

Mobile Based Complaints and Suggestions System with Geospatial Data

By: Demeke Getaneh



A Thesis Submitted to the
Department of Computing
School of Electrical Engineering and Computing
Presented in Partial Fulfillment for the Degree of Master of
Science in Software Engineering

Office of Graduate Studies
Adama Science and Technology University

Adama
January, 2018

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Declaration

I hereby declare that this MSc Thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

Name: _____

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This MSc Thesis has been submitted for examination with my approval as thesis advisor.

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Date of submission: _____

Acknowledgment

I would like to express my sincere gratitude to my advisor Dr. Mesfin Abebe, who is the staff member of the School of Electrical Engineering and Computing at Adama Science and Technology University for his continuous support, excellent guidance, care, patience, and the excellent atmosphere he provided me for doing this research. His guidance helped me in all the time of my research and writing of this thesis.

I would also like to thank the people involved in the survey phase of my study, who provided me valuable data for this research project, Addis Ababa community and service providers organizations staffs. Without their passionate participation and input, the research study could not have been successfully conducted.

Finally, I must express my very profound gratitude to my parents and to my friends for providing me with unfailing support and continuous encouragement throughout my years of study, researching and writing this thesis. This accomplishment would not have been possible without them.

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List of Acronyms

API	Application Program Interfaces
ARM	Advanced RISC Machines
CDMA	Code Division Multiple Access
CHO	Complaint Handling Officer
CSS	Cascading Style Sheets
E-CSMS	Electronic Complaints and Suggestions Management System
FTP	File Transport Protocol
GPL2	General Public License version 2
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global system for Mobile Communication
GTP	Growth and Transformation Plan
HTML	Hyper Text Markup Language
HTTP	Hypertext Transfer Protocol
HTTPS	Hyper Text Transfer Protocol Secured
IIS	Internet Information Server
JSON	JavaScript Object Notation
m-CS	Mobile Complaints and Suggestions
MIT	Massachusetts Institute of Technology
MVC	Model View Controller
REST	Representational State Transfer
RIM	Research in Motion Limited
RISC	Reduced instruction set computing
SDK	Software development Kit
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
UDDI	Universal Description, Discovery, and Integration
UI	User Interface
URI	Uniform Resource Identifier

WCDMA	Wideband Code Division Multiple Access
WSDL	Web Services Description Language
XML	Extensible Markup Language
XSD	XML Schema Definition

Abstract

The public organizations plan is to improve the quality of service and citizen satisfaction, and keep citizens safety and security for the wellness of the community. To hear the real voice of the customers, the service providers are open to process suggestions and complaints of customers. Providing any suggestions and lodging complains is not an easy process for the customers. They have to follow a long procedure and formalities to report such problems like roads in bad conditions, environment cleaning, potholes, rule violations, electric related problems, water wastage etc. The purpose of this study is to investigate the problem, collect data from citizens and service providers, analyze the data, design a framework based on acquired information to solve identified problems, develop and evaluate a prototype. The framework, we developed lets citizens report problems in their city to relevant authority and track the status of their complaints or suggestions. So, whenever people come across any issues in service provision, transportation, environment cleanliness, electric, water etc... , they can inform to the concerned public body and track issue status through mobile device. The complaints are registered into the system through the mobile application. The Global Positioning System (GPS) sensor is a feature of smart mobile devices which used to determine the exact location of the problem and camera can be used to take the picture or video of visual problem. Customers can compose complaints or suggestions by recording their voice. The system shows the entire public service delivery points near the current position of the user in the order of distance. The customer needs to choose concerned authority from the list. If they do not know the concerned authority they can get help from mobile application. Then concerned authorities can get the provided customer complaints and suggestions of their own via a web application. The framework is evaluated considering different evaluation metrics like software quality attributes and ISO standards. The framework could eliminate the problems of citizens which are difficult to register complaints or suggestions and can enhance citizen participations in service improvement. The prototype is evaluated by sample users by preparing evaluation criterion.

Chapter One: Introduction

1.1. Background of the Study

Customer Complaints and suggestions are a valuable input to improve quality of service, monitor the public infrastructures, environments, and redress civic problems. The citizens may have complaints with respect to their day to day activities. Building a smooth infrastructure to handle customer complaints and suggestions encourage customers to express what they think, and what they feel. Complaint handling process that needs long procedure like going to the office and standing there for hours, wasting their valuable time and efforts discourage citizens from lodging complaints and providing suggestions in short limit citizen participation. Cities need to make better use of resources and become more efficient. Policies, regulation, citizen participations and standards are all major components needed to build a viable Smart City [1].

Improved public service delivery and greater government openness are important benefits arising from the application of ICT as highlighted in the eGovernment Vision for 2020 [2]. Ethiopian ICT envisioned to develop, deploy and use information and communication technologies to improve the livelihood of every Ethiopian, and optimize their contribution to the development of the country [2]. Currently Ethiopia has 40 million mobile subscribers and 10 million internet subscribers. Ethiopia aspires to raise its mobile subscribers to 64 million and internet subscribers to 46 million in the GTP II period [2]. The wireless technology advancements in our country motivate to conduct a research to solve big issues on governmental organizations and citizens. Information and Communications Technologies present a large spectrum of tools that current generation makes his/her life easy. Governments can easily communicate with citizens to improve the way of service delivery, to keep customer satisfaction, and gather an idea from citizens.

This study is proposed to achieve the objective to improve the complaints and suggestions handling practices that can be applied in any government organizations. The researcher designed a framework to handle suggestions and complaints through mobile phone. The public body manages the customer complaints via web application. Service providers can learn to recover from mistakes. A good feedback can turn angry, frustrated customers into satisfied one with improved performance of services and appropriate solutions. The public resources or infrastructures preserved, issues could be fixed early, and citizens will be kept from victim.

Mobile technology increasingly becomes advanced from time to time. Most mobile devices have GPS, and camera services. Complaints and Suggestions can be supported by the Geo-spatial information to specify the location where the problem is situated. The customer suggestions or complaints can contain GPS coordinates and the problems in a visual form. Based on the coordinate the issue could be plotted on the google map for the concerned public authority to indicate the exact location of the problem. The public body can easily locate the place where the issue has been occurred based on geospatial data. The citizens may not be expected to explain the issue; they can capture the photo of the issue and sends to the concerned government office through his/her mobile phone.

1.2. Motivation

Currently the people of Ethiopia are being criticizing and complaining on the public service provider organizations. The government is striving to solve the citizen's grievance. As part of the community, we have the opportunity to observe several issues that annoy citizens, make citizens unsatisfied like public resource and infrastructures that need maintenance and changes, poor service quality. The nearby resident does not report the issues before the resources are immensely get damage. The residents report the issues after the service or resources are damaged and the service interrupted. For Instance: One day I had seen lightning on the transformer. I had no idea where and how can I suggest to the concerned body. In that moment, one thing that comes in mind is every citizen should have a communication channels to contact with service provider organization effortlessly. The idea motivates me to conduct this study. This research can help the citizens to report the issues they observed without going to the office of public body in person without wasting any time, effort and with minimum cost. The public bodies also know the problem early and rectify the issues on the basis of citizen suggestions.

1.3. Statement of the Problem

Good governance is impossible without the citizen's participation [3]. Ethiopia is one of the democratic countries in Africa; government has been working with citizens cooperatively. However currently there is a semi manual complaints and suggestion management mechanism to keep public resources, customer satisfaction and to receive customer suggestions and complaints. Currently, citizen can communicate to the government organizations or public body through phone call, website, or by going to the office in person. These reporting mechanisms may not be efficient (take cost and effort), phone number of the service providers may be unavailable, and

phone line may be congested at peak time or the service provider contact information may not be known by customer. Because of these reasons customer could not report their suggestions and complaints to the concerned authority which leads to poor service quality and customer satisfaction. So far many researchers proposed many types of complaints handling solutions. Each proposed solution designed for a specific organization in a particular city. Developing a solution for each service provider in each city leads to high development cost and complaints handling system may not be convenient because user should have a complaint reporting mechanism of each service provider. Previous works uses SMS with GSM network and web application to register complaints to service providers. The complaints and suggestion handling mechanism should consider most of the user platforms and enable customer to send media file such as image, audio and video in addition to text message via an internet.

1.4. Research Questions

While conducting this Research, research questions the researcher focus on are listed below.

- What factors are hindering citizens from lodge complaints and provide suggestions?
- What techniques could increase citizen engagement on public infrastructure controlling and quality of service delivery?
- How to achieve principles of good complaints handling?
- How to design a framework that is applicable for all service providers to manage complaints and suggestions?

1.5. Objectives

1.5.1. General Objective

The general objective of this research is to design a framework and to develop a prototype of integrated complaints and suggestions system for services such as electricity, water, road, transport, and policing.

1.5.2. Specific Objective

- Review literatures to understand work done on the complaints and suggestion handling strategies, chose appropriate tools and technologies.
- Collect data from the citizens and government organizations to get relevant evidence about the current situation of complaint and suggestion handling.
- Analyze the collected data to get information

- Propose an appropriate framework based on the analyzed data to enable all organizations to handle complaints and suggestions properly and also customers could lodge their complaints and suggestion in simple way.
- Design designated architecture of complaint and suggestion system to develop a system that has good quality attributes.
- Develop prototype of a complaints and suggestions system
- Evaluate the developed prototype system based on the software quality perspective and system usability principles.

1.6. Scope and Limitations

The core feature of this thesis is to enable all governmental organizations to implement convenient complaints and suggestions management system and citizens could provide issues via their mobile phone by a means of mobile app. This technology improves the semi-manual existing system. The study is focused on governmental services in handling complaints and suggestions. The issues suggested by the citizens can be routed between government departments. Suggestions or complaints may come from different platforms or protocols like email, mobile app, portal, phone call and SMS. The research has been conducted on government sectors which provide customer services like Water and sewerage, Electricity, Road, Road transportation, and policing. The Suggestion system can handle a request from Mobile apps. The service providers get their suggestions from web applications. Other third party may include other suggestions or complaints platforms to send request to the concerned public body.

1.7. Significance of the Study

The study has significant importance for citizens and public service providers and government. By investigating factors that block customers to make complaints and suggestions provide appropriate solution that can eliminate these factors. The following are major significance of the study.

- Reduce the information gap of citizens where citizens can gain information of each service providers through single channel with a simple tap. Organizations can host their information to the public to be accessible by all customers without navigating to several websites.

- Citizens can report complaints and suggestions to the relevant public service provider without any inconvenience.
- Issues could be resolved early before the problem changed to serious. For example, if an electric poll susceptible to falls down, citizen reside in that area can suggests the issue early if the communication channel established between government body and citizen. This early suggestion may safeguard citizens from suffering
- Reduce public resources from wastage. Citizens may provide suggestion to public body before the problem become large. For example, water pipeline may leak. Citizens may report to the public body (i.e. water and sewerage authority) early before the pipe totally broken and large amount of water lost and citizens suffer with water shortage problem.
- Reduced environmental pollution. The sewer may be closed in case of different reasons at that time the sewage may explode to the land surface. This sewage will pollute the environment and expose the residents to the diseases. Some citizens may dispose dry wastes on the appropriate waste yards. In this situation, the nearby residents could report the issues immediately without any time and effort lost and with a single click.
- Reduced communication cost between government body and citizens. Some government bodies receive complaints and suggestions through phone call this leads to expend large amount of cost. Most organizations process complaints and suggestions through forms. The proposed research could reduce this cost by using mobile network which is very cheap compared with in person reporting and phone call. And it is also allowing transferring images and large information.
- Public service provider can provide sustainable services to the public by improving service quality based on customer complaints and suggestions. Service providers can fix issues before the service fully interrupted.
- Government can save expenses to maintain services. Small problem solved by little cost. Once the issues expanded the solution require large cost.
- Citizens could get full information about service providers, about where to complain, and how to complain without navigating several websites.
- Public body can easily locate the area which the issue existed with the help of geospatial data.

- The citizens can also send their complaints or suggestions through in the form of voice, images and text. The availability of different communication formats helps the user easily made complaint or suggestions.
- Government can Control and monitor crimes by establishing strong link between citizens. Criminal acts could be reduced with the cooperation of citizens and government.
- Encourage citizen participation in controlling quality of services and public resource wastage. Convenient reporting mechanism encourages citizens' participations.
- Complaints and suggestions can be an Input for policy formulation and process improvement. Well-organized data can be processed easily to identify frequent problems and high problematic areas.

1.8. Organization of the Thesis

The document is organized into seven chapters. Chapter one deals with introduction of the research activity. Literature and related works on complaints and suggestions handling are reviewed in Chapter Two. Chapter Three depicts the research methodology that the researcher followed to conduct the study. Chapter Four is data analysis which deals on the processing and presenting the collected data. Chapter Five is framework design and prototype development which deals on framework design, system architecture, system components and system stakeholders. Chapter Six presents the Evaluation, Result and Discussion followed by conclusions and recommendations which is the last chapter, Chapter Seven.

Chapter Two: Literature Review

2.1. Introduction

Complaints are valuable information to improve the quality of service. The citizens may have complaints or suggestions with respect to their environment, service delivery and infrastructure of the city. To make people living easy, technology becomes advanced. Everywhere, at every place, there are several technologies which solve problems efficiently, effectively, and quickly in daily activities. Complaining in person has enormous ups and downs such as following long procedure like going to the office and standing there for hours in line, wasting so much of their valuable time and efforts. Information technology provides several alternative solutions to simplify human activities. Many researchers conduct study on suggestion and complaint handling and try to suggest solutions. In this chapter, some of previously written research documents have been reviewed and presented.

2.2. Definitions of Complaint, Suggestion, Comment, and Compliments

Complaint: A complaint is an expression of dissatisfaction, about the standard of service, action or lack of action by the organizations or its staff that affecting an individual customer or group of customers.

Suggestions: An idea, action or plan that is suggested or the act of suggesting ideas to an organization that may improve customer services.

Comments: A volunteered individual opinion or belief, remark or feedback expressed by the customer or an idea for making changes to any part of the organization services.

Compliments: A compliment is a customer expression of positive recognition or admiration for a service or staff member.

2.3. Feedback

Feedback from customers is received and encouraged. It is very important that people communicate the organizations or service providers with suggestions, complaints and compliments regarding services [4]. Citizens can:

- provide constructive feedback and recognition to staff in organization
- Provide invaluable information that produces an opportunity for organization to improve services and avoid a negative service experience from taking place again.

2.4. Complaint Handling

2.4.1. ISO 10002:2014 Guidelines on Complaint Handling

This International Standard offers guidance for the design and implementation of an effective and efficient complaints-handling process for all types of commercial or non-commercial actions [5]. An organization and its customers, complainants get benefit. If the complaints are properly handled, the information obtained from the complaints-handling process can improve services and processes. The reputation of the organization can be improved. In a global competitive marketplace, the importance of an International Standard becomes more observable since it provides confidence in the consistent complaints treatment.

The handling of complaints with this International Standard can enhance customer satisfaction. Encouraging customers to provide feedback, including complaints when customers are unsatisfied, can offer opportunities to keep or enhance customer loyalty and support, and improve national and international competitiveness. Implementation of the process described in this International Standard can:

- Provide a customer with access to an open and responsive complaints-handling process
- Enhance the ability of the organization to address complaints in a systematic, consistent and responsive manner, to the satisfaction of organization and complainant,
- Improve the operations of organizations by enhancing the ability of an organization to identify trends and eliminate causes of complaints.
- Help an organization to practice a customer-focused approach to resolving complaints, and encourage employee to improve their skills in working with customers, and
- Provide a guide for resolution of complaints, continual review and analysis of the complaints-handling process and process improvements done.

2.4.2. Benefits of Good Complaint Handling

Complaints are an important way for the management of an organization to be accountable to the public, as well as providing valuable input to review organizational performance [6]. An effective complaint handling system has key benefits.

- It enables organizations to redresses issues raised by a person who is dissatisfied in a timely and cost-effective way.
- It provides information that improves service delivery; and

- A good system can improve the reputation of an organization and strengthen public confidence in an organization's administrative processes if complaints are handled properly.
- Increase organizations productivity. Organizations can monitor and control their properties with close customer involvement.

2.4.3. Principles for an Effective Complaint Handling System

Guidelines on Complaint Handling according to [5] the following principles are identified.

- **Customer Focused:** The organization is committed to effective complaint handling and should be open to feedback including complaints.
- **Visibility:** Information about how and where to send complaints and suggestions should be disseminated or made easily available to customers and other interested parties.
- **Accessibility:** A complaints-handling process should be easily accessible to all complainants. Information should be easy to understand and appropriate to the customer.
- **Responsiveness:** The response should be given to complainants in short time, resolved on time and according to order of urgency, and the complainant is aware throughout the process.
- **Confidentiality:** Personal information related to complaints is kept confidential.
- **Charges:** Access to the complaints-handling process should be free of charge to the complainant.
- **Objectivity:** Each complaint should be resolved in a justifiable and unbiased manner through the complaints-handling process under the control of rules and regulation and policies.
- **Accountability:** Responsibilities for complaint handling are clearly defined, and complaints and suggestions are reported to the concerned body. And responses to these complaints are monitored and reported to management and other stakeholders.
- **Continuous Improvement:** Organizations should analyze complaints and suggestions to identify frequent problems that might identify systemic issues and use this information in their complaint handling systems to identify services, process, and problems that need to be addressed.

