.

Table 4.1 Existing system data fields

	Data Items Fields	Domain (expected value)
1	Time received call of the accident	{Hour, Minutes}
2	Name of the caller	{Full name}
3	Phone number of the caller	{Mobile number, Public phone, Home phone}
4	Accident Date	{Day/Month/Year}
5	Time fire occurred	{Hour, Minutes}

6	Time required to leave the compound	{ Minutes }
7	Time required to reach accident place	{Hour, Minutes}
8	Time required to control the accident	{Hour, Minutes}
9	Accident Area	{Sub city, Kebele, House number}
10	Specific area of the accident	{Building name, Street, ...}
11	Accident type	{House burning, Vehicle burning, Electric pole burning, Office burning, ...}
12	Cause of the accident	{Electricity, Cylinder, Kerosene , ...}
13	Owner of the property	{Private, Public, Government, None Government organization}
14	Name of the owner	{Full name}
15	Property damaged	{Birr amount}
16	Property saved	{Birr amount}
17	Amount of water used to extinguish the fire	{litter}
18	Amount of chemical used to extinguish the fire	{litter}
19	Figure of fire fighters participated in the accident	{Number of fire fighters}
20	Figure of vehicles participated in the accident	{Number of vehicle}
21	Figure of ambulance participated in the accident	{Number of ambulance}
22	Casualty	{Number of injured people, Number of dead people }
23	Injured animals	{Number of injured animals, Number of dead animals}

24	Gas consumption for vehicles	{Litter}
25	Organizations help to control the accident	{Organization full name}
26	Shift of the work	{Day, Night}

4.2. Accident Location Referencing

In order to refer accident location, fire fighters use different techniques or methods such as sub city name, woreda or kebele name, near this building, in this village or compound and so on. Since there is no formal way for indicating accident location, this becomes the shortcoming of accident location recording and referring. Fire fighters, who work in Addis Ababa Fire Accident and Emergency Prevention and Control Agency, do not use Global Positioning System (GPS) so they are not able to effectively determine the specific accident location.

4.3 Data Storage

After accident data is collected from the accident location or place, the fire fighter fills in the accident information in the accident record paper form and usually keeps in file cabinets. Each accident is recorded and stored on a separate accident. These forms are processed at different periods based on different requirements by fire fighters. Such manual storage, retrieval and processing of accident information requires a lot of time and effort.

4.4 Analysis and Reporting

General statistical reports are manually produced weekly, monthly and yearly. The manual system produces general incident statistics that doesn't tailor to the specific need of the stakeholders. Moreover, it is also time taking. As the result of this it becomes obstacle for other stakeholders (court, insurance company and police) to undertake measures.

CHAPTER FIVE: REQUIREMENT ANALYSIS

Requirement analysis is a prerequisite for the success of a project development as it identifies, specifies and analyzes the requirement for the new system using functional model, object model and dynamic model. Under the following sections, the anticipated data fields for the new system, functional requirement, nonfunctional requirement and analysis models for the Fire Accident Recording and Reporting System (FARRS) are presented.

5.1 Data fields for the Proposed System

The new system requires additional data fields in addition to those specified in Table 4.1. Table 5.1 shows the complete data fields and their categories. The new fields are indicated in italics.

Table 5.1 Data fields for the proposed system

General Accident Information	
1	<i>Accident number</i>
2	Name of caller
3	Phone number of caller
4	Date (day/month/year)
5	Time of caller
6	Time required to leave the compound
7	Time fire occurred
8	Time required to arrive at accident place
9	Time required to control the accident
10	Sub city
11	District(Woreda)
12	Kebele
13	House number

14	Cause of the accident
15	Accident Type
16	<i>Weather condition (dry, cold, rain, other)</i>
17	Shift work (day, night)
Property	
18	Property type
19	Damaged property cost estimate
20	Saved property cost estimate
21	Owner name
22	Address(sub city, woreda, kebele, house number)
Human Casualty	
23	<i>Name</i>
24	<i>Father name</i>
25	<i>Sex</i>
26	<i>Age</i>
27	<i>Address(sub city, woreda, kebele, house number)</i>
28	<i>Nationality</i>
29	<i>Type of casualty (civilian, fire fighter, emergency worker, unknown)</i>
30	<i>Severity(minor, moderate, sever, death, undetermined)</i>
31	<i>Hospital name</i>
Animal Casualty	
32	<i>Animal Type</i>
33	Number of animal injured
34	Number of animal dead
Insurance	
35	<i>Insurance company name</i>
36	<i>Insurance type</i>
Accident Location	
37	Accident area
38	Specific area

39	<i>Street name</i>
40	<i>GPS reading-Longitude</i>
41	<i>GPS reading-Latitude</i>
Resources used to extinguish fire	
42	Water
43	Chemical
44	Gas
45	Vehicle
46	Participated worker
47	Ambulance
48	Assistant organization name

5.2 Functional Requirements

Functional requirements describe the interaction between the system and its environment independent of its implementation. The environment includes the user and any other environment system with which the system interacts.

The functional requirements of the FARRS are the following:

- Register fire accident
- Generate various reports based on the requirement
- Provide online notification and communication about the accident
- Allow searching fire accident record using different parameters
- Allow the user to find the nearest fire station
- Display fire accident stations and accident location on a map

5.3 Non-functional Requirements

Nonfunctional requirements describe user visible aspects of the system that are not directly related with the functional behavior of the system. Nonfunctional requirements include user interface and human requirement, hardware requirement, performance characteristics (response time), security issue, system modification and error handling.

The nonfunctional requirements of the FARRS are the following:

- The user interface should be user friendly and attractive
- The system does not permit unauthorized users to register and modify fire accident records
- The system should handle invalid inputs and display informative error messages to user
- The system should be easily modifiable and incorporate others functionality to future growth

5.4 The Analysis Model

The analysis models of the system are represented with the functional model (use case diagrams), object model (class diagrams) and dynamic model (sequence diagrams).

5.4.1 Use case Models

Use cases describe the behavior of the system from an external point of view and they are used to represent the functionality of the system. A use case model holds use cases, actors and the boundary of the system. The use case diagram of Fire Accident Recording and Reporting System (FARRS) is shown in Figure 5.1.



Figure 5.1 Use case diagram of FARRS

5.4.1.1 Actor Description

The actors that are mainly interacting with the system are fire fighter, manager, system administrator and any user of the system (insurance company worker, Addis Ababa and surrounding residents).

5.4.1.2 Use case description

A. Use case name: **Register Accident**

Participating actors(s): fire fighter

Description: allows fire fighter to register fire accident

Precondition: fire fighter must login

Flow of events:

1. The actor clicks on register link
2. The system displays registration page
3. The actor selects register accident
4. The system provides register accident form
5. The actor fills accident details in the form and submits to the system [Alt 5]
6. The system registers the record
7. The system displays acknowledgement message
8. The use case ends

[Alt 5]: [if the actor misses fields or does not fill the form properly]

5.1 The system displays an error message

5.2 The system resumes at step 5

Post condition: Accident record is registered in the system

B. Use case name: **View Report**

Participating actors(s): manager

Description: allows manager to access and view fire accident reports

Precondition: the actor must login

Flow of events:

1. The actor clicks on report link

2. The system displays report page
3. The actor selects report
4. The system provides report form
5. The actor fills criteria in the form and submits to the system [Alt 5]
6. The system displays all records that satisfy the criteria or generates report
7. The use case ends

[Alt 5]: [if the form is not filled properly]

5.1 The system displays an error message

5.2 The system resumes at step 5

Post condition: The manager should be able to view the report

C. Use case name: **Find Record**

Participating actor(s): fire fighter, manager, user

Description: allows the actors to find a particular fire accident record

Precondition: the actor should know the URL of the system

Flow of events:

1. The actor clicks on find record link
2. The system provides different forms
3. The actor chooses the forms and enters the parameters that are used to search the records [Alt 3]
4. The actor submits the criteria to the system
5. The system retrieves and displays the records that satisfy the criteria
6. The use case ends

[Alt 3]: [if the actor does not enter correct parameters]

3.1 The system displays an error message

3.2 The system resumes at step 3

Post condition: the record(s) will be displayed

D. Use case name: **View Map**

Participating actors(s): fire fighter, manager, user

Description: allows the actors to access and view fire accident location and other information on the map

Precondition: the actor should know the URL of the system

Flow of events:

1. The actor clicks on view map link
2. The system provides different operations
3. The actor chooses operation and fills the form and submits to the system [Alt 3]
4. The system displays map or information that are satisfied the criteria
5. The use case ends

[Alt 3]: [if the form is not filled properly]

- 3.1 The system displays an error message
- 3.2 The system resumes at step 3

Post condition: The user is able to access and view different accident locations and information on the map

E. Use case name: **Create Account**

Participating actor(s): system administrator

Description: allows the system administrator to create account for fire fighter or manager

Precondition: the actor must login

Flow of events:

1. The actor clicks on account link
2. The system displays account management page
3. The actor selects create account
4. The system provides create account form
5. The actor fills the form and submits to the system [Alt 5]
6. The system registers the user and creates account for him/her
7. The system displays acknowledgement message
8. The use case ends

[Alt 5]: [if the form is not filled properly]

- 5.1 The system displays an error message
- 5.2 The system resumes at step 5

Post condition: The user account is created

F. Use case name: **Delete Account**

Participating actor(s): system administrator

Description: allows the system administrator to delete accounts

Precondition: the actor must login and user account to be deleted should already exist
in the system

Flow of events:

1. The actor clicks on account link
2. The system displays account management page
3. The actor selects delete account
4. The system provides delete account form
5. The actor fills the form and submits to the system [Alt 5]
6. The system deletes user account
7. The system displays acknowledgement message
8. The use case ends

[Alt 5]: [if the form is not filled properly]

5.1 The system displays an error message

5.2 The system resumes at step 5

Post condition: The user account will be deleted

G. Use case name: **Disable Account**

Participating actor(s): system administrator

Description: allows the system administrator to disable accounts

Precondition: the actor must login and user account to be disabled should already exist
in the system

Flow of events:

1. The actor clicks on account link
2. The system displays account management page
3. The actor selects disable account
4. The system provides disable account form
5. The actor fills the form and submits to the system [Alt 5]
6. The system disables user account

7. The system displays acknowledgement message
8. The use case ends

[Alt 5]: [if the form is not filled properly]

- 5.1 The system displays an error message
- 5.2 The system resumes at step 5

Post condition: The user account will be disabled

H. Use case name: **Update Account**

Participating actor(s): system administrator

Description: allows the system administrator to update accounts

Precondition: the actor must login and user account to be updated should already exist
in the system

Flow of events:

1. The actor clicks on account link
2. The system displays account management page
3. The actor selects update account
4. The system provides update account form
5. The actor fills the form and submits to the system [Alt 5]
6. The system updates user account
7. The system displays acknowledgement message
8. The use case ends

[Alt 5]: [if the form is not filled properly]

- 5.1 The system displays an error message
- 5.2 The system resumes at step 5

Post condition: The user account will be updated

I. User case name: **Log in**

Participating actors(s): fire fighter, manager and system Administrator

Description: enables the user to log in the system

Precondition: the actor must have an account

Flow of events:

1. The actor clicks on login link

2. The system displays login page
3. The actor enters user name and password [Alt 3]
4. The system provides page based on their privilege
5. The use case ends

[Alt 3]: [if the actor does not provide correct username and password]

- 3.1 The system displays the login page with errors message
- 3.2 The system resumes at step 3

5.4.2 Sequence Diagram

Sequence diagrams represent the interaction among participating objects in a use case. They are used to formalize the behavior of the system and to visualize the communication among objects. They are also important to distinguish the missing objects that are not identified in the other analysis objects models. The sequence diagrams of Register Accident use case, View Report use case, Find Record use case, View Map use case, Create Account use case and Log in use case are shown from Figure 5.2 up to Figure 5.7 respectively.