2.5. E-Complaint

Customer complaining behavior defined as the consequences of customer dissatisfaction [7], it has long been considered an important form of market feedback. On other words, Customer Complaints Management is becoming a precarious key success factor in today's business environment [8]. Complaint Management System is a system that can collect customer feedback about any organization and let organizations get their own complaints. Best-practice organizations consider complaints as opportunities for improvement. These companies understand the relation between complaint resolution and customer loyalty and work hard to take action immediately on problems that can be easily resolved [9]. In addition, the researcher believes that either Government or any system needs user feedback to identify the challenges after running new system. User feedback can be considered as suggestions or complaints, which can be strongly considered in the organization to improve its services and products [10].

2.6. Mobile Platforms

The most adopted way of communication in the world is mobile communication with its penetration more than all other electronic devices [11]. To perform its services such as short message service, voice calls, camera, mice, and so on; an operating system should be installed on every mobile devices. The former mobile OS were simple, since the capabilities of the phones they had were limited. However, modern smartphones supports many of the features of a full-fledged computer which includes graphics processing unit , large storage space, high speed of central processing units , screens with high-resolution and cameras, multitasking and so on [11]. A mobile device operating system, also named a mobile OS, is an operating system that is specifically designed to run on mobile devices such as mobile phones, smartphones, PDAs, tablet computers and other handheld devices [12]. The functions and features existing in mobile devices are determined by operating system. The mobile OS also determine the applications which can be installed on your device. The International Data Corporation Quarterly Mobile Phone Tracker in 2017 result shows the most popular mobile platforms as presented in figure 2.1. Q1, Q2, Q3, and Q4 are a three-month period (quarter) of a company financial calendar.

Period	Android	iOS	Windows Phone	Others
2016Q1	83.4%	15.4%	0.8%	0.4%
2016Q2	87.6%	11.7%	0.4%	0.3%
2016Q3	86.8%	12.5%	0.3%	0.4%
2016Q4	81.4%	18.2%	0.2%	0.2%
2017Q1	85.0%	14.7%	0.1%	0.1%

Figure 2.1 Worldwide Smartphone OS Market Share [13]

There are many mobile operating systems in the world. As we can see on figure 2.1 most popular mobile operating systems are Android and IOS.

2.6.1. Android OS

This is a software platform and operating system developed by google for mobile devices which is based on Linux kernel. But later on Google establish companies called the Open Handset Alliance which is a group of hardware, software, and telecommunication with the goal of contributing to Android development. Java is its native development language which is the officially supported language. The application written in other languages should be compiled to ARM native code. This Operating System is used in Samsung, and HTC mobiles [14].

2.6.2. iPhone OS

iPhone OS was initially developed for iPhone devices by Apple Inc . Nowadays, the mobile operating system is called iOS and is exclusively support Apple manufactured devices like iPhone, iPad, iPad 2 and iPod Touch. Apple iOS is derived from Apple's Mac OS X operating system [12]. It is the second popular mobile operating system [13].

2.6.3. Windows Mobile (Windows Phone)

Windows Mobile is Microsoft's mobile operating system used in smartphones and mobile devices. The Mobile OS is based on the Windows CE 5.2 kernel. In 2010 Microsoft announced a new smartphone platform called Windows Phone 7 [12].

2.6.4. BlackBerry OS

The BlackBerry OS is a mobile operating system developed by RIM (Research in Motion Limited) for BlackBerry handheld devices [15]. The BlackBerry OS can use only for BlackBerry phones like iOS for apple. BlackBerry applications are developed by Java, particularly Java Micro Edition. However, in 2010 RIM introduced the BlackBerry Web development platform, which makes use of SDK to develop standalone Web apps by using HTML, CSS and JavaScript technology.

2.6.5. Symbian OS (Nokia)

Symbian is a mobile operating system targeted at mobile phones that offers a high-level of integration with communication and personal information management functionality. Nokia has made the Symbian platform available under an alternative, open and direct model, to work with the small community of platform development collaborators. Nokia does not maintain Symbian as an open source development project [12].

2.7. Cross-Platform Mobile Development

Most of the latest mobile operating systems are very rich in features and suitable for developers to develop and deploy new applications. The major advantage of these OS is the built-in features, such as Camera, GPS, Wi-Fi, etc. mobile app developers do not develop these from scratch, which it saves cost and efforts.

The major mobile OS's are Android, iOS, Windows Mobile or Windows Phone , BlackBerry, Symbian, and webOS, but the family of mobile OS's is increased globally [16]. Developers that would develop an application on various OS's face several difficulties because each OS has its own language, different Integrated Development Environments, different API's, etc. To overcome these difficulties of the developers, cross-platform mobile development tools have been developed with the purpose to write the application source code once and run on different OS's. Developing and selling an application on multiple markets with the help of these tools will minimize investment costs [16]. The reduction of capital investment for applications could inspire developers and companies to invest more in developing new app [16].

2.7.1. Cross-platform Development Tools

Cross-platform mobile development tools are becoming popular in the world due to their characteristic to compile the application source code for multiple supported OS's. The application development is very easy and time saving with these tools. There are many tools available on the market. Developers may get confusion to select one framework among them. Let us see some of them.

PhoneGap/Adobe Cordova: PhoneGap/Cordova is an open-source mobile development tool developed by Adobe System Inc. which used to develop mobile applications using standard web technologies like HTML5, JavaScript and CSS3 [16]. As a result it becomes the most popular cross-platform framework. It avoids the need to use native programming languages such as Android uses Java, iOS uses Objective-C and Windows Phone uses C#, Symbian and Blackberry use C++. An application developed using PhoneGap framework is built as a native app into which HTML and JavaScript components are embedded in WebViews. WebView is a thin container which can render a web technologies user interface, and handle interactions with the underlying device to access GPS, send a message, open the camera etc.

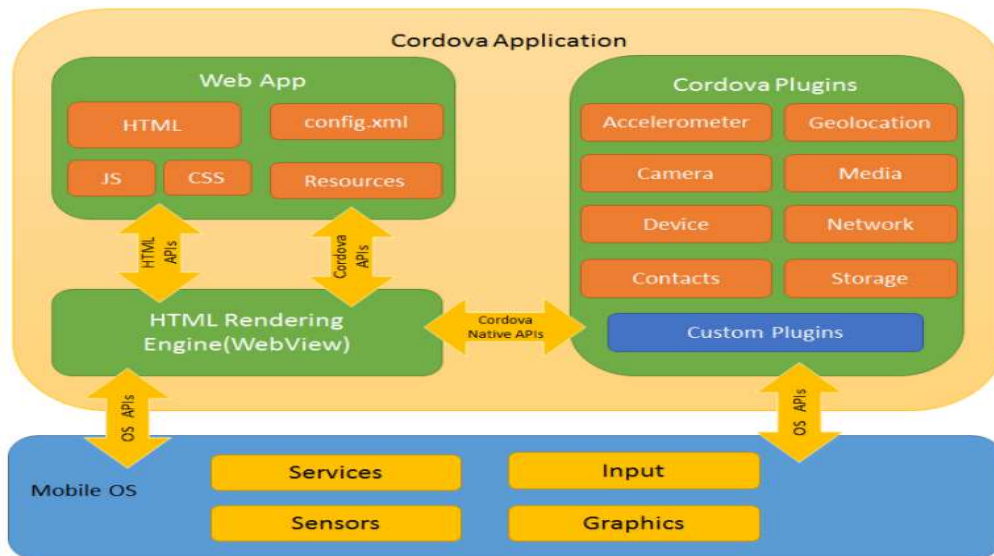


Figure 2.2 High-level View of the Cordova Application Architecture [17]

Xamarin: Xamarin is popular cross-platform framework designed for the enterprise, apps are developed using a single, shared C# codebase. This source code is compiled into native applications for Android, iOS and Windows Phone. The developers divide the code of Xamarin

application into two parts which are the ‘**core**’ and the ‘**user interface**’. The ‘core’ part is consists of data storage, business logic and the code that is not part of user interface. Once this code is written the developer can reuse across all platforms. The second part is ‘user interface’ which the developer write the underlying code in C# and use native user interface design tools to provide a different user interface specific to each platform.

Rhodes: Rhodes is a cross-platform mobile application tool developed by Motorola Solutions Inc. under Massachusetts Institute of Technology [16]. It is an open source Ruby-based mobile development environment. It is used to build native applications rapidly for all major mobile operating systems like iOS, Android, Windows Mobile/Phone, BlackBerry and Symbian. The goal of Rhodes is to increase a level of productivity and portability in application development.

MoSync: MoSync is an open source cross platform mobile applications development tool. It enables to develop cross platform mobile applications using C/C++, HTML5 and JavaScript. MoSync enable the developer to develop an application using a single codebase but target multiple platforms. It supports Android, iOS, Windows Phone, RIM, and Symbian [16].

DragonRad: DragonRad is a cross-platform mobile application development framework powered by Seregon Solutions Inc. It allows developers to design, manage and deploy mobile applications once and use it across iOS, Android, BlackBerry and Windows Mobile. It is commercial tool. DragonRad uses its own language D&D; the possibilities of extension of adding plugins and other support to the framework are quite limited.

2.7.2. Benefits of Cross Platform Mobile Development Tools

Cross platform mobile app development tools have several benefits compared to native mobile application developments. The following are main merits [18] [16].

- Developer can develop applications using common programming languages for multiple platforms; this reduces the required skill of programmers.
- The written source code is compiled for each supported OS which reduce coding.
- Decrease the development time and maintenance costs.
- No need of API knowledge of each OS, but only need the API’s provided by the selected cross-platform tool.
- Ease of development compared to building native applications for each OS.

- Increase market share. The increased usage of cross-platform mobile tools has effects on the corresponding business model of each mobile OS, such as App Store for Apple, Google Play for Android, etc.

2.7.3. Cross-platform Tool Selection Criterion

There are many tools available on the market which supports developer to build cross platform applications. There are many criterions that are helpful for developers to understand and chose appropriate tool for their purposes [16]. Some of the criterions are defined below.

- **Mobile Operating Systems** supported to understand possible effects on respective business models;

Table 2.1 Mobile Platforms Compatibility and Development Environments OS's Support

<i>Tool Name</i>	<i>Mobile OS Support</i>	<i>OS Support</i>
PhoneGap	Android, BlackBerry, iOS, Symbian, WebOS, Windows Phone	Linux,Mac, Windows,
Xamarin	iOS, Android, Windows Phone	Mac and Windows
Rhodes	Android, BlackBerry, iOS, Symbian, Windows Mobile, Windows Phone	Linux,Mac, Windows,
DragonRad	Android, BlackBerry, iOS, Windows Mobile	Linux,Mac, Windows,
MoSync	Android, iOS, BlackBerry, Symbian, Windows Mobile	Linux,Mac, Windows,

- **Programming languages** offered to developers for building applications;
- **Integrated Development Environments** available for developing applications.
- **Availability of API's** provided with the aim to get different hardware parts accessible in the OS;
- **Tool licenses** offered to assess the terms and conditions of use. The license of tools is helpful parameter for the comparison.

Table 2.2 Comparison on Development Features

<i>Tool Name</i>	<i>Language</i>	<i>IDE</i>	<i>Plug-in Extendibility</i>	<i>License</i>
PhoneGap	HTML, HTML5, CSS, JavaScript,	IDE native of the mobile OS (e.g. Eclipse, Xcode)	yes	Appache 2.0
Zamarin	C# .NET framework	Xamarin Studio, Visual studio	yes	Commercial
Rhodes	HTML, HTML5, CSS, JavaScript,	RhoStudio, RhoHub, etc..	yes	MIT, Commercial
DragonRad	D&D	DragonRad , Designer	No	Commercial
MoSync	HTML, HTML5, CSS, JavaScript, C, C++	Based on Eclipse	Yes	GPL2, Commercial

Phonegap/Cordova framework is better than others as compared on above tables. This framework can work with ionic frameworks which have many user interface components, interactive and fast in performance.

2.8. Ionic Framework

Ionic is an HTML framework made from AngularJS and Cordova used for front-end development [19]. Ionic is an HTML5 mobile app development framework deliberately designed to build hybrid mobile apps. Ionic framework has the following features:

- **AngularJS:** Ionic uses AngularJS MVC architecture for developing single page applications for mobile devices.
- **CSS components:** these components offer elements that are needed for mobile application development with a native look and feel.
- **JavaScript components:** these components are extending CSS components with JavaScript functionalities to provide all mobile app elements that cannot be done only with HTML and CSS.

- **Cordova Plugins:** Apache Cordova plugins provides API for accessing native device functions and features with JavaScript code.
- **Ionic CLI:** this is NodeJS utility powered with commands for starting, building, running and emulating Ionic applications.
- **License:** – Ionic is distributed under MIT license.

2.9. Web Service

A Web service is a means of communication between two applications or electronic devices over the World Wide Web. Software applications developed in different programming languages and running on various platforms can use web services to exchange data through a network [20]. Web service is platform independent and loosely coupled. A web service allows exchange of information among applications through a standard web protocol like http and https. There are two types of web services based on SOAP principle and REST principle. It can provide data in a number of different formats such as XML, JSON, plain text, and HTML web technology. There are two kinds of web services which are Simple Object Access Protocol and Representational State Transfer [20] [21] [22].

2.9.1. Representational State Transfer (REST)

A service based on REST is called a RESTful service. REST is an architectural style for networked applications; it is mainly used to build Web services that are lightweight, maintainable, and scalable. REST style architecture is client server architecture in which client sends request to server then server process the request and return responses [20]. By using a unique URI the clients can access the resource and a representation of the resource is returned.

- RESTful web services are stateless that means when the client sends an HTTP request, the request contains information required by the server to fulfill that request. The server never depends on information from previous requests. If previous information was important, the client should have sent it again in every request.
- RESTful web services have a good caching feature over an HTTP GET method. This can improve the performance.
- REST service is suitable for restricted-profile devices, such as mobile, for which the overhead of additional parameters are less (e.g. headers). Time needed for processing and transmission is 5 to 6 times lesser than SOAP based web services [20]. Message size of a

RESTful web services is 9 to 10 times lesser than the message size of SOAP based web services.

- A REST-based implementation is simple compared to SOAP.
- REST does not require message format like envelope and header which is required in SOAP messages. So as XML parsing is also not required bandwidth requirement is less.
- REST allows a greater variety of data formats such as Plain text, HTML, XML, JSON and whereas SOAP only allows XML.
- REST is generally faster and uses less bandwidth. The network load for RESTful web services is nearly 3 times lesser than SOAP based web service [20]. End to end time delays of RESTful web services are 3 to 5 times less than the SOAP web services. It's also easier to integrate with existing application.
- REST's exposed business logic accessed by URI.
- REST does not set too much standards.
- RESTful web service take security measures from the underlying transport.

2.9.2. Simple Object Access Protocol (SOAP)

SOAP is an XML based messaging protocol. SOAP uses different transport protocols, such as HTTP and SMTP. SOAP messages composed by envelope, header and body. The envelope element identifies the XML document as a SOAP message. A header element contains call and response information. Messages and method invocations are defined as XML documents and are sent over a transport protocol SMTP, FTP, HTTP. WSDL is xml document containing information about web services such as method name, method parameters and how to access it. SOAP messages require large bandwidth, encoding and decoding of XML based SOAP messages consumes resources which brings unacceptable performance overheads [20].

- SOAP supports several protocols and technologies, including WSDL, XSDs and WS-Addressing.
- SOAP uses WSDL for communication between provider and consumer.
- Services interfaces are used by SOAP to expose the business logic.
- SOAP defines standards to be strictly followed.

- Performance is less compared to SOAP. The need of large bandwidth, encoding and decoding of XML messages consumes resources; these are the performance overheads. So, using RESTful web services are an alternative to get better performance.

REST is selected for this study because REST has better feature than SOAP as discussed above.

2.9.3. Web Service Benefit

Web services provide several technological and business benefits, a few of them are:

- **Application and data integration:** Web Services allows different applications to talk to each other and share data and services among themselves.
- **Versatility:** They can be accessed by humans via a Web-based client interface, or they can be accessed by other applications and other Web services. A client can even combine data from multiple Web services.
- **Code re-use:** One service can be utilized by several clients, Instead of having to create a custom service for each unique requirement, portions of a service are simply re-used as necessary.
- **Future changes:** Web services try to keep the web service interface unchanged, even though the data and code behind the web service may change in future versions of a product. This helps applications that use the web service to continue working properly, even though the application behind the web service has changed.
- **Cost savings:** These all aforementioned feature reduce expenses.

These feature of web service made web service technology preferable. The use of this technology helps the developer of the complaints and suggestions system easily implements with low cost. The logic developed for web application also used by mobile applications. Web applications and mobile app share the same code and data.

2.10. ASP.NET Web API

Web API is a framework for creating HTTP services that can be accessed by a broad range of consumers like browsers, mobiles, and tablets [23]. ASP.NET Web API is an ideal platform for creating RESTful applications on the .NET Framework. It is a part of the core ASP.NET platform and can be used with MVC and other types of Web applications like Asp.Net

WebForms. It can also be used as stand-alone Web services application. It is light weight architecture and good for devices which have limited bandwidth like smart phones. Web API can be published in IIS, other web server that supports .NET 4.0+. And also it can be hosted by itself.

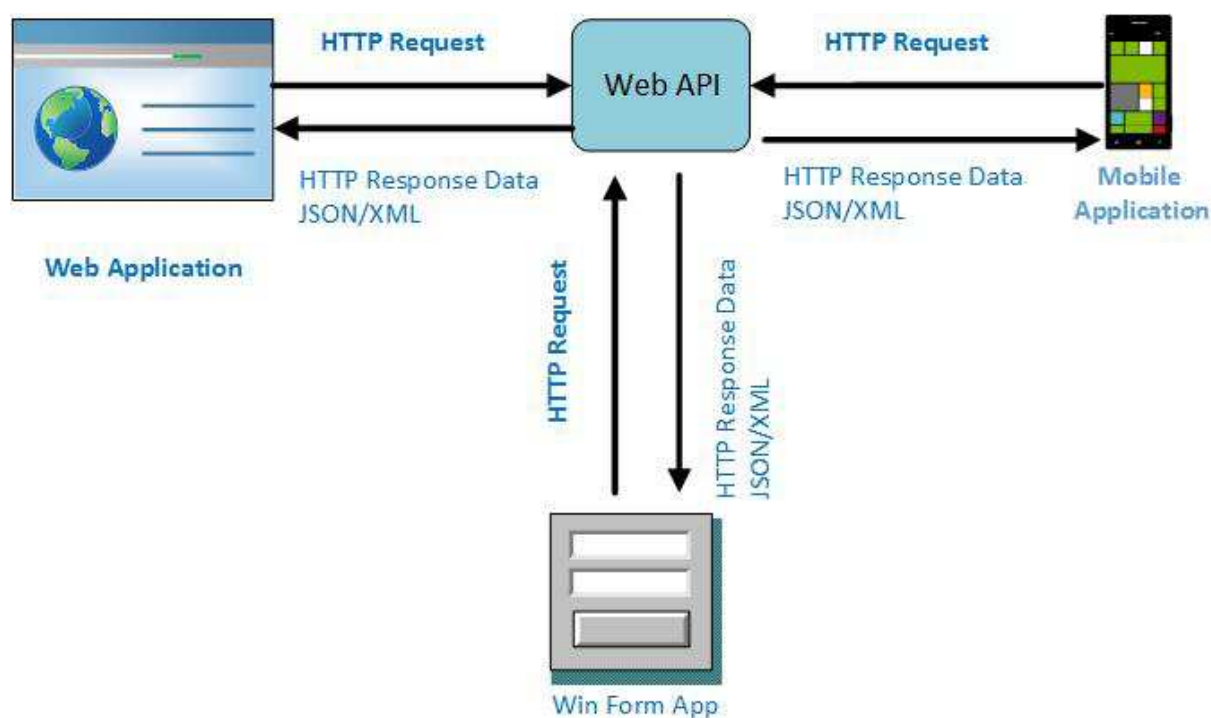


Figure 2.3 ASP.NET Web API Architecture [23]

ASP.NET Web API is a smart framework which is selected and utilized to implement the RESTful web service. It is easy to configure and test services.

2.11. Types of Mobile App

There are a number of ways to develop applications for mobile devices. Each way has strengths and weaknesses. There are three ways which are native apps, mobile websites, and hybrid apps [24] [25].

2.11.1. Native Mobile Apps

Native apps are developed with the default language of the mobile platform, for example Objective C or Swift for iOS and Java for Android [25]. Native apps are directly run on the device. Based on the platform API the app can communicate with the underline platform to

access device data or load data from an external web resource using http requests. Both Android and iOS offer a set of tools to allow developers to leverage features of the platform through predefined APIs. There are many commercial and non-commercial tools, which can aid to develop native apps. Developers also use frameworks in their native app to make development easier and faster.

The native app type has many benefits compared to the other types. Native app can be strongly integrated with the device platform. They can use the native APIs directly in the app, making the tightest connection to the platform these leads native apps can experience highest levels of performance. Native apps are built with native APIs, which is helpful for developers who are familiar with the languages they used. Native app development has some disadvantages which are:

- **Language requirements:** Requires skill in the platform language (for example Java, C#) and knowledge how to use platform-specific APIs.
- **Single platform:** Native apps developed for only one platform at a time.
- **High level of effort:** native apps require more work and overhead to build which increase costs.

2.11.2. Web Apps

Mobile apps are applications that are put on server and work well on a mobile device, which are accessed by mobile browser. Sometimes they are called Web Apps. Web apps are websites viewed on a mobile device in a mobile browser. Mobile apps have benefits, primarily in the level of effort and compatibility [24].

- **Maintainability:** web apps are easy to update and maintain without the need to go through an approval process or updating installations on devices.
- **No installation:** web apps put on the internet; no need of installation on mobile devices.
- **Cross platform:** web apps developed by web technologies and run inside a browser. Browser is a default app for every mobile device which provides a capability to access web apps from any device.

Web app execute inside a mobile browser, which is the main cause of limitations and disadvantages.

- **No native access:** web app is executed in the browser; it cannot access the native APIs or platform, just the APIs available in the browser.
- **Requires keyboard to load:** The user must remember and write address in a browser to find or access mobile website, which has more difficulty than pressing an icon.
- **Limited user interface:** developing touch friendly applications is difficult.
- **Mobile browsing is decreasing:** users' browses the web on a mobile device is decreasing, while mobile app usage increases.

Mobile websites can be significant even if the mobile app is available, depending on product or service type. Users spend much more time on using mobile apps compared to the mobile browser, so mobile websites have a lower engagement [24].

2.11.3. Hybrid Apps

A hybrid app is a mobile app that contains a web view to enable a web application run inside a native app; using a native app wrapper that can communicate with the device platform and the web view. This means web applications can run on a mobile device and have access to the device, such as the camera and GPS features. When a hybrid app is built, it will be compiled; which means transforming a web application into a native app. Hybrid Apps have several advantages:

- **Cross platform:** You can build your app once, and deploy it to multiple platforms with minimal effort.
- **Similar skills with web development:** It allows developing mobile apps by the same skills which are used to build web applications and websites.
- **Access to device:** Since the web view is wrapped in a native app, your app has access to all the device features available to a native app.
- **Ease of development:** they don't need constantly rebuild to preview, so they are easy and fast to develop. They also let to use the same development tools used for building websites.

Hybrid apps offer a robust foundation for mobile application development. Most of the applications developed as a website, but it is possible access to a native API, the hybrid app framework can provide infrastructure to access platform API. Hybrid App has some disadvantages as shown below.

- **Web view limitations:** The application can only run in the web view instance, which means performance is dependent on the quality of the platform's browser.
- **Absence of plugins:** Access to the native APIs may not be existed, and it may require further development to develop a plugin to support it.
- **No native user interface controls:** developers would have to create all the user interface elements.

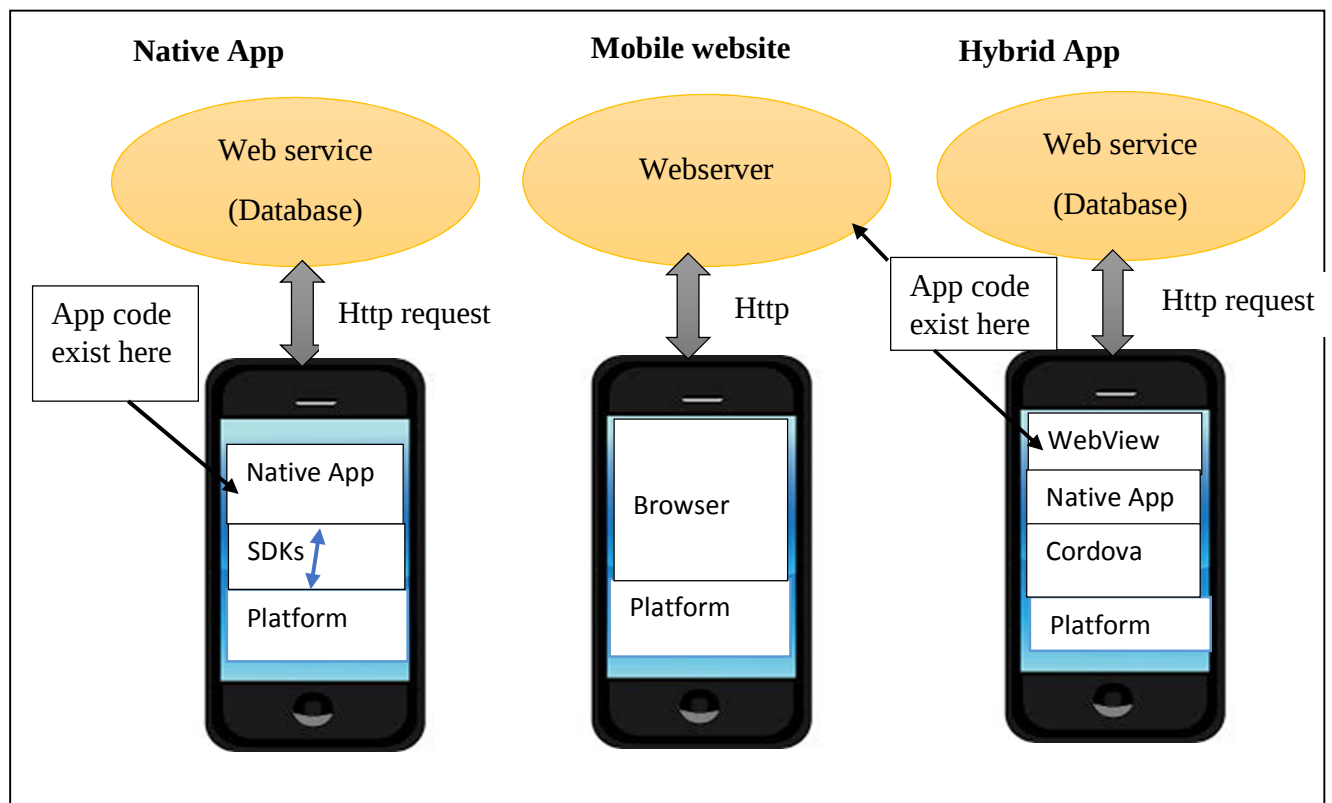


Figure 2.4 Native Apps, Mobile Websites, and Hybrid app Architectures Comparison [24]

So far each mobile app development types have been discussed, now let's compare it in table.

Table 2.3 Mobile App development Types Comparison

	Mobile application development types		
Criteria	Native app	Web App	Hybrid App
Cross platform	X	✓	✓
No need of new Language skill	X	✓	✓
Native access	✓	X	✓
Easy to development	X	✓	✓
Maintainable	X	✓	✓
Installation	✓	X	✓

As shown in table 2.3 hybrid app developments has better feature so it is selected to support multiple user mobile platforms to send their suggestions and complaints by building application once and compile for several platforms which reduce development costs.

2.12. Location Tracking Techniques

A mobile telephone can be located by a mobile telephone itself or through a mobile telecommunication network. To locate the mobile telephone by itself, the mobile telephone is provided with a GPS receiver to calculate its location in latitude and longitude coordinates based on the location information received from a satellite through the GPS receiver. The Location Tracking techniques can be worked with all today's market cell phones with networks such as GSM(Global system for Mobile Communication),GPRS(General Packet Radio Service) and CDMA(Code division multiple access) [26]. The comparison of various techniques to locate mobile device is defined below.

2.12.1. Cell Identification

Cell Identification is a simple, easy and cost-effective technique to provide the Location information of cell phone. This Technique operates in GSM and WCDMA cellular networks. It determines the serving cell of wireless Network, which the device is using. The Location of Base station is send as a Location of mobile user. The accuracy of cell identification technique

depends upon the size and density of cells [26]. The systems having smaller cells have more precision i.e. in rural areas than the systems having large cells. The precision of cell identification is between 200m to 20 km which is inaccurate. The accuracy of cell identification can be increased by adding Time advance and signal strength. But this technology is only used if mobile user is 550m or more away from base station.

2.12.2. GPS

GPS is a navigation system using worldwide. It gives accurate precision and higher accuracy. The system consists of networks of 24 satellites in six different 12 hour orbital paths spaced so that at least five are in view from every point on the globe and their ground stations [26] [27]. Trilateration is the base of GPS. One can determine the Longitude, Latitude and altitude of device. GPS gives higher accuracy than cell identification; however the location of device updated after every five seconds. Therefore, the response time is become slow which the major drawback of GPS. To determine the exact position of GPS user, the exact position of satellites at all the times should be known. GPS cannot locate indoor device which is the other limitation of GPS.

2.12.3. Assisted GPS

Assisted GPS also called A-GPS which covers the shortcoming of GPS for detecting a device indoor. Assisted GPS receiver in the mobile can detect and demodulate the weaker signals which are needed by GPS receivers for accuracy. A-GPS optimize the air interface traffic. An advantage of A-GPS that the user can hold the data for privacy and the network operator restricts the assistance to service providers.

2.13.4. Accelerometers and Electronic Compass

GPS is good method for Location Tracking but it has a drawback of poor indoor accuracy, Long acquisition time and low accuracy in densely populated area [26]. Therefore, in Today's world the alternative solution is use of Accelerometers and Compasses in addition to GPS. It gives better accuracy in indoors and has better energy utilization. They have accuracy of less than 30 meters. But the drawback of the techniques is extremely noisy and too expensive. Also, the change of motion and orientation results in error in Location.

Each of location tracking techniques has its own advantages and disadvantages, so the application should use a combination of them to provide the most accurate and reliable device location. Cell phones without GPS capabilities could use their location service, but GPS enabled mobile device produce more accurate location information.

2.13. Web Application

Web application is a computer program developed by web technology that runs on web browsers to perform tasks over the internet. Web application is published on the underlined web server such as IIS, Appache web servers. Web technologies can run on any platforms regardless of operating system or device. They cannot be installed on the hardware device. All users have access to the same application and any modification or change is reflected to all users.

2.14. Geospatial Data

Geospatial data also called spatial data. Special data is a data that has a geographical component to it. This means that the records in a data set have locational information such as geographic coordinate. Spatial data can be acquired, manipulated and stored by geospatial technology such as GPS.

2.15. Related Work

Customers have the right to complaint or give feedback on the services and facilities provided. Researchers have been conducted a study on different area such as Traffic Complaint and Pothole Notification, Road Management, transportation complaints, administrative complaints and so on. There are several alternatives to lodge complaints to relevant authorities such as calling the authorities or customer service center, sending an email, sending a Short Message Service and filling up a complaint form on its website. Several researchers propose solutions for effective complaints and suggestions handling mechanism.

Razulaimi Razali [3] design theoretical framework to establish a guideline to develop web-based complaint management system. By analyze and integrate reliable attributes from prior research the new framework has been developed. Appropriate and good theoretical framework for complaint handling can be used as a reference to develop an effective complaint handling system. In this paper, the framework is mainly to support research and future research on developing on-line complaint management system. **Razali** [28] Develop e-Aduan system which

is web based complaint management system to university of Technology Mara Pahang. It is a platform for customers to register complaint and feedbacks regarding the services and facilities provided by the university. Both customers and management can access to the system to complaint and retrieve information. In this study the researchers also defined workflow procedures to be followed by the management to address customers' complaints and comments. This new workflow produced good impact to both customers and management; customers now get a platform to communicate their dissatisfaction and the management takes counter measures immediately on any customer feedback. **Najar** [29] also design a new model based on Service Oriented Architecture to improve relation between Citizens and Government. By utilizing the suggested model in Government bodies, organizations can minimize Citizens' dissatisfaction and encourage citizens to participate in controlling Government body such as Governments' staffs and organizations. The Researcher believes by using SOA in e-Complaint Systems can gain flexibility for complaint sectors to change their complaint services.

Anand Kulkarni [30] Develop an android based mobile application for Traffic Complaint and Pothole Notification System by using Short Message Service with speech recognition to register complaints and suggestions. A new feature is integration of Global Positioning System technology with Global System for Mobile Communication to show the exact location of the problem which helps the concerned organization easily locate problems.

Aditi Mhapsekar [31] had developed architecture for Voice enabled Android application for vehicular complaint system using GPS and SMS technology. This application has speech to text functionality to create the complaint. It acquires the GPS coordinates, then appends it at the end of the complaint and sends the information in the form of SMS message to SMS server through the GSM network. The server receives this information and save it in the database. The web interface then plots this information on a map to the concerned body. **R.Saranya, K.Arun** [32] Propose a system based on android user interface to emulate the functionality of web portal complaint filing system. The users use mobile phone to register complaints and do not need to access the web portal interface to file their complaint. The user downloads and installs an application on his mobile phone, open the application. The user can compose his or her complaints in 160 characters. The user can take picture of the visual problem such as power cable hanging around, water leakage, tree fall, etc. The application will embed the current mobile device position through Global Positioning System where the picture is taken. Then the picture is

sent to the concerned authority. If the numbers of complaint are more in that area the priority of the complaint would be higher.

Victor M.Ruiz Penichet [33] proposed Complaints and Suggestions Web-Based Collaborative Procedure to allow citizens to post their complaint or suggestion in an easy way using a web and, at the same time, the system enforces public administration to solve the complaints and suggestions to respond for citizens in a timely manner. The complaint and suggestion process increases customer engagement in the city management and allows politicians to get a real feedback from people. The system takes a complaint or a suggestion which is sent to the Town Council through the Web.

Kim Nee Goh [34] presents architecture of a GPS-Based Road Management System with a combination of GSM and GPS for reporting thoroughfare problems through GSM for road maintenance management environment. **Tejaswita Badhe** [35] proposed android mobile application which can help customers with registering the complaints online to eliminate the need to stand up in queues for hours and enable to lodge a complaint anywhere, anytime intended. It makes complaints easier to coordinate, Monitor and resolve. The aim is to make cities a better place to live in. **Devika Radhakrishnan** [36] also introduced a mobile application for citizens to register complaints against the problems they are facing which can be solved by municipal corporations.