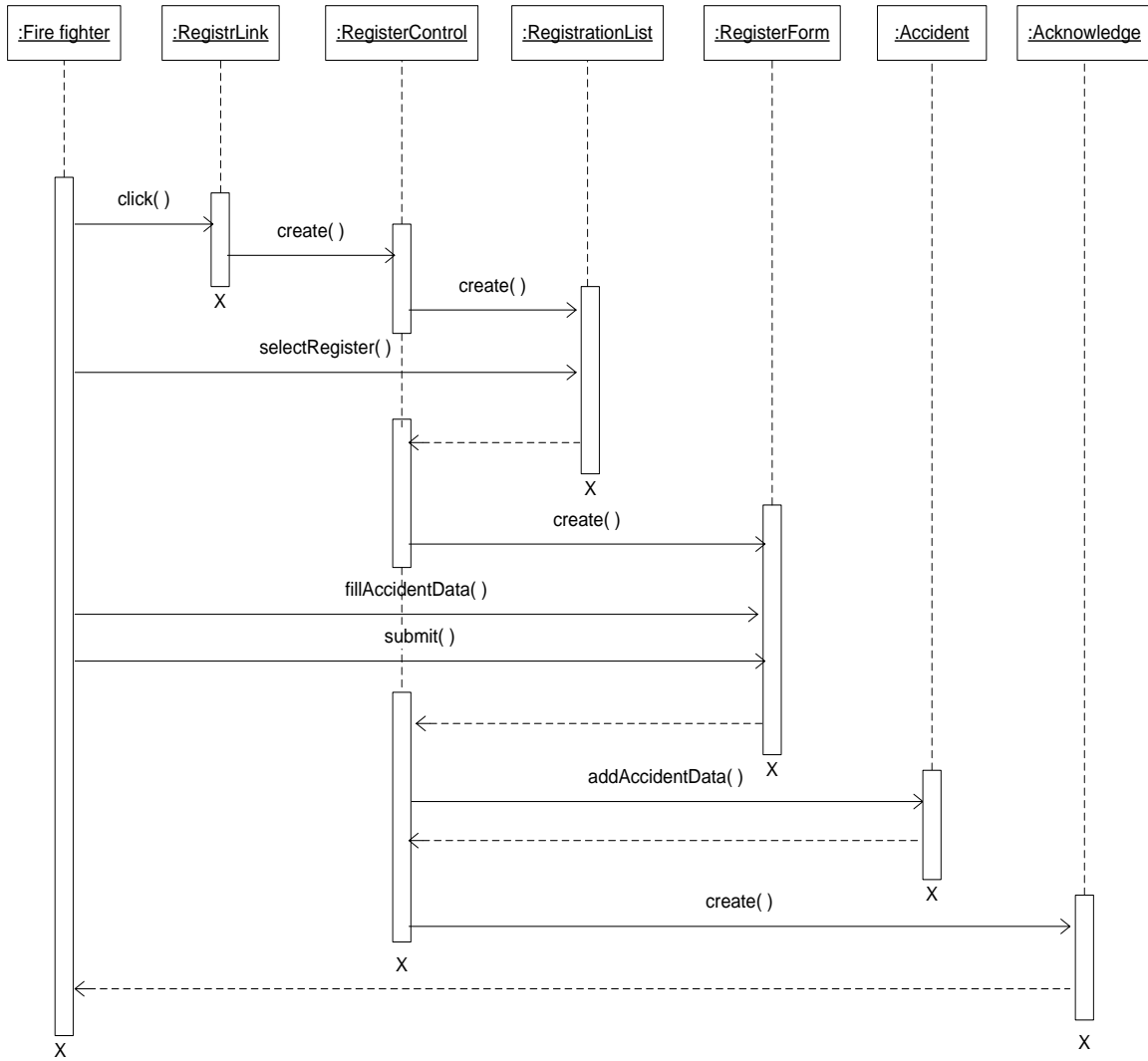


Figure 5.2 Sequence diagram for Register Accident use case

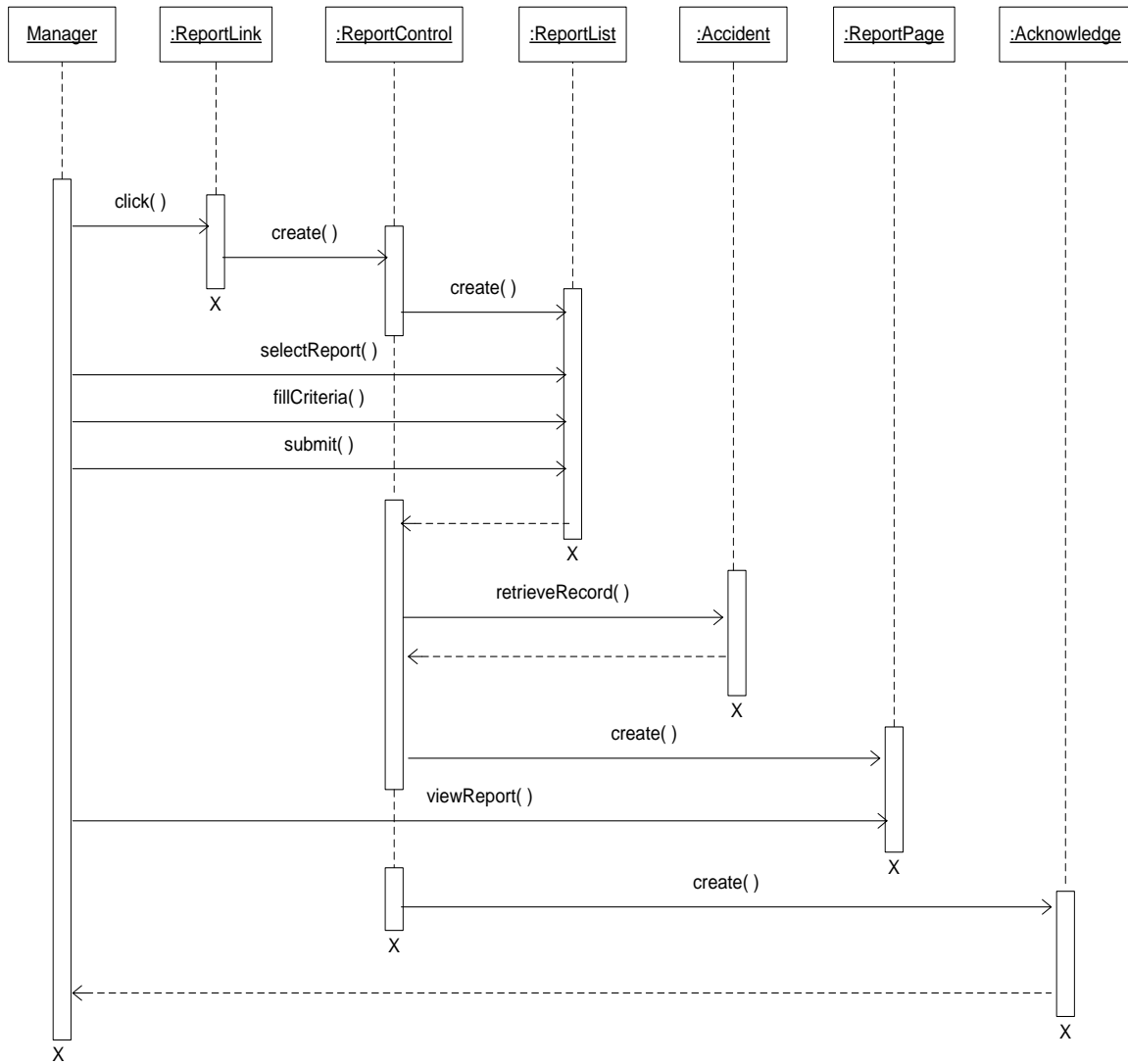


Figure 5.3 Sequence diagram for View Report use case

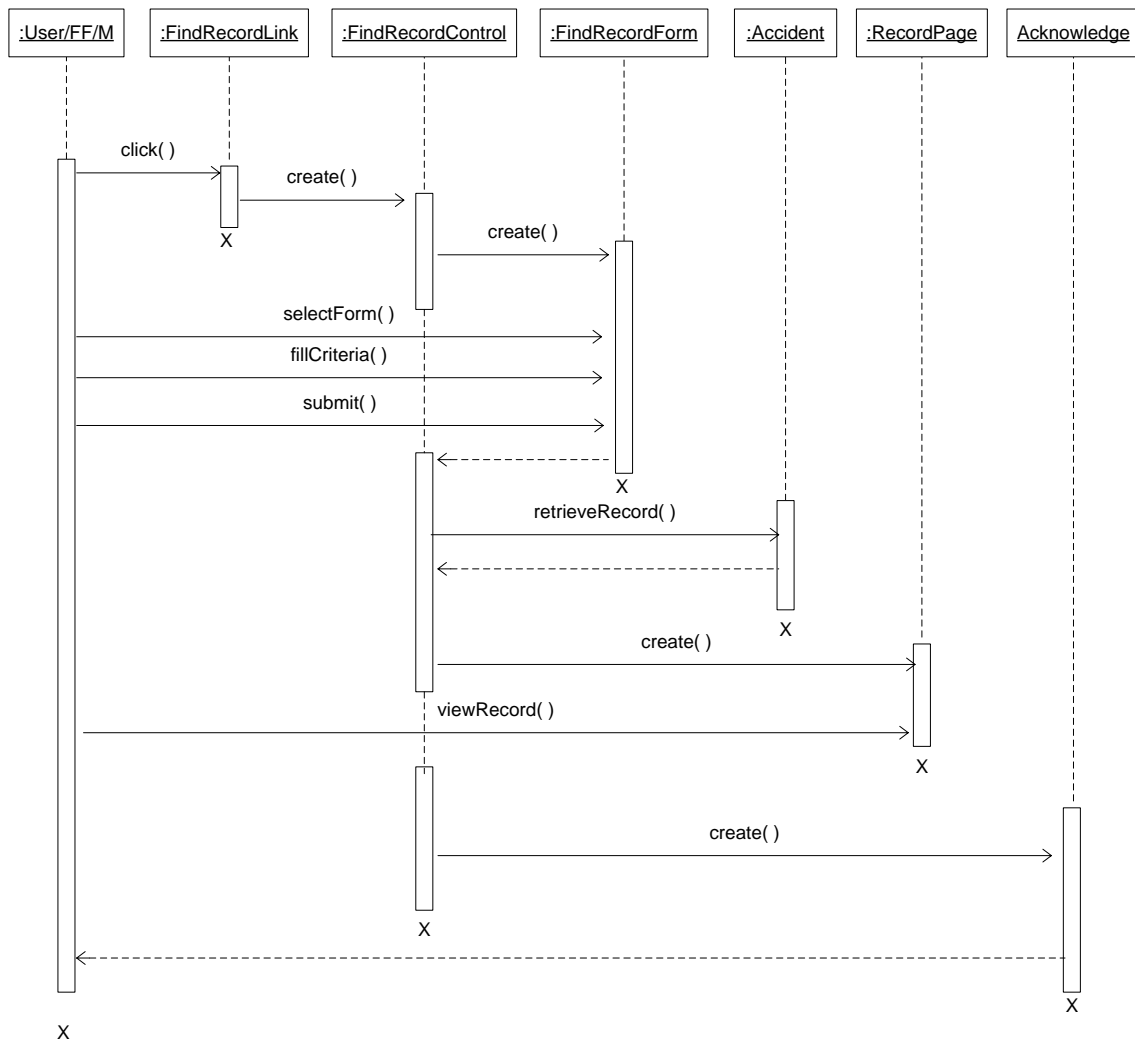


Figure 5.4 Sequence diagram for Find Record use case

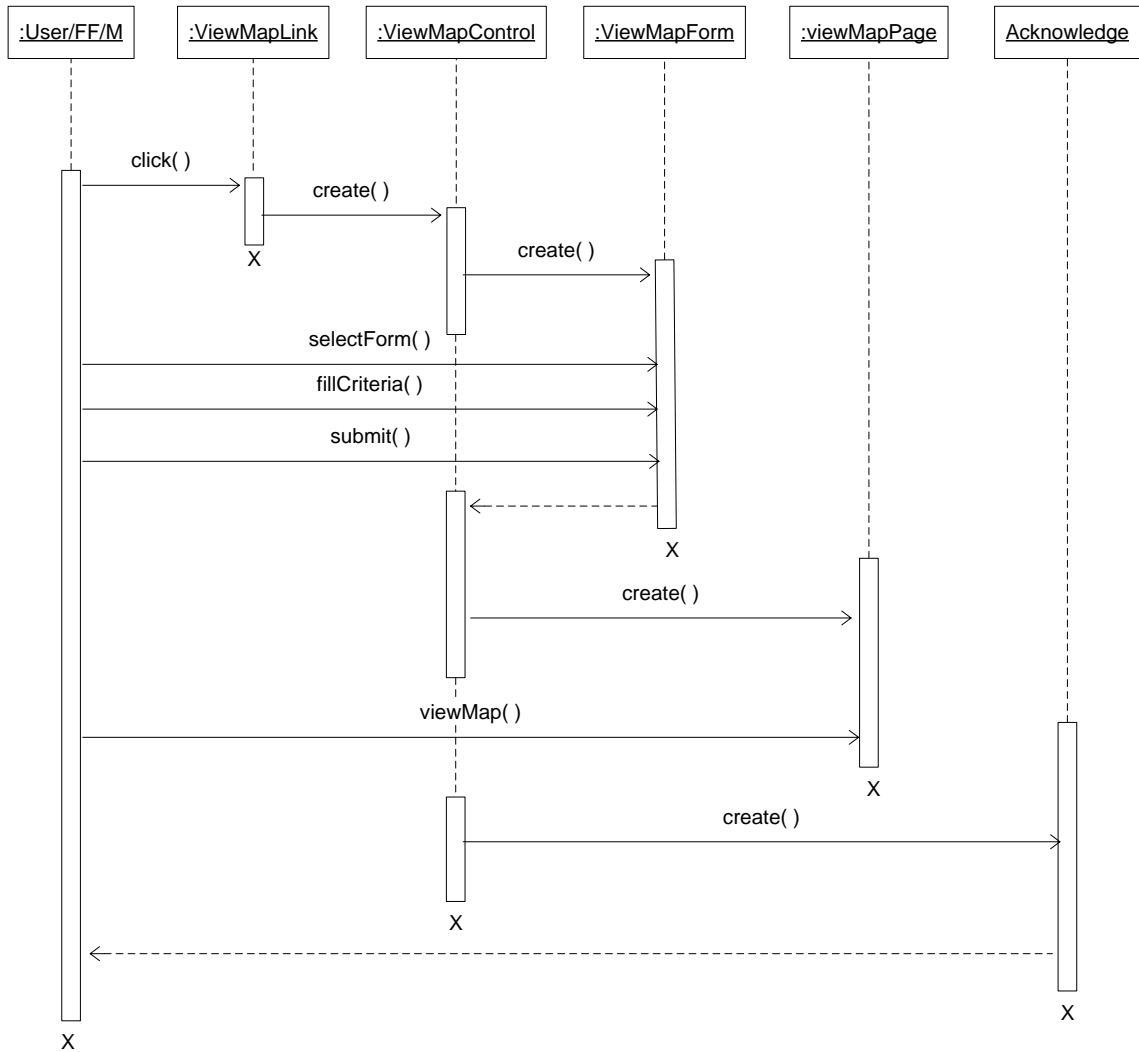


Figure 5.5 Sequence diagram for View Map use case

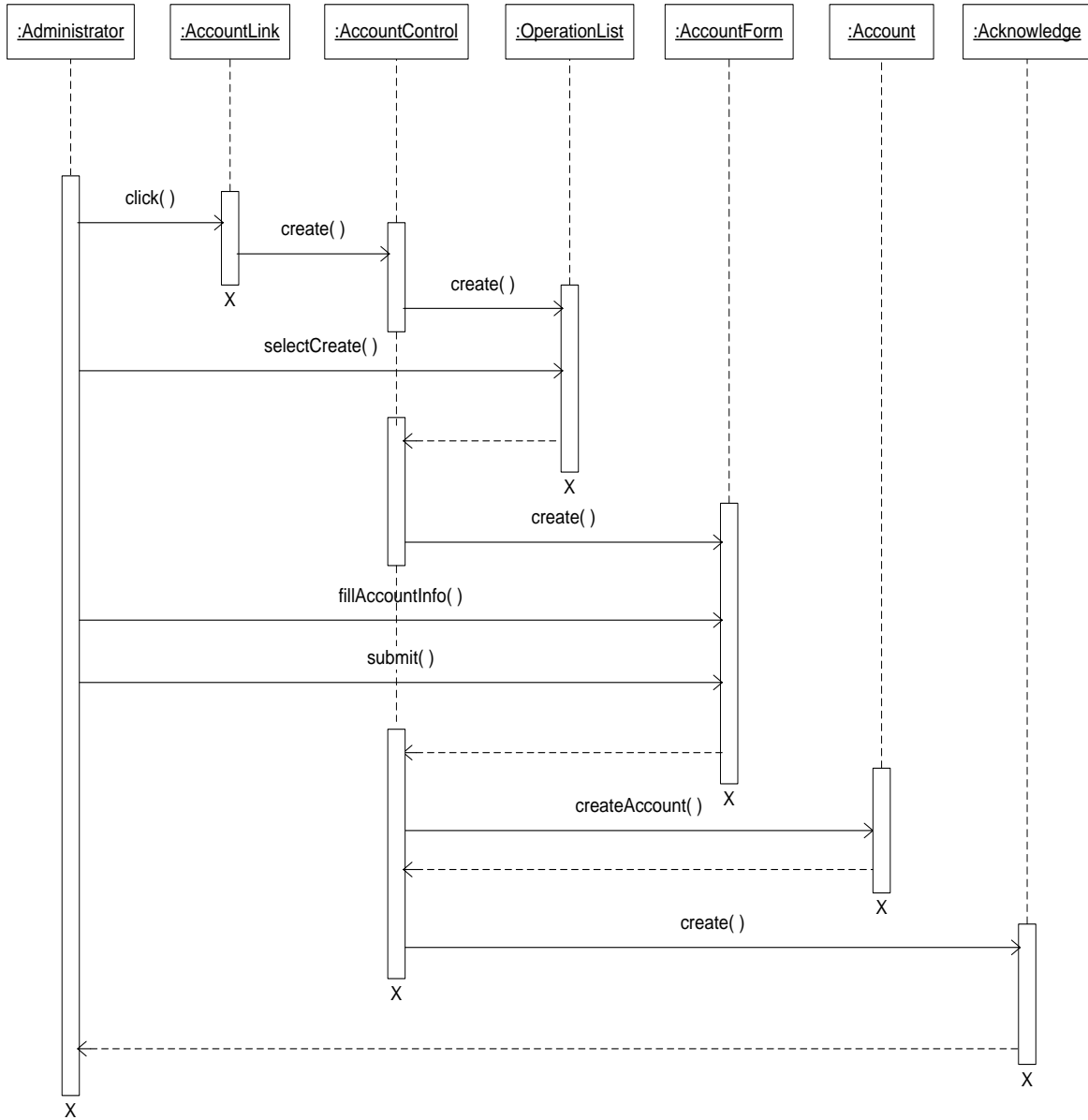