Several researches have been conducted to enhance customer satisfaction, improve customer services and customer service provision. These researchers list several problems and propose solutions for that problem as we have seen above. The researchers focus on particular organization complaints handling; this requires the customers retain each organization applications or web-address. Assume if there are ten service providers the customers install ten mobile applications or remember ten website addresses, recall ten hotlines. If the user moves to other new location, he/she may not know the service providers location, address, and office, in this situation the user should ask residents, finding address from websites it takes immense effort and time. These situations make the users to ignore complaining or providing suggestions.

As aforementioned above researchers proposed many types of solutions such as android based solution and web based solution with including enhanced features. A solution based on a single

platform prevents some of the people from complaining. Complaints or suggestion handling via web application is less usable and missed some features like camera, video and audio and it require web address recall. These shortcoming and issues discourage the customer to lodge complaint and provide suggestions. To overcome these difficulties an integrated location aware cross platform mobile application is significant to meet all service providers in one door. The research could eliminate the difficulties to lodge complaints and suggestions by providing relevant information from their hand without any overhead. Image, audio and video messages format are supported in addition to text message. The only thing customer need to do is remembering the service provider name, service provider's duty and responsibility.

Chapter Three: Research Methodology

3.1. Overview

This research studies the causes that refrained customers from lodging complaints and providing suggests and provides a framework to enhance the customer participation on controlling service quality and city infrastructures. It also provides complaints handling practices that can be applied in any government organizations and by considering best practices design a framework to handle suggestions and complaints. This section depicts the research methodology such as methods, sampling technique, and tools adopted in this research. A researcher requires several data gathering tools or techniques which vary in complexity, design, interpretation, and administration; each technique is suitable to get certain type of information [37]. Data collection techniques such as interviews, questionnaire, direct observation, and document analysis have been used to get different type of information. The data collected from public service provider organizations and citizens.

3.2. Research Design

The research design is to provide for the collection of relevant evidence with optimum effort, time and expenditure [38]. A mixed research design involves having both a quantitative design and qualitative design [39]. A mixed design is the best approach since the study needs both quantitative and qualitative designs to address the problem statement. Complaints are generated from customer, and an idea could be suggested from customer. Collecting relevant data needs a strategic plan; otherwise the research result may be incorrect [40]. The research data has been collected from Addis Ababa which is the capital city of Ethiopia in order to get a sample of all nation and national peoples of Ethiopia. The data collected via questionnaire, observation, interview, and document analysis. Questionnaire is used to collect data from citizens to know what they do when they face a problem and have a suggestion, opinion of the citizen on services, the existence of the problems. The questionnaire distributed on shopping centers, at home, offices by targeting to meet different persons in different educational background, sex, age and field of study in order to get multiple viewpoints on one idea. Obtaining data from participants with different experience prevents information bias and thus increasing credibility regarding the information. The interview conducted at the public service providers, such as Ethiopian Road

Authority, Ethiopian Transport authority, Addis Ababa Water and Sewerage Authority, and Ethiopian Federal Police Commission. These organizations are chosen because of they can get information of regional service providers. The organization could have similar structure and working procedure.

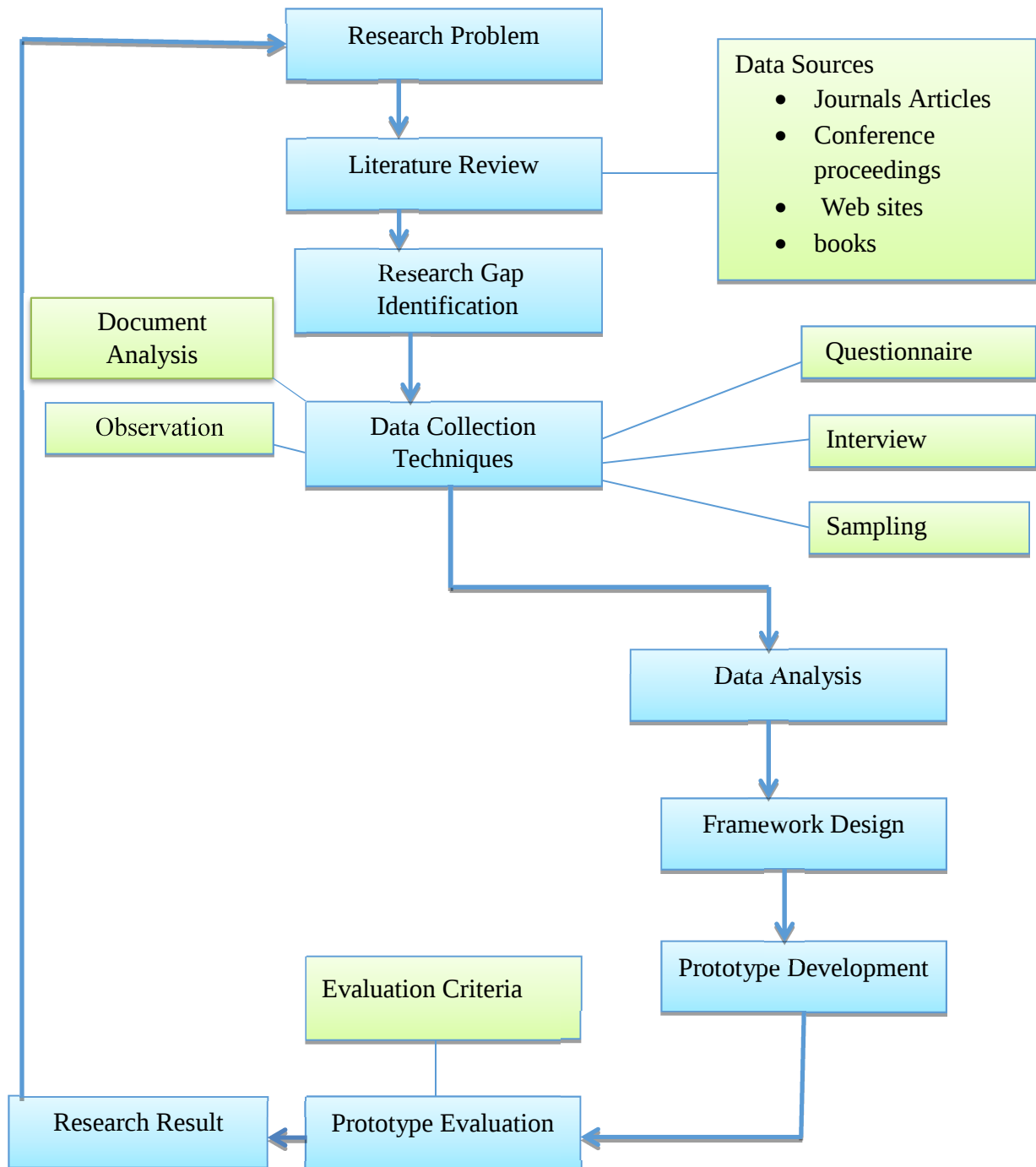


Figure 3.1 Research Design

3.3. Data Collection Techniques

The research method used for this research is qualitative and quantitative methods which includes interviews, questionnaire, direct observation, and document analysis in the public service provider organizations and citizens in Addis Ababa. The goal is to receive qualified surveys data from public bodies in order to gain a clear picture of the problem and possibly identify methods to resolve the problem. Several data collection techniques are used parallel to crosscheck data for validity and also use as a compliment.

3.3.1. Interview

Interview is Primary data source which is one of the methods used for data collection in which it gives a chance of asking different questions. Interview conducted at work based on interview question that has been prepared (appendix B). It is prepared based on the information needed. Interviewing the organization staff allows to understand and analyze the existing situations and it helps to design the solution in a desirable way and to solve the problem.

3.3.2. Direct Observations

Direct observation is a primary data collection tool. The researcher observed different problems that reduce citizens' satisfaction by moving to different areas in Addis Ababa city. Direct observation was very easy to realize the situation. It is possible to look at all issues in the residents. This method is highly preferred to the researcher in order to understand the problems that really exist in the community. Before the observation is conducted the observation checklist is prepared. The data collected through observation is used to cross check the data collected from questionnaire.

3.3.3. Questionnaire

Questionnaires are used to collect regular data from large amount of customers. A questionnaire requires respondents to fill out the form themselves, and so requires a high level of literacy. Questionnaire is designed based on questionnaire design guidelines and reviewed by peers to collect relevant data from citizens. In order to maximize return rates, questionnaires designed as simple and clear as possible. The questionnaire is basically considering the data that is important for researcher. The questionnaire is prepared in two languages in Amharic (appendix A) and English languages to reduce language constraints and enable respondents could understand

easily. Questionnaire is used for collecting data about user internet usage statistics, platforms, stance of citizens about service problem like water, electric, road, transport, and policing.

3.3.4. Document Analysis

This data collection tool is used to get data from written documents such as organization's rule and regulations, responsibilities, complaint and suggestion forms that have been used.

3.4. Population Sample

A small group or sample is selected to represent the whole population to acquire accurate and reliable information of the universe with minimum of cost, time and energy [37]. Most study use sample populations and descriptive statistics which are described as conducting a study with small enough population, such as an individual organization or group. When a population size is too large a sample of the population must be studied. The goal of a sample population is to be an accurate representation of the population but in a smaller number. Researcher uses simple random sampling to extract a sample from a larger population from Addiss Ababa city residents. Each individual is selected entirely by chance and each member of the population has an equal chance of being included in the sample. The use of this technique is ease to use, reduce the potential for human bias, and its accurate representation of the larger population [41]. The central limit theorem states that even if a population distribution is strongly non-normal, its sampling distribution of means will be approximately normal for large sample sizes over 30 [42]. Larger sample sizes lead to increased precision. By considering this theorem we take one hundred citizens for gaining several customer's opinion and ideas.

There are many governmental public service providers in Addis Ababa; from these organizations the researcher focuses on organization that works on Water and sewerage, Electric power, Road, Transportation, and Policing. These five organizations are selected purposefully since they are major services and as discussed in chapter two most of the previous studies are conducted on these areas to handle complaints effectively and efficiently.

3.5. Data Validation Techniques

Data quality is a crucial to research. The data that will be collected should be correct and reliable. To ensure this several techniques are considered for data validation. Questions were based on information gathered during the literature review. The questionnaire is designed and reviewed by experts to collect relevant data. By using different data collection techniques we

can look at the discrepancy. The questions and instructions were prepared in simple language for clarity and ease of understanding.

3.6. Data Analysis Techniques

After the data was collected it has to be organized and analyzed. Qualitative data analyzed with thematic analysis which is widely-used qualitative data analysis method and quantitative data via descriptive statistics.

	<i>Tool</i>	<i>Qualitative data analysis method</i>	<i>Quantitative data analysis method</i>
Data	Questionnaire	-	Descriptive statistics
	Interview	thematic analysis	-
	Observation	thematic analysis	-

3.7. Software Tools

There are many development tools which have great significance for data analysis, drawing diagrams, formatting thesis document, data storage, prototype development, and simulating prototype. The tools are chosen based on several criteria like popularity, features, simplicity, compatibility, robustness, closeness to advanced technology. The following are the tools which were used in the study.

- **Microsoft Excel:** Microsoft Excel is a powerful software package, included in the Microsoft Office Suite, which enables simple data comparison and analysis, and creates graphs, Simple sort and filtering. Built-in formulas can be used for calculation.
- **Microsoft SQL server database:** It is relational database management system owned by Microsoft used to storing retrieving data to or from the application.
- **Android SDK:** A software development kit that used to build application for the Android platform.
- **Android Studio (IDE):** Used setup android emulators. The Android Emulator simulates various Android phones, tablet devices on a computer to test the developed application
- **Visual studio (IDE):** it is Integrated Development Environment used to develop web applications, mobile apps, websites, web services, and computer programs. Visual studio helps us to develop Web API with a C# programming language. Web API is the great

framework for exposing your data and service to different devices. Web API is open source an ideal platform for building REST-ful services over the .NET Framework [23].

- **Webstorm:** Webstorm is a lightweight and powerful JavaScript IDE developed by JetBrains. It can be used as editor for HTML, CSS, and JavaScript. It supports Cordova, ionic, and AngularJS frameworks. This tool is used for mobile app development and web application development while developing the prototype.
- **Web browser:** A software application used to retrieve and display web applications. Web browsers such as Chrome and Firefox were used to preview the web application and mobile application at development time. These modern browsers allow you to preview mobile application for android, IOS and windows platform.
- **AngularJS:** A JavaScript framework developed by google which is designed to make front-end development easy. It enable dynamic web application development with JavaScript, html, and CSS
- **Node.JS:** An open source cross-platform run time environment for developing networking application [43]. It contains several JavaScript modules which simplifies the development of web application.
- **Phonegap/Cordova:** A framework used to develop cross platform mobile application which has a JavaScript API to access mobile native API.
- **Ionic:** A front-end UI framework that handles all the look and feel and UI interactions which is built on top of AngularJS and Cordova.
- **Internet information server (IIS):** A web server used to host the web API and web application.
- **Google Map API:** A service used to add google map inside a web application.
- **Smart Mobile phone:** used to test the prototype on a physical device in addition to emulators.
- **Postman:** A tool for testing APIs, which helps building APIs faster.

3.8. Evaluation Approach

The evaluation criterions were prepared to evaluate the framework whether it achieve the required objective or not. The framework evaluated by experts and customers. The customer evaluates based on prepared evaluation questions and experts evaluate based on interview.

Chapter Four: Data Analysis

4.1. Overview

Once the data has been collected the next step is data analysis. Then encode the collected data into excel sheet to easily calculate with good precision. The data obtained from interview, questionnaire, observation and documents are processed and presented in this section. Then, based on the analysis result an appropriate solution could be designed.

4.2. Observation Analysis

The researcher observes several problems that the citizens could complain on. But, most of the people ignore complaining to the concerned bodies. Some of the problems related to the transportation, road, policing, electric and water services are identified as below.

Table 4.1 Observed Problems in the Community

Issues	Concerned body
• Refuse of short distance ride • Asking more fee to commuters • Unsafe driving such as the driver: - o Listening Radio, tape loudly, - o Driving faster than the speed determined by law. - o phone talking, - o watching TV or video while driving • A tree or large branches hide driver's sight.	Transport Authority
• Damaged roads and Potholes • A missing manhole cover • Floods on the road	Road Authority
• Street lighting problem, Transformer and electric poll problem, interrupted electric	Electric Authority
• Theft and conflicts	Police station
• Water pipe leaked • Water distribution problem or shortage	Water and Sewerage Authority



Figure 4.1 Problems Observed in the Community

4.3. Interview Analysis

4.3.1. Ethiopian Federal Police Commission

Ethiopian Federal Police Commission Contribute huge role to development prosperity of the nation by respecting and enforcing the constitution and other laws of the land, preventing crime and criminal threats and ensuring prevalence of peace and security through active participation of the people. Ethiopian Federal Police Commission currently receives complaints and suggestions which is an input for process and service delivery improvements from citizens via agents (in person), phone and mobile app communication channels.

4.3.2. Ethiopian Road Authority

Road is one of the largest national assets which need to be preserved, and Ethiopian Road Authority (ERA) has a responsibility to maintain, improve, replace and preserve these assets. The government assigned administration of rural roads to the regional self-governments and main roads to ERA as part of the Federal Government's responsibility. The regular customers

and stakeholders' satisfaction survey, the different impact assessment studies helps to appraise the service quality. ERA uses a web site to facilitate information exchange between ERA and its customers and stakeholders.

4.3.3. Ethiopian Transport Authority

Ethiopian Transport Authority, By Coordinating, supporting, monitoring the road transport sectors and partners of road transport sectors, applying transport policy and strategies to provide efficient, economical, secure and convenient transport services to the community. Ensure transportation is secure and comfortable. This institution receives complaints and suggestion from customers and other organizations via written letter, phone call, agent and websites forms.

4.3.4. Addis Ababa Water and Sewerage Authority

A system where customers can file complaints wherever they have a complaint about service delivery is prepared at Addis Ababa Water and Sewerage Authority headquarters and at eight branches. Complaints about service delivery can be handled by executives, officers, senior management at any time, and if they do not get enough response from employer, they can file to Grievance Committee. Customers can apply for a grievance procedure in the head office of the Addis Ababa Water and Sewerage Authority and each branch office. Complaints may be made by a representative or agent in written, verbal, fax, e-mail, or telephone. So the institution prepares Suggestions boxes, records, and forms, as well as phones, which the people can provide feedback or lodge complaints at the headquarters or at the branch offices. Complaints and suggestions provided from customers and stakeholders considered as an input to the improvement of institution and service provision.

4.4. Document Analysis

The complaint and suggestion forms are collected from each organization. Each organizations use almost similar complaint forms with a little difference. These variations are considered and integrated into one form. During interview researcher get an opportunity to collect and observe these forms. Suggestion box, suggestion notebook, and complaints forms are the major document that can be observed. These complaints and suggestion forms are aggregated and researcher design one single form.

4.5. Survey Analysis

4.5.1. Participants Educational Status

According to educational level the survey participants has been grouped into 2nd degree, 1st degree, 1st degree student, diploma & certificate, and grade 8-12, and below grade 8. Participants of each group are shown in the following chart. A category below grade eight means a person who stops learning before completing grade eight. Participants under age eighteen is not considered.