Figure 5.6 Sequence diagram for Create Account use case

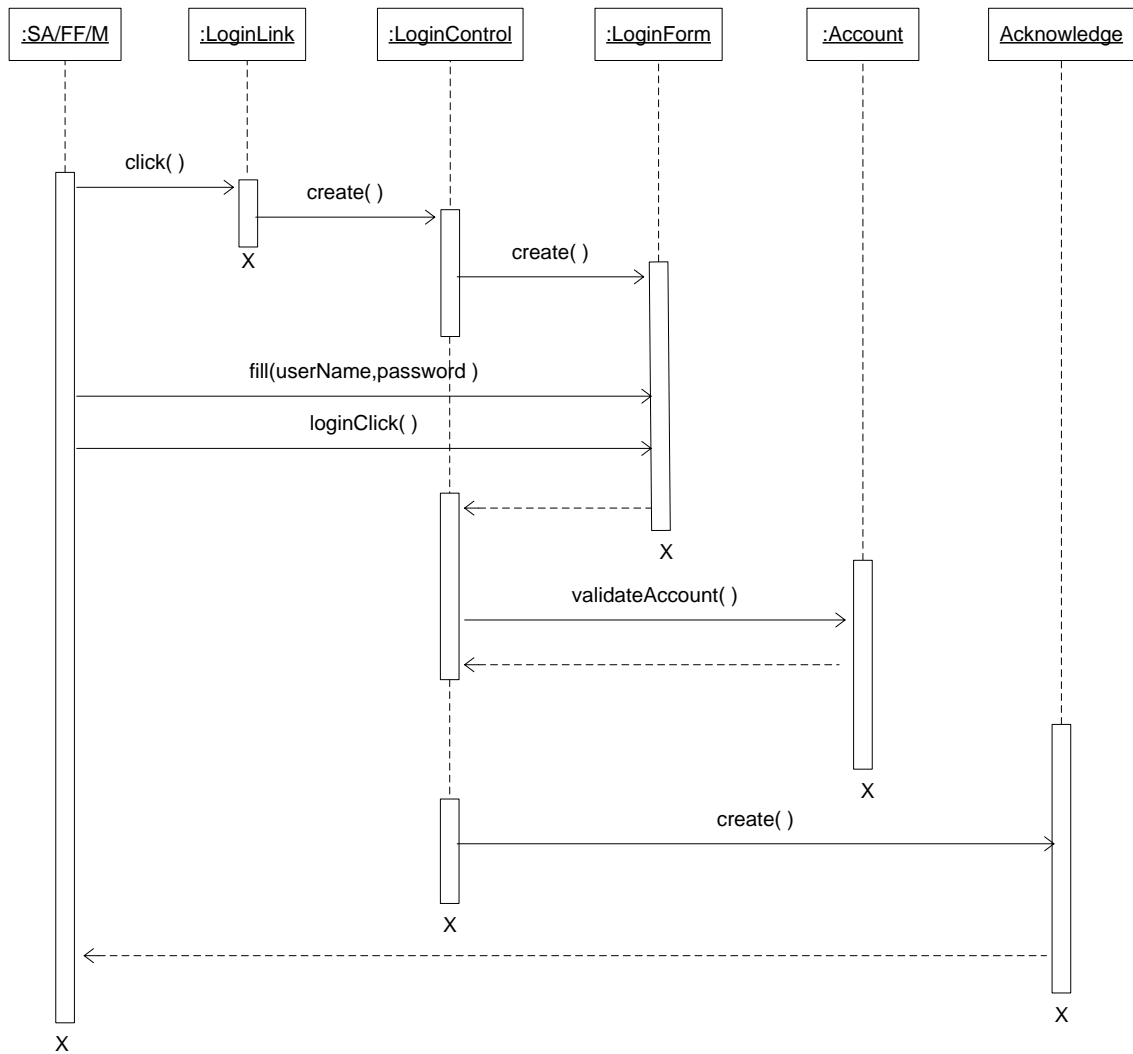


Figure 5.7 Sequence diagram for Log in use case

5.4.3 Class Diagram

Class diagrams are used to describe the structure of a system in terms of classes, attributes, operations and association of objects in the class. The class diagram of Fire Accident Recording and Reporting System (FARRS) is shown in Figure 5.8.

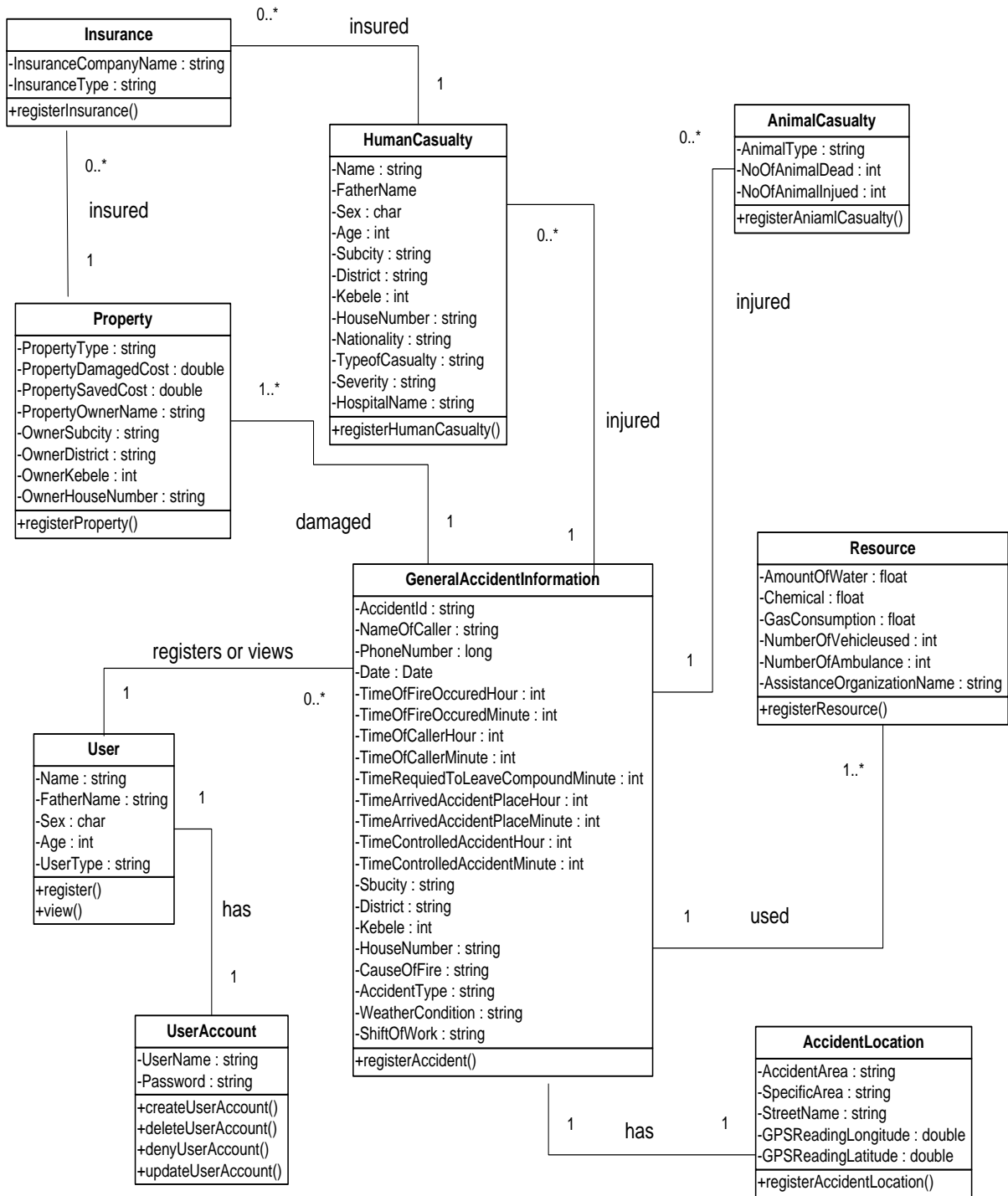


Figure 5.8 Class diagram of FARRS

CHAPTER SIX: SYSTEM DESIGN

During requirement elicitation and analysis phase the services that are intended to be provided by the system are identified but they are not defined internally and logically how they work. System design is the transformation of the analysis model into a system design model. During system design, design goals, decomposition of the system into smaller subsystems, architecture of the system and persistent data management are described.

6.1 Design Goals

Design goals represent the anticipated qualities of the system. Most of the design goals of the system are derived from the non-functional requirements. The design goals can be generally organized into dependability, maintenance and end user criteria.

6.1.1 Dependability Criteria

The system should be designed to reject invalid user inputs during fire accident recording, searching record and others related activities to ensure the system's robustness for all interacting users. The system should also be designed to prompt the user with password and user name. This provides security in such a way that unauthorized users are not able to register, alter and view sensitive data about fire accident records. Moreover, the system should be available for any legitimate users as long as the service provider is available.

6.1.2 Maintenance Criteria

The system should be easily extensible to add new functionalities without affecting the general frame work of the system. It also should be easily modifiable.

6.1.3 User Criteria

The system should be user friendly and self-explanatory graphical user interface that eases to use and learn the system.

6.2 Subsystem Decomposition

The system is decomposed into four subsystems to reduce the complexity of the system. While performing system decomposition we considered the two basic concepts namely coupling (the dependencies between two subsystems) and coherence (the dependencies among classes within a subsystem). Figure 6.1 illustrates the subsystem decomposition of Fire Accident Recording and Reporting system.

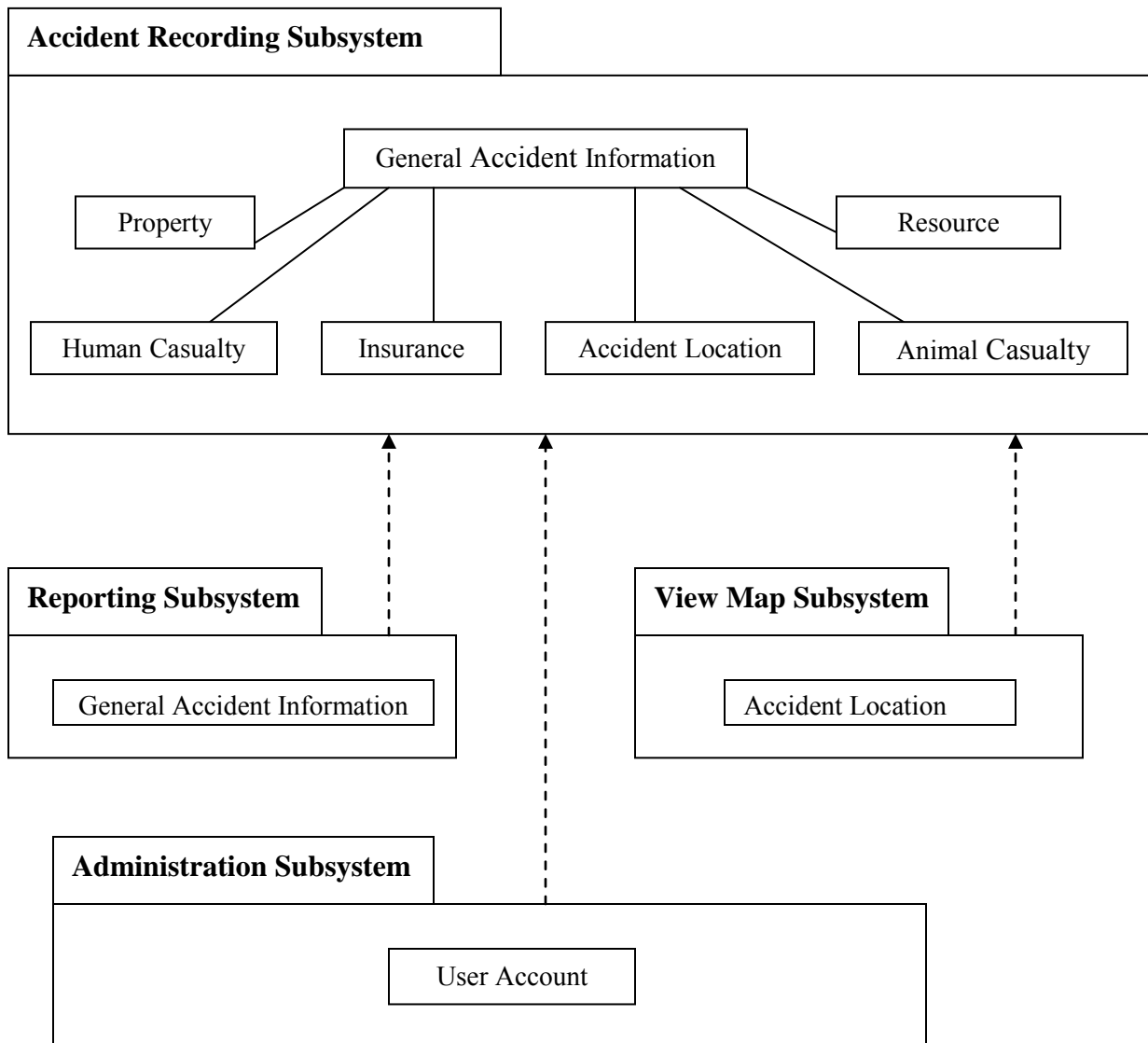


Figure 6.1 Subsystem decomposition of FARRS

The accident recording subsystem is responsible for registering general information about the accident, accident location, property damage, casualty, resources used to extinguish fire and other related accident data.

The reporting subsystem generates different reports based on the requirement like casualty figures, the number of fire accident happened in each sub city, amount of property saved by fire fighters, amount of property damaged by fire, amount of resources used to halt the fire and so on.

The administration subsystem enables the system administrator to manage user accounts. This management includes creation of new user accounts, deleting existing user accounts, disabling user accounts and updating user accounts.

The view map subsystem enables the users to see fire brigade stations on a map. It also displays the specific accident location on the map. Moreover, it helps the users to easily identify the nearest fire brigade station.

6.3 Architecture of the System

The architecture of an application defines how different parts of the system are organized and logically connected. The architecture of Fire Accident Recording and Reporting System is designed to be client-server application that consists of three tiers namely client tier, middle tier and data tier as shown in Figure 6.2.