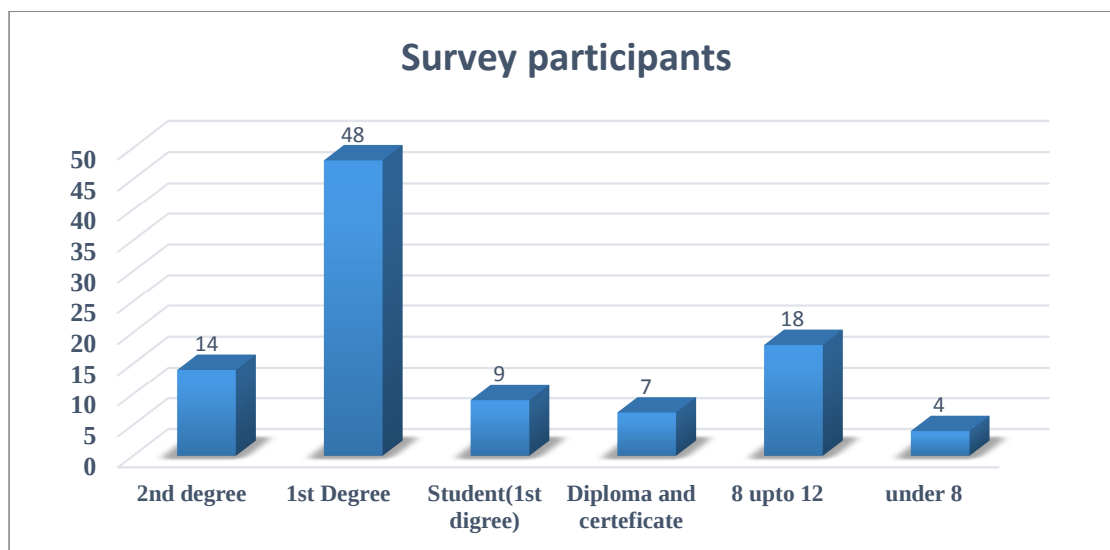


Figure 4.2 Survey Participants Educational Status

This data clearly shows that the collected data is from matured and responsible peoples. They know the conditions and what should be improved. As shown on the figure 4.2 most of the respondents have a degree level educational status.

4.5.2. Participants Stance on Problems

Here the participant's answers on different services like water, road, electric, policing have been discussed. This response helps to realize the major reason of customer not to complain. According to question number five (see appendix A); Participants response when they see water related problems such as water loss, broken pipe are depicted in table 4.2.

Table 4.2 Respondents Answer on Water Related Issue

<i>No. of Respondents (%)</i>	<i>Action taken</i>	<i>Reason</i>
38%	Could Suggest	-
31%	No action taken	They don't know the responsible body.
11%	No action taken	Lodging complaints or suggestion takes time and money.
17%	No action taken	There will not be any party that considers the suggestion.
3%	No action taken	They thought this is not their duty.

As shown table 4.2; 62% of the respondent couldn't report the problem of water service. To make the user report issues when they observe, there should be a mechanism to avoid these reasons listed in the above table.

The participants' response according to question six and seven (see appendix A); 92% of the participants have seen potholes, damaged roads, uncovered trench, and uncovered man holes that are risky for human, animal, children and elders. 8% of the participants have not seen these problems. From these 92% of the participants who see the road related problems most of them have not report to the concerned body because of several reasons as shown in table 4.2.

Table 4.3 Participants Answer on Road Related Problem

<i>No. of Respondents (%)</i>	<i>Action taken</i>	<i>Reason</i>
17.39%	they could report	-
52.17%	No action taken	They don't know the responsible body.
6.52%	No action taken	Lodging complaints or suggestions takes time and money.
11.96%	No action taken	They did not know the physical location or office of responsible body.
11.96%	No action taken	They think responsible bodies couldn't provide a solution even if they know the problem.

As shown on table 4.3; 82.61% of the respondents could not report road related problem due to the several reasons listed in the table. The proposed solution should eliminate these reasons and encourage these people to file complaints and suggestions.

According to question seven (see appendix A); Citizens who face road transportation related problems such as refuse of short distance ride and asking more fee and unsafe driving, 77% did not report complaints, 12% register complaints, 6% uses force to protect their right and 5% assumes the responsible body couldn't take proper action even the problem is known.

According to question nine to eight (see appendix A); Citizens who have seen broken Sewer or improper waste disposal that pollute the environment are 92. This implies the problem exists frequently. 8 participants have not seen such types of problems. From these 92 participants 20.65% report the issue to the responsible body; 79.35 % did report the problems due to several reasons as shown in table 4.4.

Table 4.4 Participants Answer on Waste Disposal Related Issue

No. of Respondents (%)	Reason
28.77%	They don't know the responsible body.
20.55%	Lodging complaints or suggestions takes time and money.
15.07%	They did not know the physical location/office of responsible body.
34.25%	They thought responsible bodies couldn't provide a solution even if they know the problem.
1.37%	They thought, they are not ready to accept suggestions

This indicates that customers do not know the concerned body that have a responsibility of waste disposal. There should be a way of making awareness to customers. Customer should get aggregated information about any service providers through one window.

Most of customer who have seen criminal acts or rule violation report to the concerned authority. However, some customers said that they didn't report the issue. Respondents' answers according to question eleven (see appendix A) presented in table 4.5.

Table 4.5 Participants Answer on Criminal Acts

No. of Respondents	Action taken	Reason
67%	Report to the responsible body	-
10%	No action taken	Lodging complaints or suggestions takes time and money.
13%	No action taken	They don't know the responsible body.
6%	No action taken	They think the responsible body couldn't consider the complaints or suggestions.
4%	No action taken	They will inform the person who will be injured.

The solution that will be proposed should encourage 33% of the respondents to lodge complaints and suggestions by overcoming the reasons that refrained customers from complaining.

The participants response according to question twelve (see appendix A); 72 participants observe employees who did not serve customers properly. 28 participants haven't seen such type of problems.

Table 4.6 Respondents Answer on Employee Poor Service Provision

Participants	Action taken
12.5%	Report to the responsible organization
52.78%	didn't take any action
29.17%	Report by suggestion box
5.56%	They thought no appropriate solution provided by employee supervisor.

According to table 4.6; 58.34% of the respondent couldn't report bad administration. To bring these people to report complaints and suggestions, there should be some ways of mechanism which supports organizations to follow up customer complaints and suggestions. The availability

of well-organized records helps the organization to handle and review complaints and suggestions.

The participants' response according to question fourteen (see appendix A) shown in table 4.7.

Table 4.7 Respondents Answer on Electric Related Problems

<i>Participants</i>	<i>Action</i>	<i>Reason</i>
61%	They have reported the problem to the responsible body	-
15%	No action taken	They don't know the responsible body.
11%	No action taken	Lodging complaints or suggestions takes time and money.
10%	No action taken	They did not know the physical location or office of responsible body.
3%	No action taken	They haven't their phone number and The concerned body didn't answer the phone call.

As shown on table 4.7; 39% of the population couldn't report the problem of service of electric. There should be some way of mechanisms to bring these peoples to participate on complaints handling process.

The participants response according question fifteen (Q15); the number of hotlines that the customers knows grouped into five sections zero hotline, one hotline, two hotlines, three hotlines, above four hotlines.

- Zero hotline means the participants do not have any phone numbers (hotline) of the service providers. Hotline means special telephone lines that people can use to get information or to talk about something.

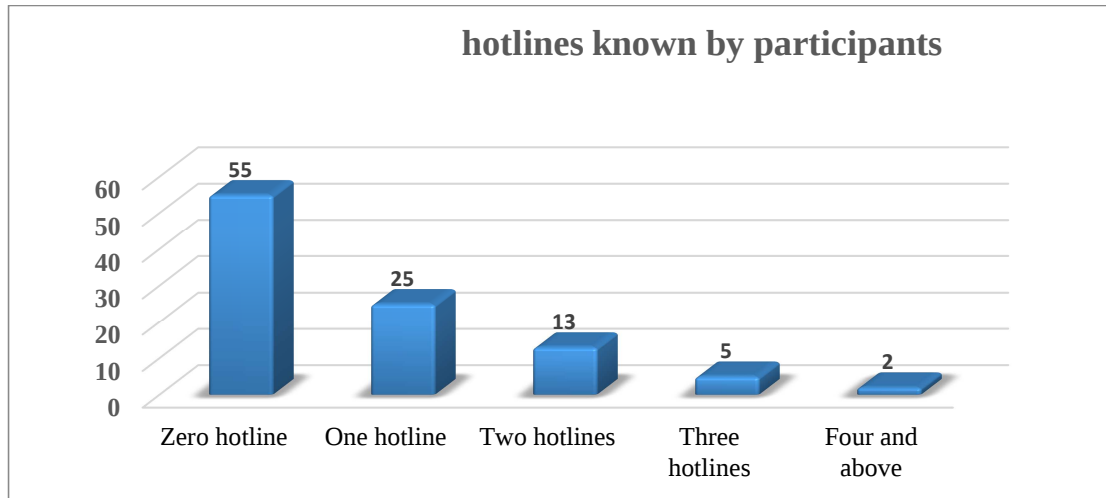


Figure 4.3 Participants vs Service Provider Hotlines

As shown on the figure most of the respondents have no phone numbers of service providers that used to provide suggestion or lodge complaints. To avoid these recalling issues the solution should provide information to citizens.

4.5.3. Participants Internet Usage

The participants response according to question one (see appendix A); 89 participants uses an internet and 11 participants do not use internet. Out of these 89 participants internet users:

Table 4.8 Respondent Most Frequently Device to Use Internet

<i>Participants</i>	<i>Frequently used device</i>
68.54%	Mobile phone
29.21%	Computer
2.25%	Tablet

This data is used to make ensure the complaints and suggestions by handheld device like phone through internet is correct choice.

4.5.4. Participants Mobile Platforms

As shown in the following chart most of the users have android platforms. IOS is the second popular operating system. This data could be an input to select the cross platform mobile development framework.

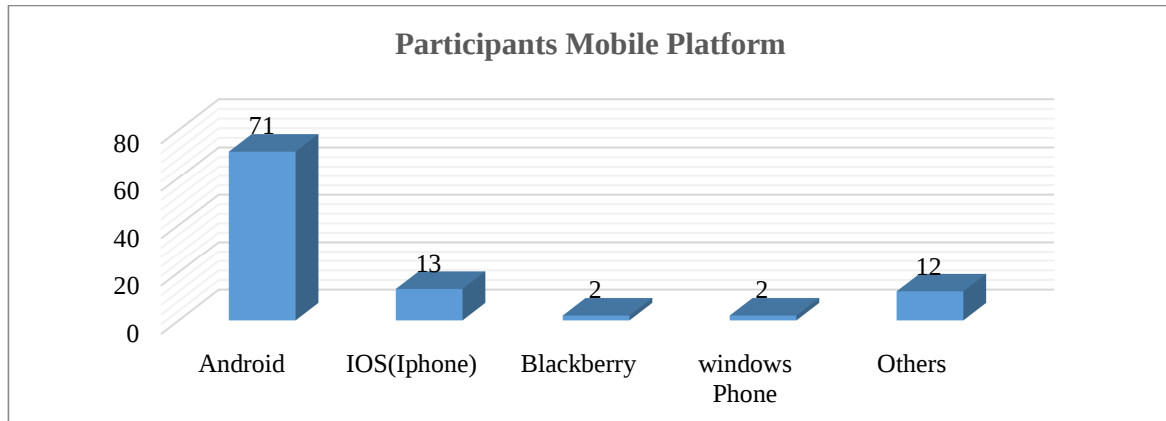


Figure 4.4 Participants Mobile Platform

Figure 4.4 clearly shows most of the client device platform is android followed by iOS. This data is considered during cross platform mobile development tool selection.

4.6. Causes hindering citizens to lodge complaints and provide suggestions

The survey result indicates that there have several problems on service provider organizations. Based on the survey many of citizens ignore reporting to the concerned body due to several reasons. Let's summarize these reasons.

- Lodging complaints and providing suggestion in person is inconvenient.
- Unable to know nearest physical location of the office.
- Couldn't know the concerned public body.
- Phone not answered by the responsible public bodies.
- Time Shortage. Citizens may not have enough time to lodge complaints or suggestions so they ignore registering complaints.
- Hotlines may become congested at peak hours due to which the citizens have to wait for a long time to register the complaint.
- Difficult to remember different hotlines, emails and websites of each service providers.

By considering these causes that limits citizen participation on the service delivery quality improvements, controlling public infrastructures and environmental pollutions, mitigating crimes, resource wastage and increases customer satisfaction and so on, the new proposed framework should be designed. The framework could solve or reduce the customers' knowledge gap, effort and time costs. The framework also considers the user platforms, mobile internet costs, device resources, usability and efficiency.

Chapter Five: Framework Design and Prototype Development

5.1. Overview

Complaints are valuable information for service quality improvement. Every Service providers are willing to receive customer complaints and suggestions. Currently providing suggestions or complaints are inconvenient. Service providers may prepare a complaint handling communication channels. These communication channels may not be recognized by citizens because it is difficult to keep all channels. In this case customer may hesitate to provide complaints and suggestions. Now the researcher proposed the new system that boosts customer participation on reporting and controlling problems by providing infrastructures to customers easily register complaints and provide suggestions. Customers can sends image, audio, video and geographical location of the issue occurred. Customer can also get information about the service provider responsibilities and duties to support the customers where the complaints and suggestions should be sent, and where the organization located. The organizations that subscribed to this service can receive complaints and suggestions and can observe the exact location of the problem plotted on the map.

5.2. Proposed Framework

The framework depicts the overall communication and processes among the system stakeholders. As shown in figure 5.1; service providers, system admin, mobile clients, complaints handling officers, complaints handling units and top managements are the system backbone. The framework designed by considering all public service providers, customers and the problems that prevent customers to participate on service quality improvement. The structure of organization and complaints handling unit vary across organizations. The framework tackles these problems. It also avoids the development of mobile app to each service providers. The customer can lodge complaints and provide suggestions to all service providers with one application. The framework is designed to operate for all organizations without area and number of organization limitations. The framework is designed by considering the information gained from questionnaire, and interview. Components and techniques are used to incorporate solutions for each problem.

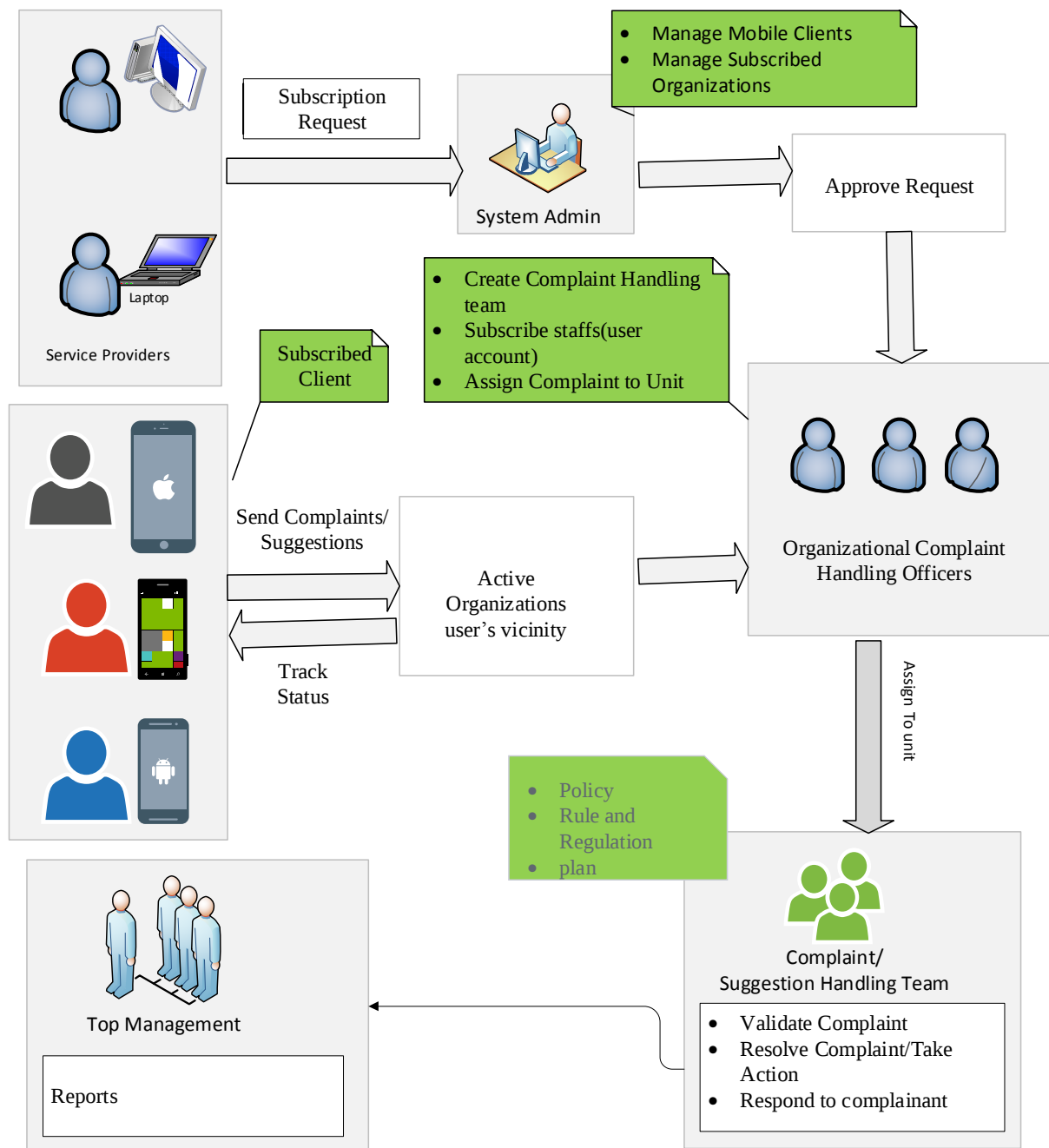


Figure 5.1 Proposed System Framework

5.2.1. Service providers

Service providers can be organizations and its service delivery points. Every service delivery points first subscribed to be a member of e-CSMS using web application. During registration provider name, geographical location and complaints handling officer information is mandatory.