The client tier is the application's user interface containing accident registration forms, reports page, user account management page, view map and client side application that are running on the web browser of the user machine. The fire fighters, manager, system administrator and other users of the system directly interact with the system through user interface. It interacts with the web server or AspMap server to make requests, to display the data that are retrieved from the database and shapes files that are retrieved from ArcGIS on the page.

The middle tier of the Fire Accident Recording and Reporting system contains web sever, AspMap server and the business logic. The web server handles all the HTTP requests coming from the client machines. It also manages the responses that are returned to the client machines. The AspMap is a set of server-side mapping controls and components that allow adding maps into web applications. The business logic is responsible for handling the main activities such as input validation, report generation, performing calculations, access and retrieval of data required by the client. It also interacts with an external system such as ArcGIS to fetch shapes files and displays them on the page.

The data tier manages the actual data that is being stored in the database. It is implemented using Microsoft SQL server 2005 database. The database accepts the SQL statement and executes it by DBMS component and then returns the required output to the application

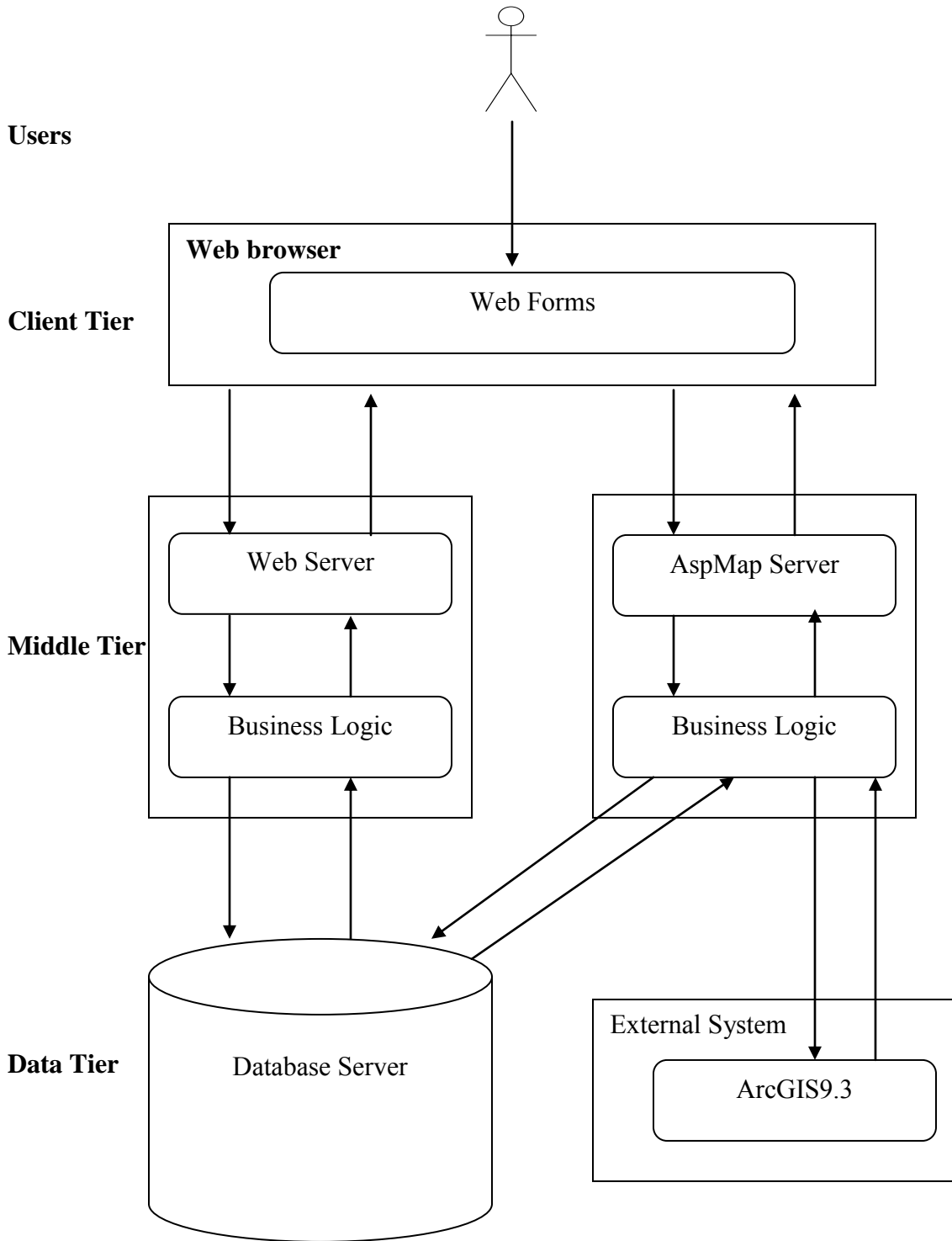


Figure 6.2 Architecture of FARRS

6.4 Deployment Diagram

A deployment diagram of a system shows the hardware/software mapping. The subsystems of Fire Accident Recording and Reporting system identified in the subsystem decomposition section are mapped onto the client and the sever nodes as depicted in Figure 6.3.

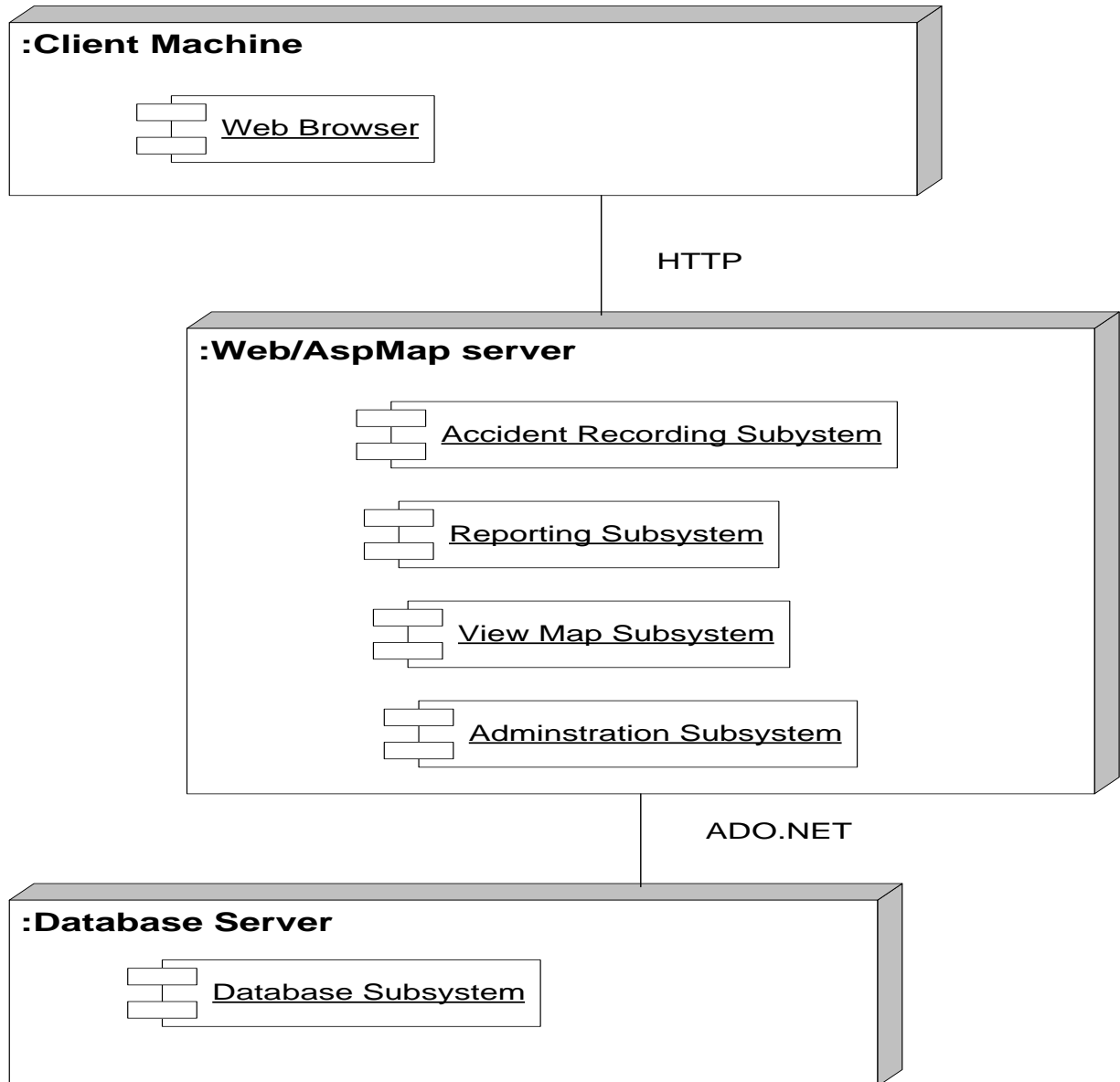


Figure 6.3 Deployment diagram of FARRS

6.5 Persistent Data Management

Persistent data management deals with how the persistent data are stored and managed. Information related to accidents, casualty, property damaged, resources use to extinguish fire and other related information are persistent data and stored in a database management system.

In order to store data persistently in a database, those entity classes identified in analysis model of class diagram of Fire Accident Recording and Reporting system are transformed into tables and attributes of the classes are also mapped into tables fields. The tables of the database with their respective fields and their relationship among tables are shown in Figure 6.4.