The registered provider needs approval from system administrator to start receiving their complaints from customers. Service providers can receive complaints and suggestions from nearby residents.

5.2.2. System Admin

Any person who has System administrator role can manage mobile clients and endorse service providers that have been registered. Endorsed service provider organizations can receive complaints and suggestions from citizens (complainant). Ministry of information and communication Technology (MCIT) is providing web hosting services to the various Ethiopian Government Ministries/Organizations/Institutions as well as State Government Departments. This organization has a responsibility to provide solution to government organizations to accomplish their works easily and achieve its goal. It is good if this role is held by this organization.

5.2.3. Complaint Handling Officers (CHO)

Subscribed service providers have a complaints handling officer who receive complaints from mobile clients. CHO can create user accounts for staffs who involves in complaints or suggestions handling. Create units that have a responsibility to resolve complaints and suggestions. Staff members assigned to complaint handling unit. Received complaints or suggestions from complainants are assigned to these units by CHO. CHO Have knowledge of, all aspects of the organization's internal complaint procedures and be trained to receive, investigate and deal with complaints about the organization's products and services. Complaints should be handled by people who have the appropriate skills and authority to resolve or investigate complaints and, provide remedies and identify improved practices.

5.2.4. Mobile Clients

Mobile clients are citizens that install mobile application to send complaints and suggestions to active service providers without going to office in person. Mobile clients should be registered before using the mobile app. The complainants can track the status of the complaints and suggestions of he/she suggests, get helps to know the responsible body, providers information such as phone number, locations, email etc.. This issue reporting mechanism or channel increases customer participation and satisfaction.

5.2.5. Complaints and Suggestions Handling Unit

The complaints and suggestions assigned to the responsible unit by complaint handling officer are viewed by this unit. These units validate and take action on the provided complaints or suggestions by considering the organization plans, rules and regulations. They can locate exact area that of complains or suggestions on the google map. Respond the status of the complaints to the requester.

5.2.6. Top Management

The organizations top management need organized and aggregated data review and evaluate their organization performance and service quality. Well organized data has a crucial role in the organization service improvement and customer satisfaction level. The reports could use as input to review rules and regulations of the organizations and prepare organization plan to improve service delivery quality and improve customer satisfaction.

5.3. Architecture of the System

Software application architecture is the process of defining a structured solution that meets all of the technical and operational requirements, while optimizing common quality attributes such as performance, security, and manageability [44]. The goal of architecture is to identify the requirements that affect the structure of the application. The Architecture used in the study is a Service Oriented Architecture (SOA). SOA is a services-centric architectural pattern for constructing and accessing suites of software components/services [45]. Service-oriented architecture enables extensible architecture, loosely coupled, and enhanced reuse, multiple clients and multiple client types to access, more maintainability, better Scalability of applications. Service oriented architecture is chosen because of these reasons. Web browser and mobile clients are major agents that consume web services in the proposed model. The web service is divided into layers. Layering represents the logical separation of an application's components into groups that represent distinct roles and functionality. Using a layered approach can improve the maintainability of services and make it easier to scale out.

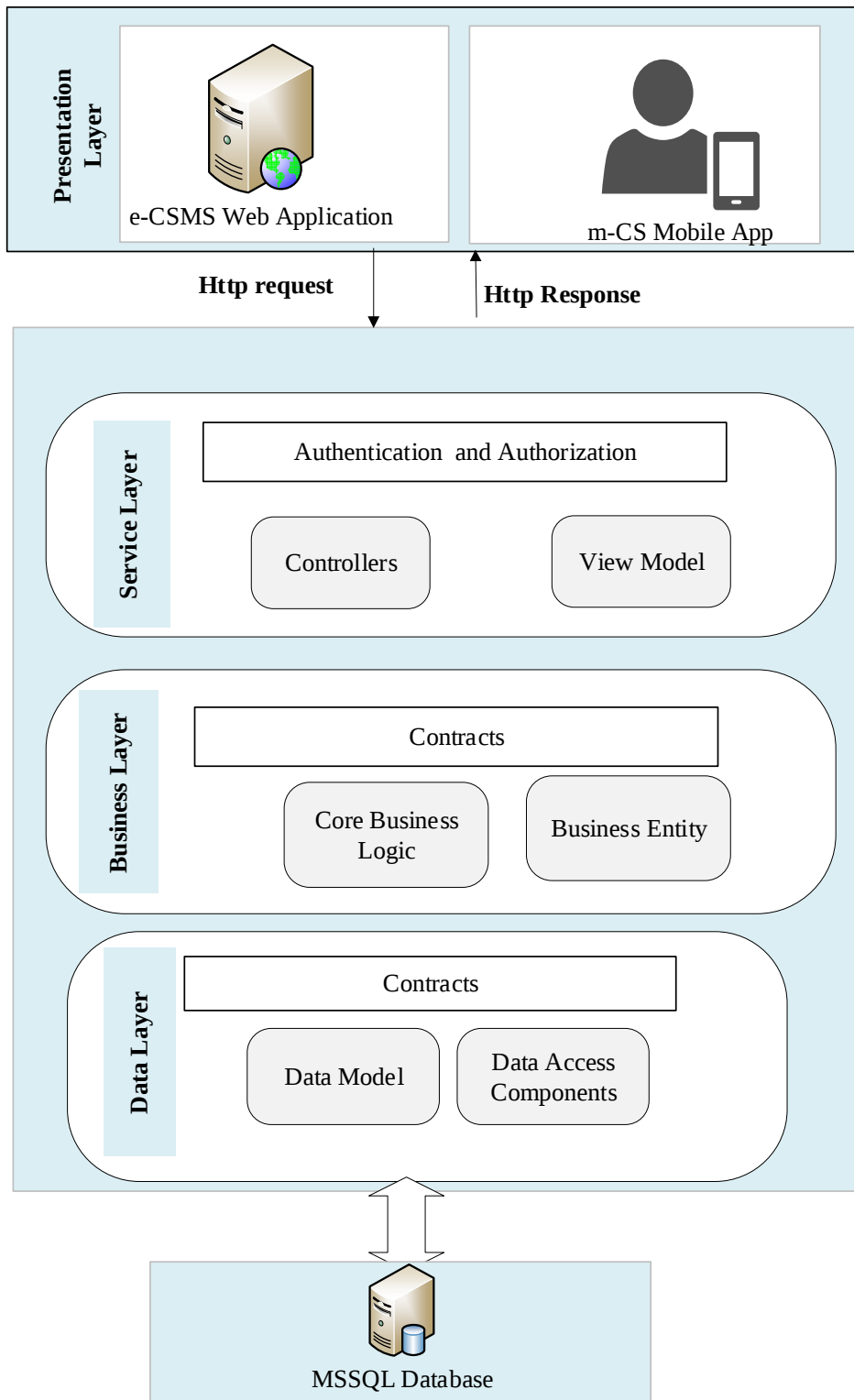


Figure 5.2 Architecture of the Proposed System

5.3.1. Presentation Layer

The layer has two types of components which are web application and mobile application. Mobile application is deployed on user mobile phones. A mobile app used to register complaints and track complaints status in general it allows communicating all service providers. And web application is deployed on a web server which is used to manage service providers and its complaints and suggestions. The data source of both mobile and web applications are a web service. Presentation layer communicate with web service through http protocol. The components discussed below.

5.3.1.1. Mobile Application

PhoneGap is a useful solution for building mobile applications using modern web programming languages, such as HTML, HTML5, CSS, CSS3 and JavaScript and the functionality of SDK's [16]. PhoneGap/Cordova allows developers to enclose applications written in known programming languages into native applications. PhoneGap is a distribution of Apache Cordova. Apache Cordova is the engine that powers PhoneGap. It supports multiple platforms than other frameworks as discussed in chapter two. Ionic framework is an open-sourced software development tool that is used in order to create hybrid mobile applications [19]. It is built using AngularJS and Apache Cordova. It provides tools and services for building Mobile UI with native look and feel. A combination of PhoneGap/Cordova plus AngularJS gives Ionic framework. Ionic framework enable to separate source codes into three parts which are controllers, views and services.

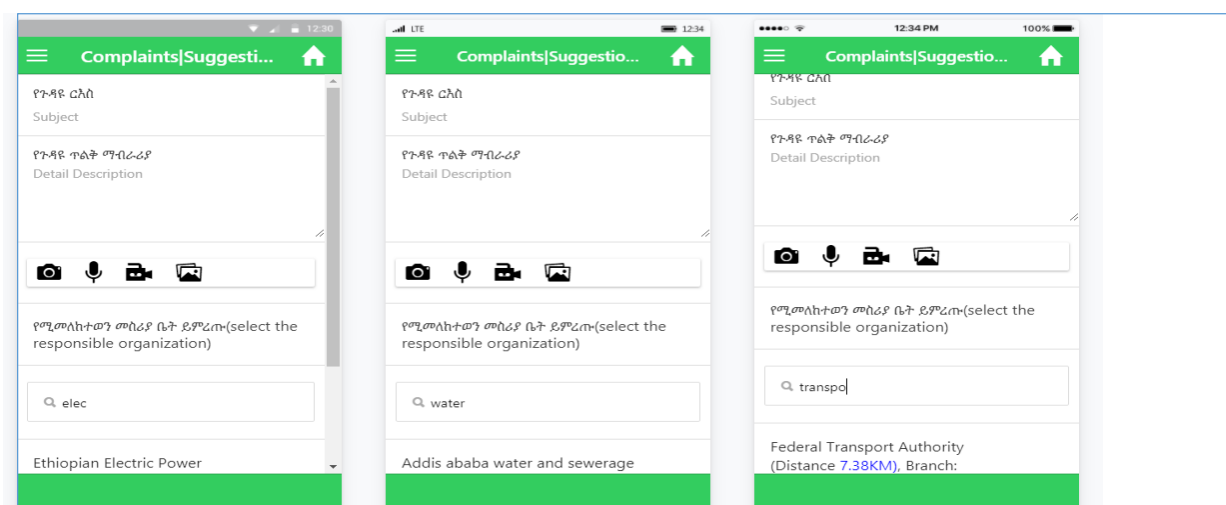


Figure 5.3 User Interfaces on Different Platforms

Controllers: controllers are JavaScript constructors which are the backbone for Ionic app. They control the flow of logic and data. Controller calls service or factory to retrieve and save data to and from server respectively. The controller that needs to access data from ionic service first the service should be injected to the controller as indicated by ① in figure 5.4. The line marked by ② invokes service methods and the returned result assigned to a variable as shown by ③. This data could be bind to views.

```
(function () {
  'use strict';
  angular
    .module('starter.controllers')
    .controller('SuggestionController', SuggestionController);

  SuggestionController.$inject = ['suggestionService'];

  function SuggestionController(suggestionService) {
    var vm = this;
    vm.title = 'Suggestion controller';
    activate();
    function activate() {...}
    function getOrganizations() {...}
    function getNearbyOrganizations() {
      vm.showLoading();
      var currentUserLocation = {Latitude: vm.user.Latitude, Longitude: vm.user.Longitude};
      vm.OrganizationsList = [];
      suggestionService.getNearbyOrganizations(currentUserLocation)
        .then(function (result) {
          vm.OrganizationsList = result;
          vm.hideLoading();
        }, function (error) {
          vm.hideLoading();
        });
    }
  }
  //...
})();
```

Figure 5.4 Controller Code Snippet

Services (Factory): The Data layer of an Ionic app is the provider of data, usually from an external backend or web service. The controller requests the data from the Data layer to use in binding to the view. These Data layer classes are known as Services or Factories. The service implementation looks like below.

```

(function () {
  'use strict';
  angular
    .module('starter.controllers')
    .factory('suggestionService', suggestionService);
  suggestionService.$inject = ['$q', '$http'];
  function suggestionService($q, $http) {
    var service = {"saveSuggestion": saveSuggestion...};
    return service;
    function getNearbyOrganizations(location) {
      var deferred = $q.defer();
      $http.post(server_url + 'MobileDevice/GetOrganizationsByLocation', location).then(
        function (d) {
          deferred.resolve(d.data);
        },
        function (err) {
          deferred.reject(err);
        });
      return deferred.promise;
    }
  }
}

```

Figure 5.5 Service Code Snippet

The line marked by ① is used to inject services which help to the services to do its task. \$http is a service marked by ② used to send http AJAX request to a remote web server to a specified address. The returned data is returned to the caller controller function as shown by ③ which is from web service

Views: Views in an Ionic App are often referred to as templates which are an html file controlled by controller. The variable marked by ① is found in a controller which holds a data returned from service.

```

<ion-view title="organizations">
  <ion-content>
    <ion-list>
      <ion-radio class="item-text-wrap" ng-repeat="row in vm.OrganizationsList | filter:textbox2"
        ng-model="pr.user.OrganizationID" ng-value="row.ID">
        <a href=""> {{row.Name}}
          (Distance <span style="color: blue">{{row.DistanceKM}}KM</span>,
          Branch: {{row.Branch}},
          Exact Location: {{row.Location}}
        </a>
      </ion-radio>
    </ion-list>
  </ion-content>
</ion-view>

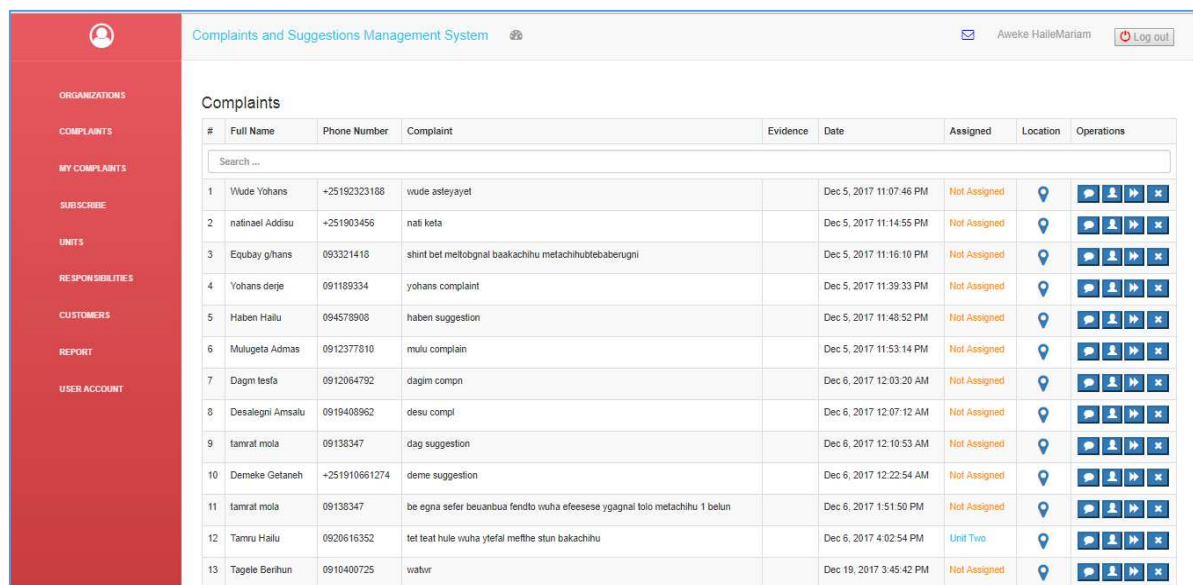
```

Figure 5.6 Ionic View Code Snippet

5.3.1.2. Web Application

The complaints and suggestions that have been sent by mobile user should be depicted to the concerned public body. To comprise this requirement web application should be developed. The presentation layer contains the components that display data in an interactive way. The user interface built by HTML, CSS, and AngularJS. AngularJS is a structural JavaScript framework for dynamic web applications. It is used in Single Page Application (SPA) projects. It extends HTML DOM with additional attributes and makes it more responsive to user actions. AngularJS is open source and completely free. AngularJS allows MVC software design pattern for developing web applications. MVC isolates the application logic from the user interface layer and supports separation of concerns. The web application divided into three components models, views, and controllers.

- The model is responsible for managing application data. It responds to the request from view and to the instructions from controller to update itself.
- View is responsible for displaying data to the user. The view uses the data prepared by the controller to generate a final presentable response.



#	Full Name	Phone Number	Complaint	Evidence	Date	Assigned	Location	Operations
1	Wude Yohans	+25192323168	wude asteyayet		Dec 5, 2017 11:07:46 PM	Not Assigned		   
2	natinael Addisu	+251903456	natli keta		Dec 5, 2017 11:14:55 PM	Not Assigned		   
3	Equbay g/hans	093321418	shirt bet mettobgnal baakachihu metachihubtebaberugni		Dec 5, 2017 11:16:10 PM	Not Assigned		   
4	Yohans derje	091189334	yohans complaint		Dec 5, 2017 11:39:33 PM	Not Assigned		   
5	Haben Hailu	094578908	haben suggestion		Dec 5, 2017 11:48:52 PM	Not Assigned		   
6	Mulugeta Admas	0912377810	mulu complain		Dec 5, 2017 11:53:14 PM	Not Assigned		   
7	Dagm tesfa	0912064792	clagim compn		Dec 6, 2017 12:03:20 AM	Not Assigned		   
8	Desalegn Amsalu	0919408962	desu compli		Dec 6, 2017 12:07:12 AM	Not Assigned		   
9	tamrat mola	09138347	clag suggestion		Dec 6, 2017 12:10:53 AM	Not Assigned		   
10	Demeke Getaneh	+251910661274	deme suggestion		Dec 6, 2017 12:22:54 AM	Not Assigned		   
11	tamrat mola	09138347	be eгна sefer beuanbua fendto vuha efeesees yagnal tolo metachihu 1 belun		Dec 6, 2017 1:51:50 PM	Not Assigned		   
12	Tamru Hailu	0920616352	fet teat hule vuha ytefal metthe stun bakachihu		Dec 6, 2017 4:02:54 PM	Unit Two		   
13	Tagele Berhun	0910400725	watur		Dec 19, 2017 3:45:42 PM	Not Assigned		   

Figure 5.7 User Interface Presenting Complaints

- A controller is a JavaScript object containing attributes and functions. The controller responds to user input and performs interactions on the data model objects. It receives

input, validates it, and then performs business operations that modify the state of the data model.

```
/** Created by SEPG on 9/28/2017. ...*/  
(function () {  
    'use strict';  
    angular  
        .module('webUi3App')  
        .controller('ComplaintCtrl', ComplaintCtrl);  
    ComplaintCtrl.$inject = ['$log', '$scope', 'complaintFactory', '$state', '$uibModal', 'authService'];  
    /* @ngInject */  
    function ComplaintCtrl($log, $scope, complaintFactory, $state, $uibModal, authService) {  
        var vm = this;  
        vm.title = 'ComplaintCtrl';  
        activate();  
        function activate() {...}  
        function getComplaints() {  
            vm.complaintList = [];  
            var organization = {ID: $scope.authentication.organizationID};  
            complaintFactory.getComplaints(organization).then(function (data) {  
                vm.complaintList = data;  
                vm.CollectioncomplaintList = data;  
            }, function (err) {  
                alert("Server refuse connection");  
            })  
        }  
    }  
    /*...*/  
}()  
})();
```

Figure 5.8 Controller Code Snippet

AngularJS provides \$http service to read and send data from or to the web server. AngularJS needs data in JSON format. The web application can get data from web service by sending http request. The web service returns a JSON data to the requestor.

```
function getComplaints(organization) {  
    var deferred = $q.defer();  
    $http({  
        method: "POST",  
        url: server_url2+'api/ComplaintsManagement/GetComplaintsByOrganization',  
        data: organization  
    }).then(function successCallback (d) {  
        complaintsCount=d.data.length;  
        deferred.resolve(d.data);  
    },function errorCallback(err) {  
        deferred.reject(err);  
    })  
    return deferred.promise;  
}
```

Figure 5.9 Service Code Snippet Retrieve Data from Remote Web Service

5.3.2. Service Layer

Service layer contains models, controllers and configurations. Controller is a class that inherits **ApiController** of a web API framework controller. The methods within this controller are accessible over a network through HTTP protocol. The Web API is a framework for building web services; these web services use the HTTP protocol. It can be accessed from any client such as browsers and mobile devices. The Web API returns the data on request from the client, and it can be in the format XML or JSON.

Web API binds HTTP request data to the parameters of an action method. The parameter data type can be primitive or complex. Models can be used as a complex parameter data types. The model maps the http request data to entity and business entity to model. Authentication and authorization of the service requester located in this layer.

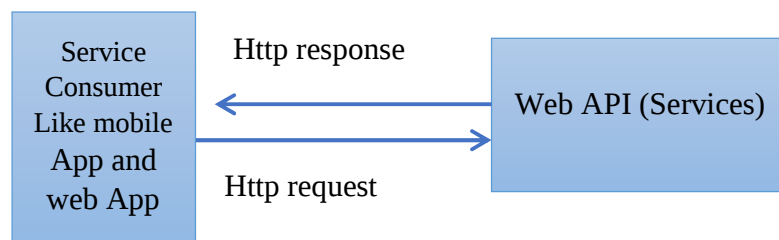


Figure 5.10 Service Consumer and Web API Communication

The presentation layer has two agents or components which are mobile App (m-CS) and web application (e-CSMS) as discussed above. These applications rely on the web services provided by CSMS web services. The presentation layer components require a number of services to accomplish their tasks. The following component diagram shows the m-CS App and e-CSMS application communication with the web services.

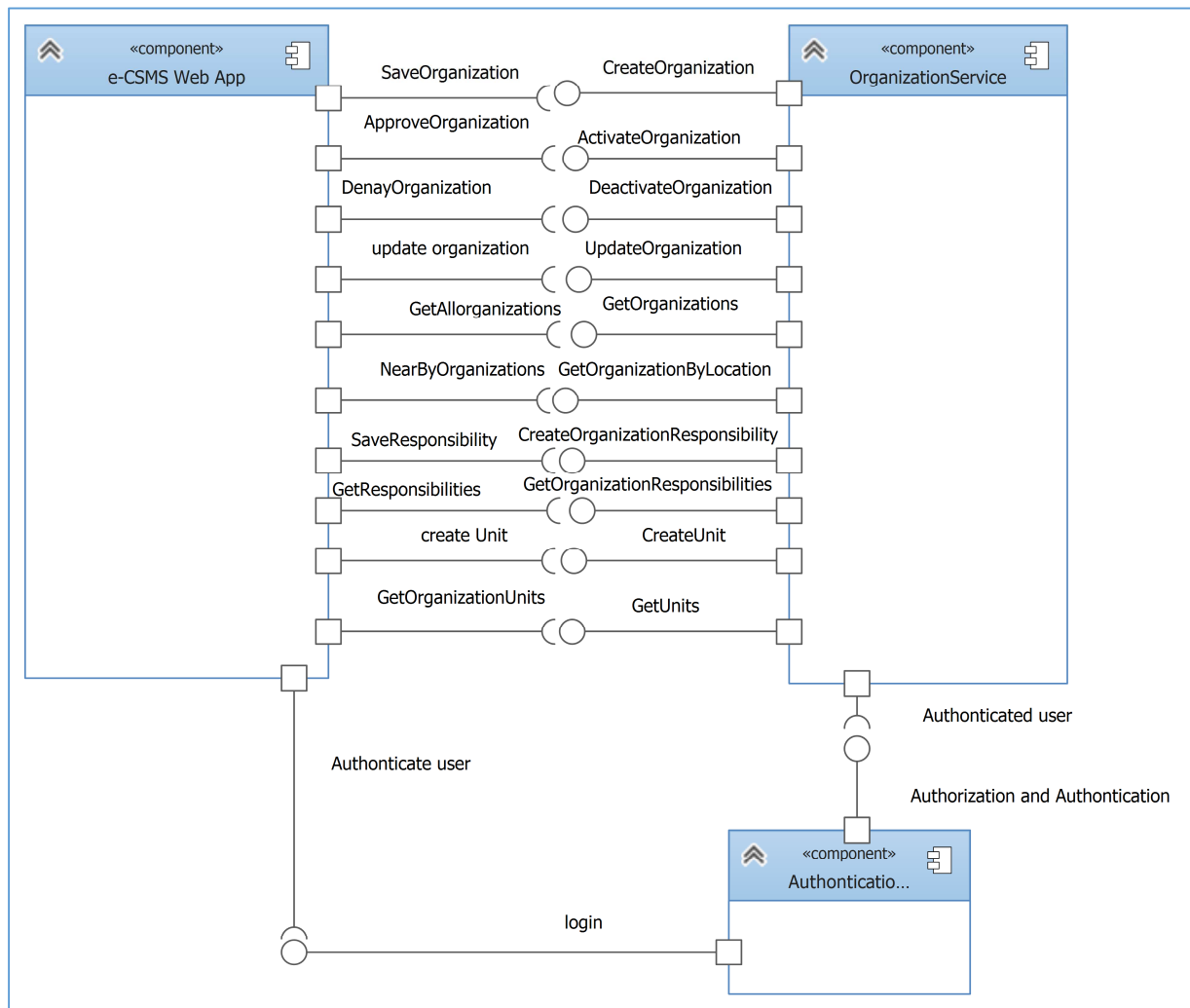


Figure 5.11 e-CSMS with Organization Services Interfaces

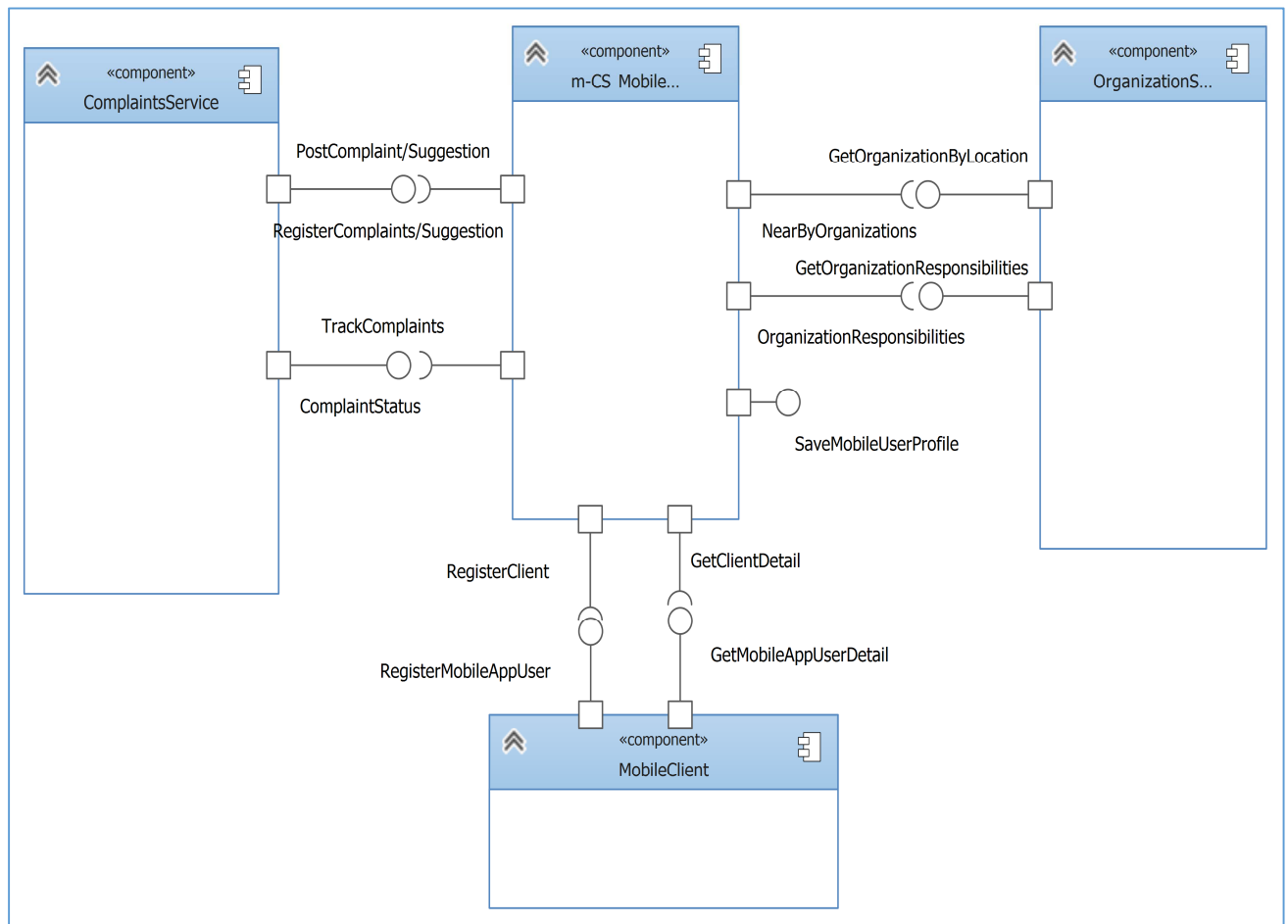


Figure 5.12 m-CS Mobile App with CSMS service Interfaces

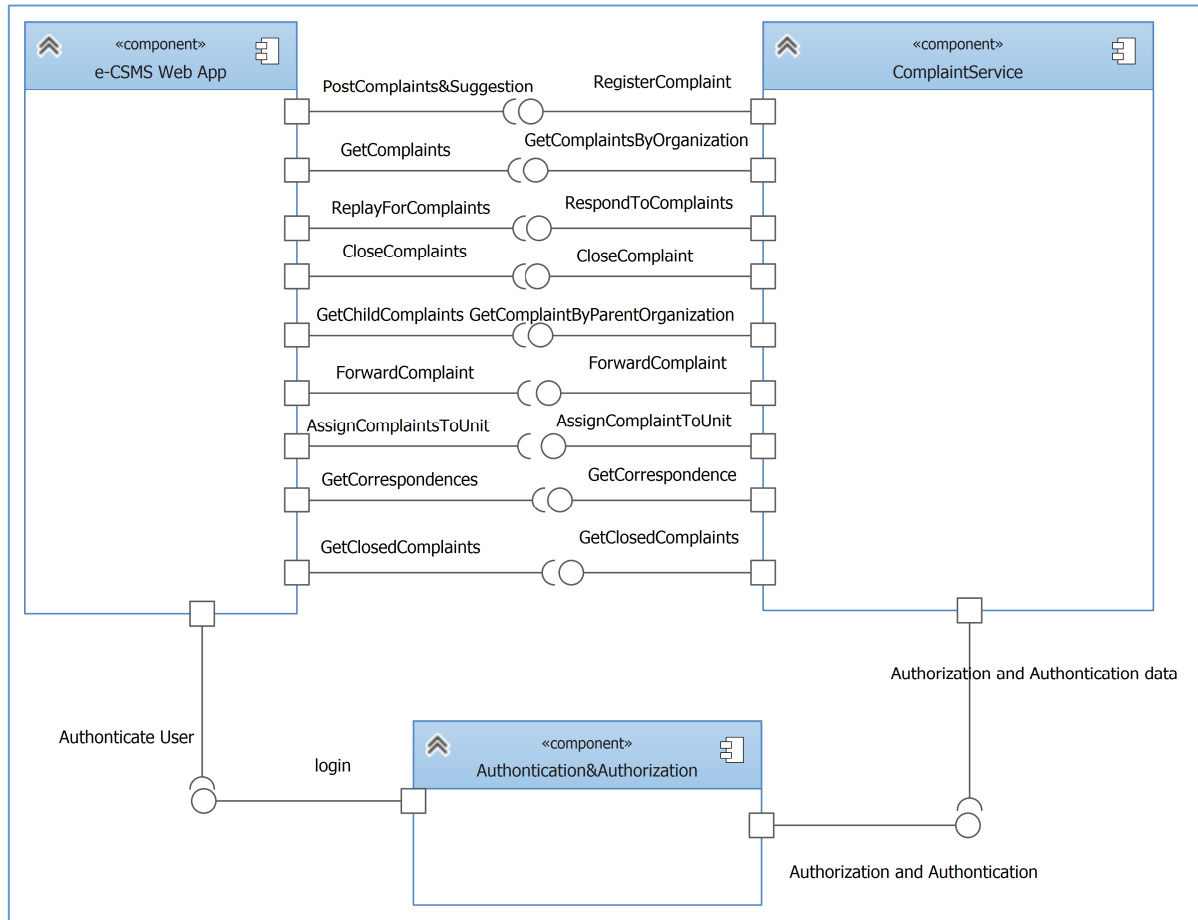


Figure 5.13 e-CSMS App with CSMS Services interfaces

To be more maintainable and manageable services the CSMS services are grouped into small logical components as shown on the above component diagram. Let us explain one of the component **complaintService** component and its interface **RegisterComplaint**. Figure 5.14 shows the sample code of **RegisterComplaint** in the **complaintService** component. **IComplaint** marked by ① is interface implemented by a class called **Complaints** which are located at business layer. **RegisterComplaint** marked by ② is a service which is accessible by clients through http request. This method receives a parameter of type **ComplaintModel** marked by ③ which is a complex parameter data types. **ComplaintModel** receive attribute data sent from clients. The model data transferred to business entity as indicated by ④. This service calls a business layer method “**RegisterComplaint**” marked by ⑤ with argument of **ComplaintEntity**. The code marked by ⑥ converts the returned data which have entity type from business layer into model. Finally the data returned to requestor.

```

IComplaint complaintService;
[HttpPost]
0 references
public ComplaintModel RegisterComplaint(ComplaintModel complaint)
{
    complaintService = new Complaints();
    ComplaintModel result = new ComplaintModel();
    ComplaintEntity complaintEntity = new ComplaintEntity();
    if (complaint != null)
    {
        complaintEntity = complaintService.RegisterComplaint(complaint.MapToEntity<ComplaintEntity>());
        result = new ComplaintModel(complaintEntity);
        result.Status = complaintEntity.Status;
        result.Message = complaintEntity.Message;
    }
    else
    {
        result.Status = false;
        result.Message = Messages.modelEmpty;
    }
    return result;
}

```

Figure 5.14 Service Layer Web API Code Snippet

5.3.3. Business Layer

Business Components implements a logic that is concerned with the retrieval, processing, transformation, and management of application data, application of business rules and policies, and ensuring data consistency and validity are considered in this layer. Business Entities are components maps user data to database models and maps database models to business entity. When this layer needs a data from database it can call the data access layer functions. Contracts are interfaces implemented by business concrete class.