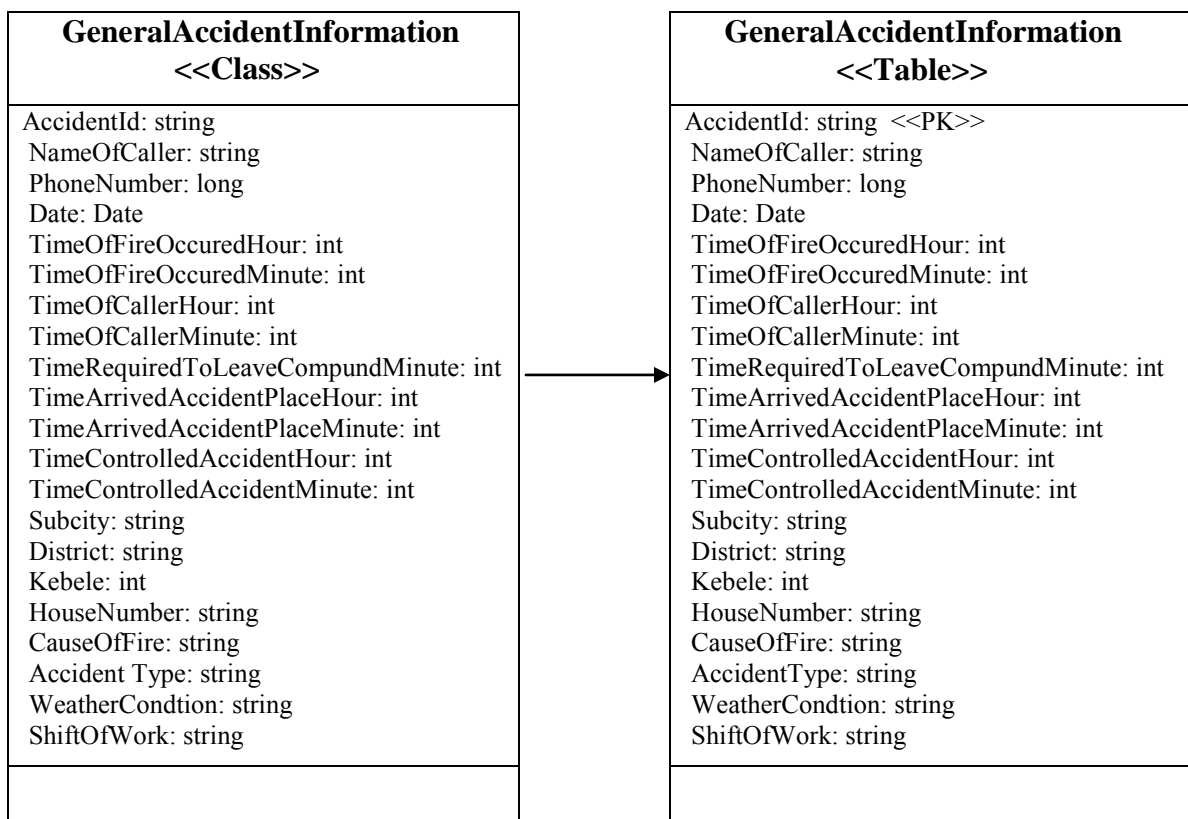


Figure 6.4 Mapping objects into tables

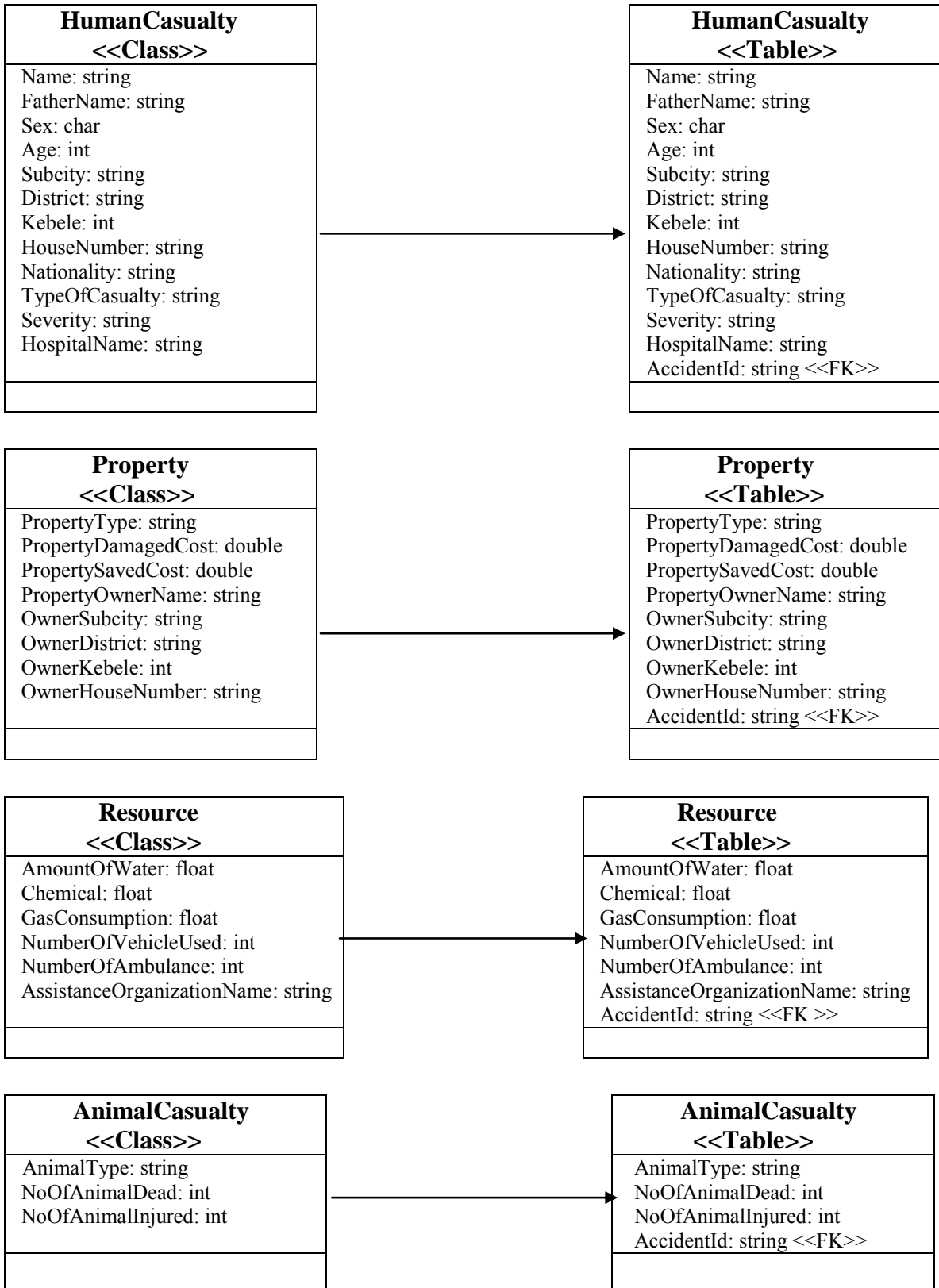


Figure 6.4 (Continued)

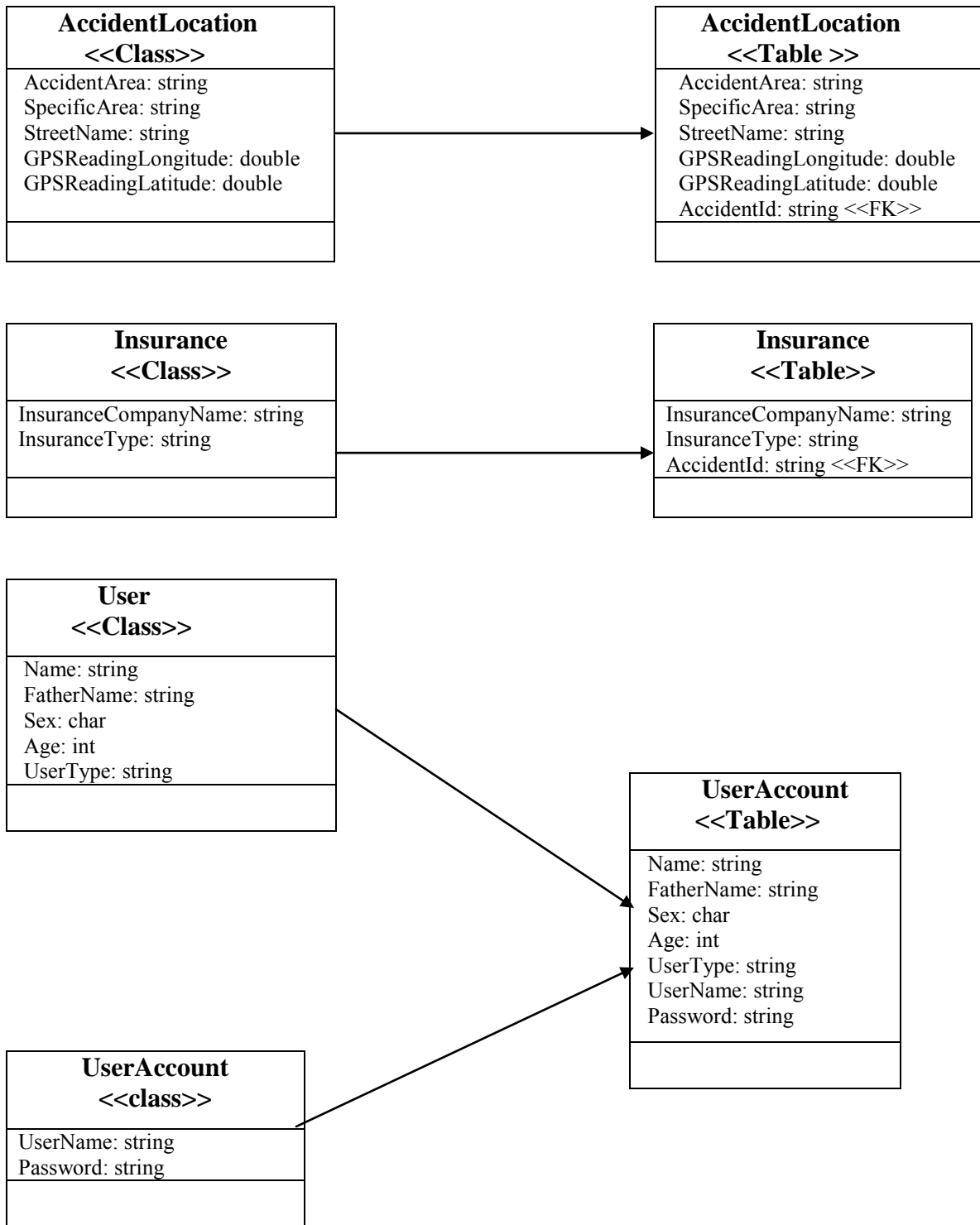


Figure 6.4 (Continued)

CHAPTER SEVEN: IMPLEMENTATION OF THE SYSTEM

Fire Accident Recording and Reporting prototype is designed and implemented with various development tools. ASP.NET is used to build the server side of the web applications, C# language is used to write the applications code behind the web pages, Microsoft SQL server 2005 is used to develop the back end of the database, ArcGIS 9.3 is used to manage spatial and non spatial data and AspMap 4.6 is used to control map and allow adding maps into web applications.

The system has an administration subsystem, accident registration subsystem and view report subsystem which can be initiated from Login whereas accident record searching and view map can be initiated from home page as shown in Figure 7.1.



Figure 7.1 Home page of the system

The log in page, create user account form, general accident information registration form, human casualty registration form, resource report, periodic report, yearly report, general report, fire brigade stations on a map and the nearest fire brigade station to accident location on a map are shown from Figure 7.2 up to Figure 7.11 respectively.

አዲስ አበባ አሳትና ድንገተኛ አደጋዎች መከላከልና መቆጣጠር ኤጀንሲ

[Home](#) [Login](#) [Find Record](#) [View Map](#) [Contacts](#) [Help](#)

UserName

Password

Login

Figure 7.2 Log in page

Create User Account

Name

Father Name

Sex ▼

Age

UserName

Password

Catagory ▼

Status ▼

Create Reset

Figure 7.3 Create user account form

General Accident Information Registration Form

AccidentId NameOfCaller
 PhoneNumber Date

Time

Fire Occured Hour Min
 Caller Hour Min
 Required to leave the compound Min
 Required to reach accident place Hour Min
 Required to control the accident Hour Min

Subcity District
 Kebele HouseNumber
 CasuseOfFire AccidentType
 WeatherCondtion Shift Work

Figure 7.4 General accident information registration form

Human Casualty Registration Form

Accident Id

Name Father Name

Sex Age

Subcity District

Kebele House Number

Type of Casualty Severity

Nationality Hospital Name

Insurance Company

Figure 7.5 Human casualty registration form

Resource Report

Starting Date Date

Ending Date

< March 2011 >						
Su	Mo	Tu	We	Th	Fr	Sa
27	28	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9

Date	Water	Chemical	Gas	Vehicle	Ambulance	Worker
1/17/2011	195000	0	78	4	1	35
1/29/2011	20000	0	100	4	2	30
2/13/2011	1000	0	25	1	1	11
2/26/2011	9000	0	55	2	0	10
3/1/2011	22500	0	124	4	0	27
3/3/2011	4500	0	45	2	0	14
3/6/2011	3000	0	20	1	0	8
3/22/2011	7500	0	40	2	0	11
3/22/2011	9000	0	35	2	0	14
1/24/2011	27000	0	157	4	2	27
Total	298500	0	679	26	6	187

Figure 7.6 Resource report

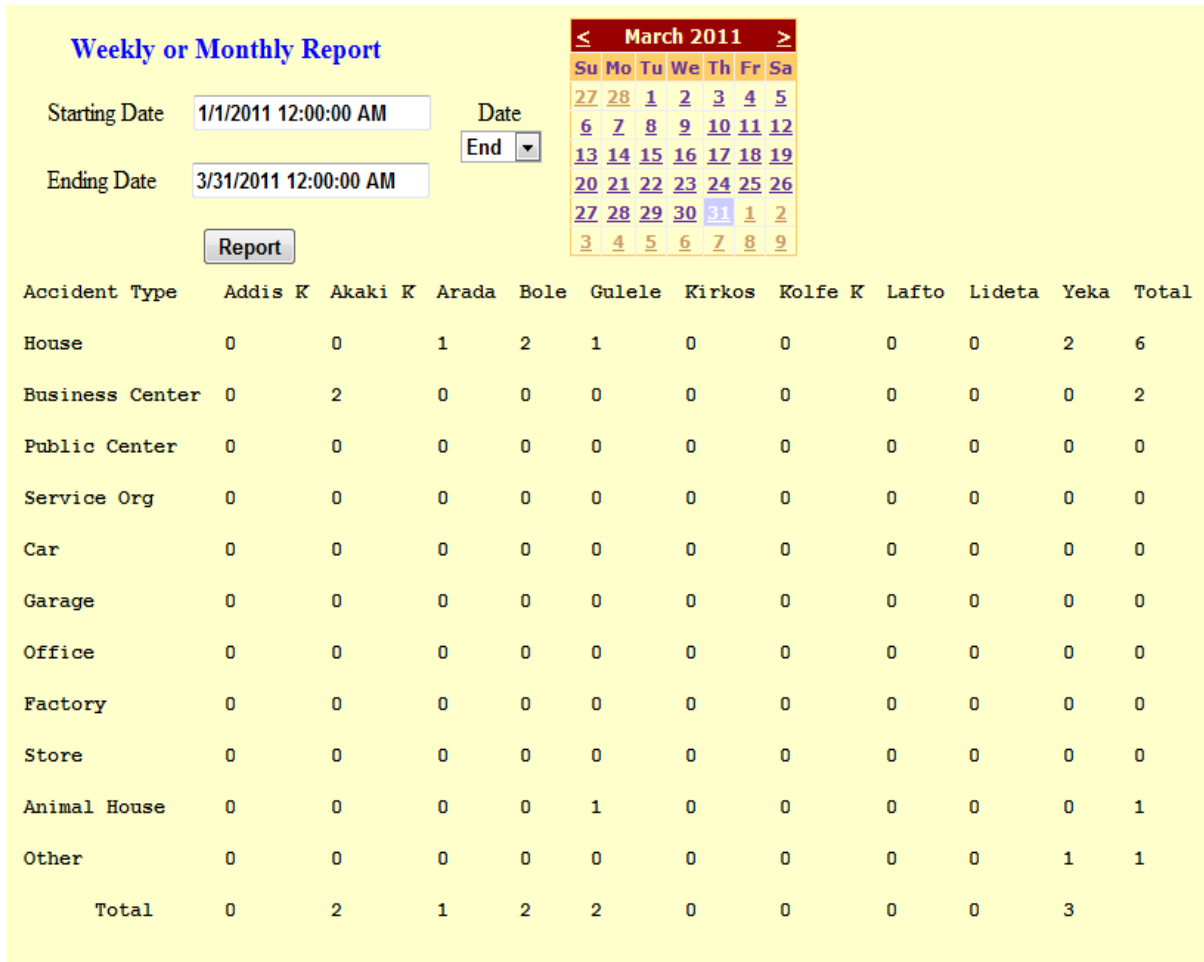


Figure 7.7 Periodic report

Yearly Report

Year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Addis Ketema	0	0	0	0	1	0	0	0	0	0	0	0	1
Akaki Kality	0	0	2	1	0	0	0	0	0	0	0	0	3
Arada	1	0	0	0	0	0	0	0	0	0	0	0	1
Bole	0	1	1	0	0	0	0	0	0	0	0	0	2
Gulele	1	0	1	0	0	0	0	0	0	0	0	0	2
Kirkos	0	0	0	0	0	0	0	0	0	0	0	0	0
Kolfe Keraniyo	0	0	0	0	1	0	0	0	0	0	0	0	1
Lafto	0	0	0	0	0	0	0	0	0	0	0	0	0
Lideta	0	0	0	0	0	0	0	0	0	0	0	0	0
Yeka	1	1	1	0	0	0	0	0	0	0	0	0	3
Total	3	2	5	1	2	0	0	0	0	0	0	0	

Figure 7.8 Yearly report

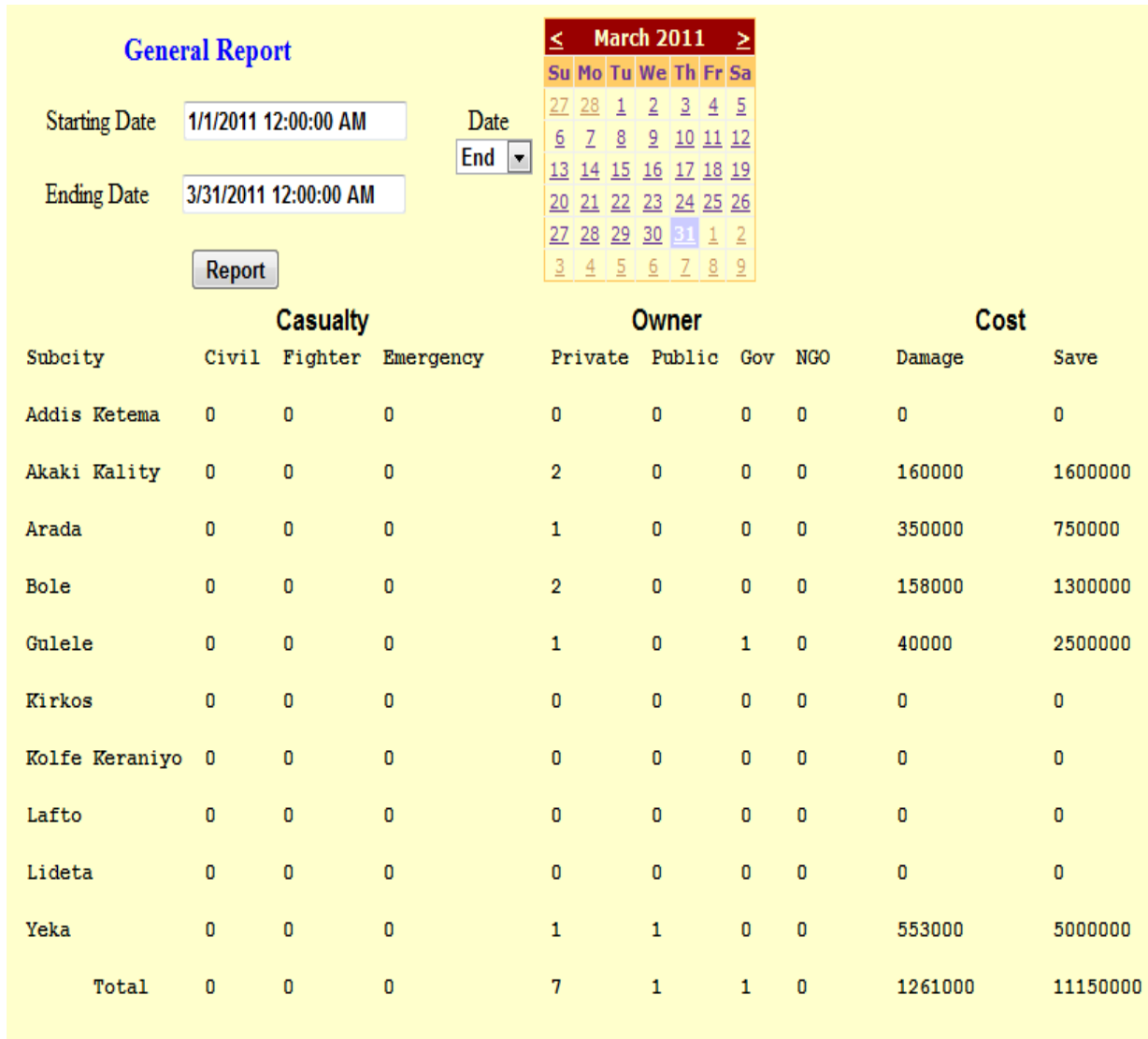


Figure 7.9 General report

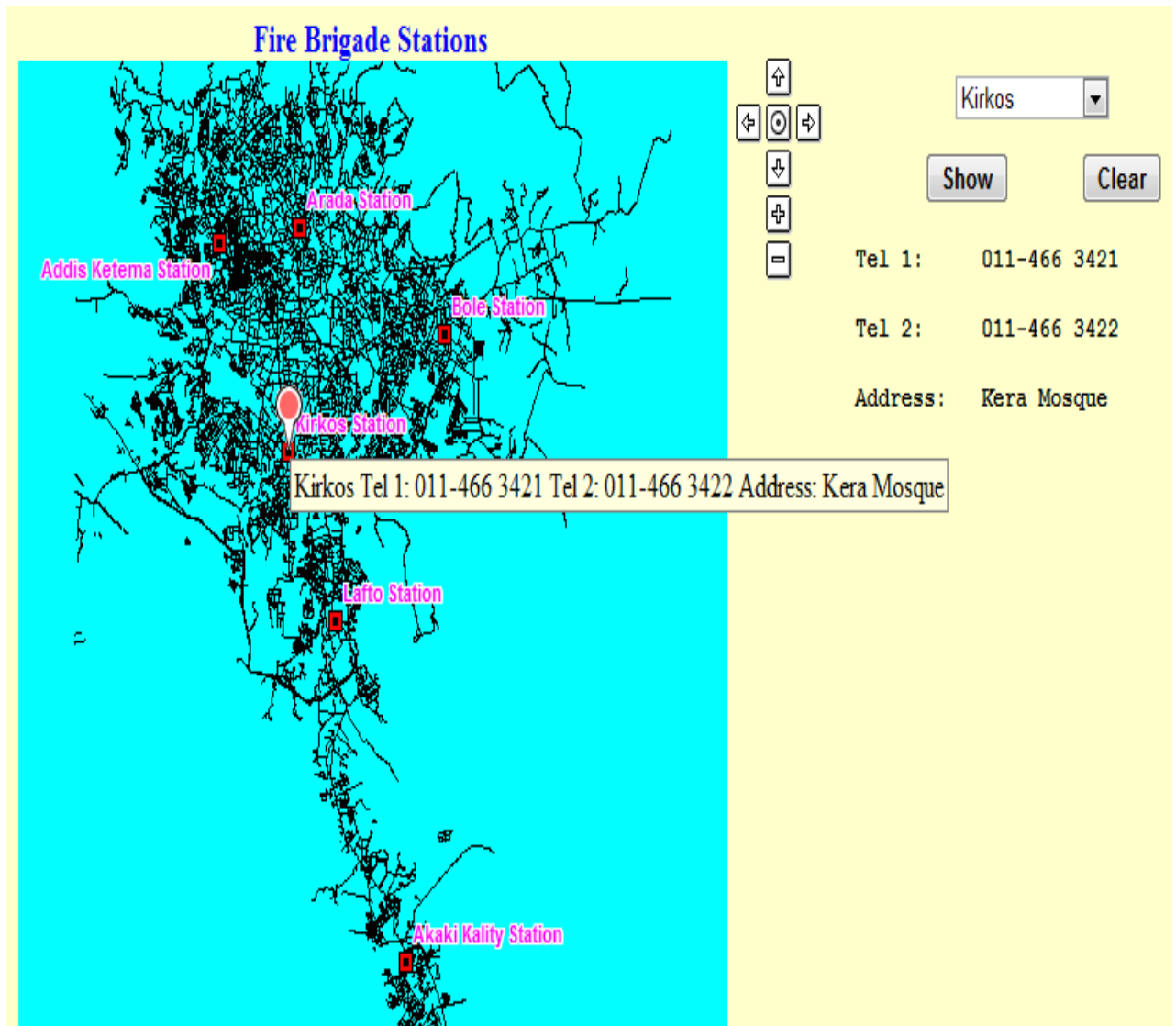


Figure 7.10 Fire brigade stations on a map

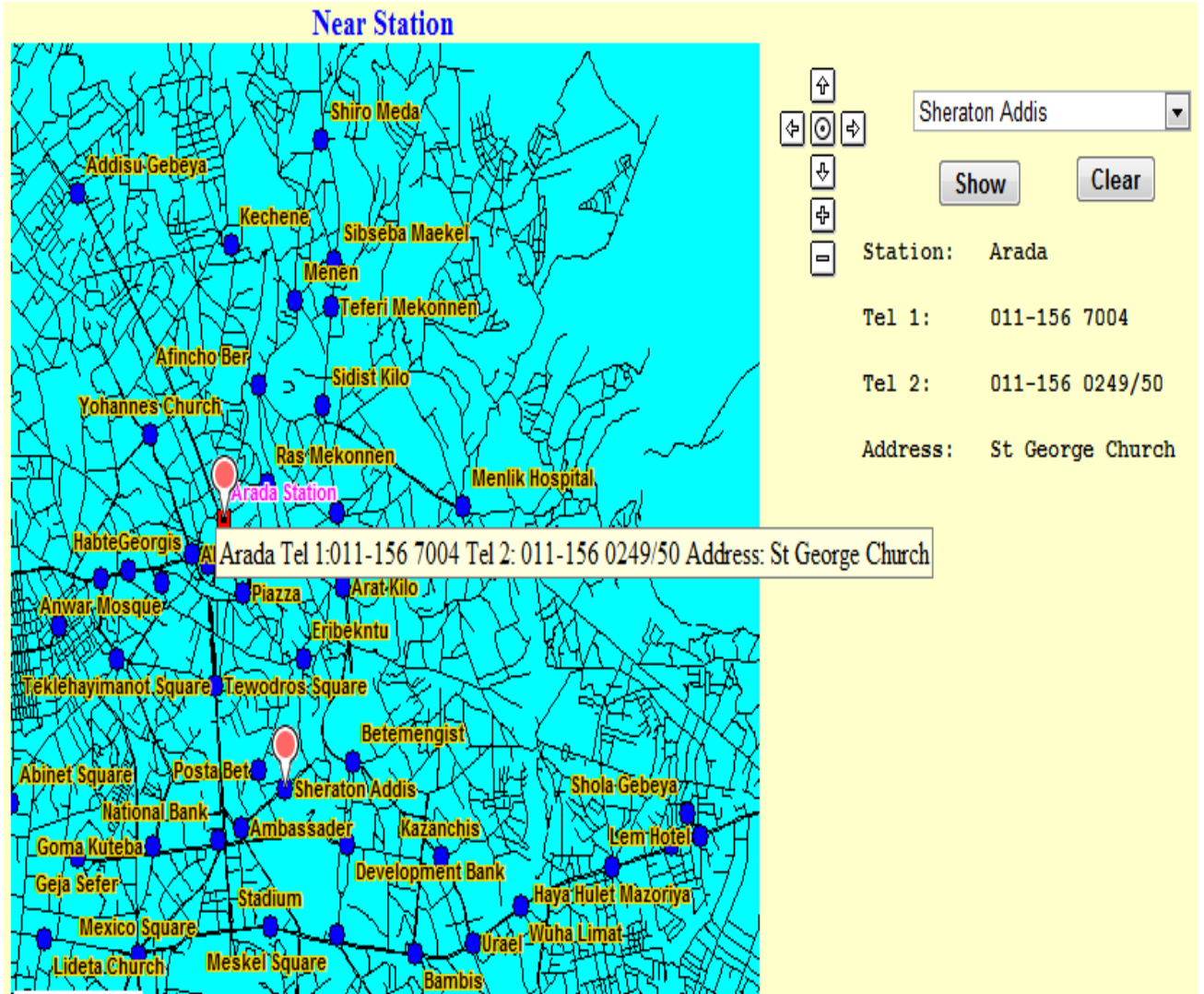


Figure 7.11 The nearest fire brigade station to accident location on a map

CHAPTER EIGHT: CONCLUSION AND FUTURE WORKS

8.1 Conclusion

Recording and tracking of fire incidents is crucial to understand the magnitude of the fire problems and to alleviate catastrophic fire accident. In order to take appropriate measure, automated system should be available to all stakeholders.

In this project, we have analyzed the existing manual fire accident recording and reporting system being utilized by the Addis Ababa Fire Accident and Emergency Prevention and Control Agency (AAFAEPCA) and developed a web based Fire Accident Recording and Reporting System (FARRS) which also has GIS enable feature.

FARRS also generates weekly, monthly, yearly, general and other reports which greatly reduce time and effort to prepare reports. Fire fighters, police, insurance workers and any interested users can easily search about accident records with different parameters. The prototype has been thoroughly tested with the actual data from the agency and it is found to be promising.

8.2 Future Works

The Fire Accident Recording and Reporting System (FARRS) has implemented most of the services of the Agency. However, there are some issues that need further investigation and we recommend them as future work. These include the following:

- 1 Mobile based Fire Accident Recording and Reporting System that is used to register the accident location within the allowed tolerance and transfer the data to the central database.
- 2 Integrate Fire Accident with traffic of Addis Ababa in order to reach accident place immediately.
- 3 Develop Fire Accident Recording and Reporting System with local language enables the users can easily understand and use the system.

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Appendix A: Structured Interview

1. What is the duty of Addis Ababa Fire Accident and Emergency Prevention and Control Agency?
2. In what way accident is reported to the agency?
3. Fire accident recording:
 - 3.1 What kind of information (data field) is recorded?
 - 3.2 What kind of methods do you use to record the accident? (Paper form or electronic form)
4. Accident location referring:
 - 4.1 What techniques do you use to refer accident place?
 - 4.2 Do you use Global Positioning System (GPS) to indicate accident place?
5. Data storage:
 - 5.1 What kind of methods or techniques do you use to store accident data?
6. Analysis and Reporting:
 - 5.1 How often do you prepare reports? (daily, weekly, monthly, yearly)
 - 5.2 How do you prepare reports? (manually, computerized(automated))
7. What problems do you face with the current system?
8. How many fire stations are found in Addis and where?
9. What kind of techniques do you use to reach the accident place immediately?
10. What is your future plan to improve or change the current fire accident recording and reporting system?

Appendix B: Accident Recording Form

የፎንተኛ አደጋዎች መከላከልና መቆጣጠር ኤደንሲ 824 ሰዓት ውስጥ የተሰጡ የተጠራ አደጋዎች መመዘኛ ፍርድ

የአደጋ ጥሪ የደረሰበት ሰዓት.....የጥሪ አድራጊው ስምና ስህ/ቁ ቁጥር.....

ሳይረገግ የተደረገበት ሰዓት..... መኪናው ከግቢ ለቆ የመጣበት ሰዓት/ደቂቃ.....

አደጋው የተሰራበት ቀን..... ኪሎተሜ..... ቀበሌ..... ቤቅ.....

አደጋው የተሰራበት ልዩ ቦታ.....

የአደጋው አይነት..... አገልግሎት.....

የአደጋው መንስኤ..... ንብረትነት.....

የሰላሳቤት ስም.....

የወይመ ንብረት ግምት..... የሰላሳ ንብረት ግምት.....

የተረጨ ውሀ መጠን በሊትር..... ፎም በሊትር.....

የተሰማሩ ሰራተኞች ብዛት..... የተሰማሩ የአደጋ ተሸከርካሪ ብዛት..... አምቡላንስ ብዛት.....

በአደጋው የሞተዎቹ/ሰላሳዎቹ..... የነዳጅ ፍጆታ መጠን በሊትር..... የሞቱ እንስሳት ብዛት.....

አደጋው ቦታ ስመድረስ የፈጸመ ሰዓት..... አደጋውን ለመቆጣጠር የፈጸመ ሰዓት.....

በአደጋ ቦታ የተሰጠው መቆጣጠር እገባ.....

አደጋ ከደረሰባቸው ግለሰቦች የተሰጠ ትክክለኛ እስተያየት.....

ከአደጋ ስራ መልስ ስለ ተሰራው አደጋ ይካሄድ ጠንካራ ጎን የተደረገ የግምገማ ውጤት.....

አደጋውን የሰራው ሸዋት..... በክልሉ/ክልሉ ውጪ.....

ሪፖርቱን የሰጠው የመረጃ ሠራተኛ ስም.....

ሪፖርቱን የተቀበለው የመረጃ እናሲስት ስም.....

Appendix C: Accident Reporting Form

በአሳቶና ደንገቶች አደጋዎች መከላከልና መቆጣጠር ኤጀንሲ በየውሩና በዓመቱ የሚከሰቱ አጠቃላይ አደጋዎችን ሪፖርት ማድረጊያ ፎርም

ተ.ቁ	የአደጋው አይነት	የአደጋው ጠየት										አጠቃላይ ደምር					
		አራዳ h/hተግ	ቁርቆስ h/hተግ	አይላ hተግ h/hተግ	ገፋላ ስልክ ላዳቶ h/hተግ	አቃቆ ቃላት h/hተግ	ቦሌ h/hተግ	ልደታ h/hተግ	ጉብሌ h/hተግ	ጉልፌ ቀራንቶ h/hተግ	የካ h/hተግ		አጠቃላይ ደምር				
1	የቦት ቃጠሎ አደጋ																
2	የንግድ ቦት ቃጠሎ																
3	የአላክትሪክ ጉልፍ ቃጠሎ																
4	የኅሩ ክፍለ ቃጠሎ																
5	የከተማ ግድግዳ ቃጠሎ																
6	የግዛገን ቃጠሎ																
7	የአገልግሎት ግንባታ ቃጠሎ																
8	የአህጉር ክፍለ ቃጠሎ																
9	የጥጥ ግዛገን ቃጠሎ																
10	የቅጠል ክፍለ ቃጠሎ																
11	የጋራ ቃጠሎ																
አጠቃላይ ደምር																	

Declaration

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

Declared by:

Name: Daniel Bekele

Signature: _____

Date: _____

Confirmed by advisor:

Name: Dr. Dida Midekso

Signature: _____

Date: _____

Place and date of submission: Addis Ababa, June 2011.