Figure 5.15 Web Service Internal Components and their Communication

Let us explain how the business layer works to retrieve organizations for mobile agents. The presentation layer agents (like m-CS app) send requests to get organizations which are located nearby mobile user to a service layer service **GetOrganizationByLocation** shown in Figure 5.15. The mobile app includes the current location of the mobile phone in the request. This service receives the arguments latitude and longitude and invokes the business layer method **GetNearbyOrganization** in Organization class. This method needs all active organizations to

find out the closest organizations which far up to 25KM+n from mobile location where n start from 0 and incremented by five. Active organizations are public service providers which are subscribed to this system and endorsed by system admin to use complaints and suggestions system. The **Organization** business class method **GetNearbyOrganizations** invokes the data layer component **OrganizationRepository** of service **GetActiveOrganizations** as indicated by ②. The data layer retrieves active organizations and return to the caller. Then the business class method **GetNearbyOrganizations** calculates the distance of each organization by referencing mobile user location. If the distance is under the specified length, add it to the list otherwise skipped. The code marked by ③ calculates the distance between mobile user and the service providers. Repeat the steps to all organizations. After the closest organizations selected then sort by distance in ascending order to make useable for users the code marked by ④ in figure 5.6 do this task. These chosen organizations returned to caller service of the service layer. The service layer provides list of sorted organizations to requestor. The mobile application component displays these organizations to user to be selected for lodging complaint or provide suggestion.

```

0 references
public List<OrganizationEntity> GetNearbyOrganizations(double sLatitude, double sLongitude, int distance){
    List<OrganizationEntity> result = new List<OrganizationEntity>();
    double eLatitude = 0;
    double eLongitude = 0;
    foreach (Data.Models.Organization organization in this.repository.GetActiveOrganizations()){
        var sCoord = new GeoCoordinate(sLatitude, sLongitude);
        eLatitude = (double)organization.Latitude;
        eLongitude = (double)organization.Longitude;
        var eCoord = new GeoCoordinate(eLatitude, eLongitude);
        double distanceBetween = sCoord.GetDistanceTo(eCoord);
        var organizationModel = new OrganizationEntity(organization);
        organizationModel.RelativeDistance = distanceBetween;
        #region
    }
    var orderdList = result.OrderBy(x => x.RelativeDistance).ToList();
    return orderdList;
}

```

Figure 5.16 Business Layer Code Snippet that Access Organization by Distance

How the business layer components works to save data from e-CSMS web application. Communication among components held on via function calling. **ComplaintRepository** is a class of Data Layer which has several methods that can save and retrieve data to or from physical database respectively. **AssignComplaintsToUnit** marked by ② on figure 5.17 is a method at business layer which assign a complaint to a particular unit. To accomplish the operation first the

existence of the record in a database should be check as pointed by ③ in the following figure. If it is available, set unit for complaint and save changes to database.

```

public class Complaints : IComplaint
{
    IComplaintRepository repository;
    MessageLiterals messages = new MessageLiterals();
    2 references
    public Complaints()
    {
        this.repository = new ComplaintRepository(new Context(new eCEMSConnectionString()).Contexts());
    }
    2 references
    public ComplaintEntity AssignComplaintsToUnit(ComplaintEntity complaint, int toUnit)
    {
        ComplaintEntity result = new ComplaintEntity();
        Complain comp = this.repository.GetComplaintByComplaintID(complaint.ID);
        if (comp != null)
        {
            try
            {
                comp.TeamID = toUnit;
                this.repository.Update(comp);
                this.repository.UnitOfWork.SaveChanges();
                result.Status = true;
                result.Message = messages.AssignedToUnitSuccess;
            }
            #region
        }
        return result;
    }
}

```

Figure 5.17 Business Layer Code Snippet

5.3.4. Data Layer

The data layer manages the physical storage and retrieval of data. The objective of the Data layer is to provide data to your business objects without using database specific code by exposing a series of data access methods. All interaction between business objects and the data layer occurs by calling data access methods in the data layer from code in business objects. This pushes database-specific code into the data layer and makes the business object's database independent. Data Access components contain the logic to access the underlying data stores. Data models contain the properties of table which generated from database. Entity framework is an Object/Relational Mapping (O/RM) framework. It is an enhancement to ADO.NET that gives developers an automated mechanism for accessing & storing the data in the database. Entity Framework is an open source framework by Microsoft. This framework enhances development speed by making data access mechanism easy. Contracts are interfaces implemented by repository concrete class. Figure 5.18 shows the **IComplaintRepository** contracts.

```

namespace eCEMS.Data.Repositories.Contract
{
    public interface IComplaintRepository : IRepository
    {
        List<Complain> GetComplaintsByOrganizationID(int organizationID);
        List<Complain> GetComplaintsByParentOrganizationID(int parentOrganizationID);
        List<Complain> GetComplaintsByClintID(int clientID);
        List<Complain> GetComplaintsByUnitID(int clientID);
        Complain GetComplaintByComplaintID(decimal complaintID);
        List<Correspondence> GetCorrespondance(decimal complaintID);
        int GetComplaintsCount(int ID);
    }
}

```

Figure 5.18 Data Layer Contracts

The **ComplaintRepository** concrete class implements the above interfaces shown in figure 5.18. The arguments are passed from business layer. The business layer can get data by calling these methods which are shown below. The method returns a data with type of database model object. The business layer class that calls methods of data layer class methods has a responsibility to convert data model to business entity.

```

7 references
public Complain GetComplaintByComplaintID(decimal complaintID)
{
    return FindOne<Complain>(x => x.ComplainID == complaintID);
}

2 references
public List<Complain> GetComplaintsByClintID(int clientID)
{
    return Find<Complain>(x => x.SenderID == clientID).ToList();
}

2 references
public List<Complain> GetComplaintsByOrganizationID(int organizationID)
{
    return Find<Complain>(x => x.OrganizationID == organizationID && x.IssueStatus==true).ToList();
}

2 references
public List<Complain> GetComplaintsByParentOrganizationID(int parentOrganizationID)
{
    return Find<Complain>(x => x.Organization.ParentOrganization==parentOrganizationID).ToList();
}

```

Figure 5.19 Data layer Code Snippet

The data models are generated from database design. The database design show figure 5.20.

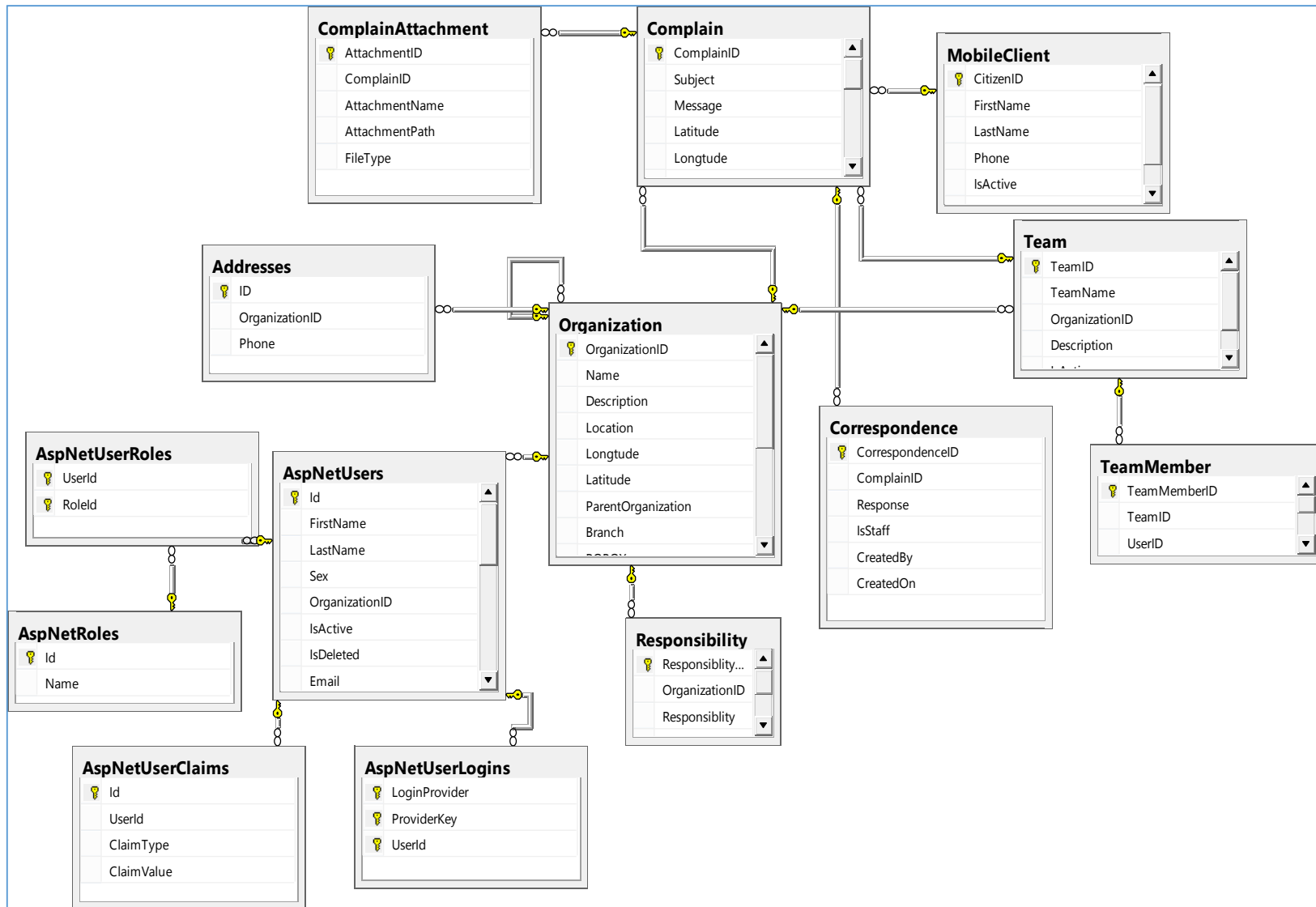


Figure 5.20 Database Design

5.4. Mobile Complaints and Suggestions App (m-CS)

m-CS is a mobile application which is designed to be usable by every service providers without making any change. All Ethiopian cities and towns of service providers could use this mobile solution to get customer complaints and suggestions. The customers who install this application can register complaint and provides suggestions to all service providers. One service providers may have several service delivery points each service delivery points must be subscribed to get suggestions and complaints from citizen. Service providers registered with its geographical location latitude and longitude. The App is designed to be location aware in order to increase cost effectiveness and usability. If we see service providers' country wide, they are too huge in numbers that is difficult to select one concerned body. To avoid this difficulty the application is to be location aware. For example the user who lives in Addis Ababa can register complains or suggestions to service providers located around Addis Ababa. The user can register complaints from current user position up to 25KM+n where n start from 0 and increment by five.

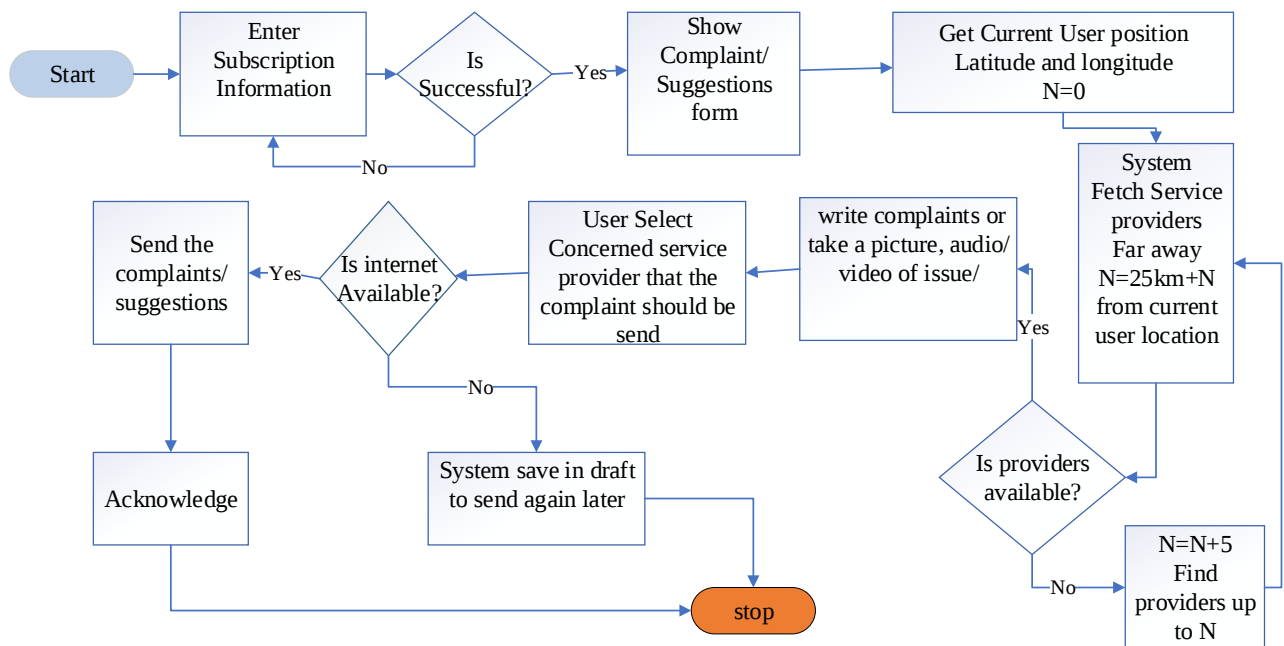


Figure 5.21 M-CS Application Process Flow Chart

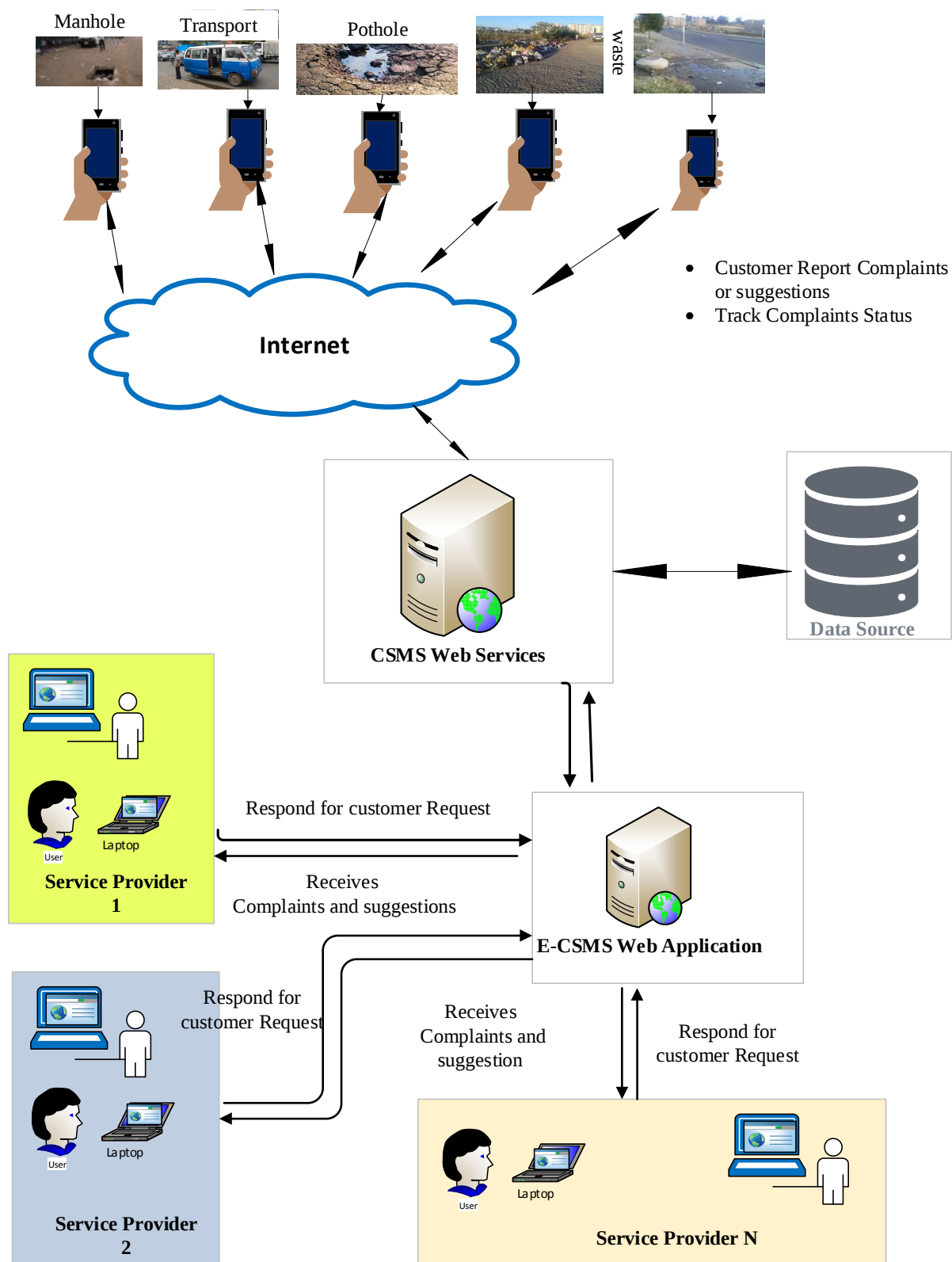


Figure 5.22 Overall System communication

5.4.1. User's Registration

The user has to register with his full name and phone number, all these data has been stored to database by calling web service. A web service saves and returns the registered user information with unique user code generated by the system to identify uniquely the customer. This information also saved to SQLite on local device. Whenever the user sends request (complaints or suggestions) this unique code included with message they need to send.

5.4.2. Capturing an Image

The user can take a snap shot of the particular visual problem i.e.: water leakage, overflowed garbage, potholes, fallen poll etc. they can also write a description of that image if they need. The location of the picture is embedded automatically with latitude and longitude form. Then the users select the concerned body from the list. The service providers are filtered by location and ordered by the distance from the user current position in the ascending order. If user has any other sort of problem which cannot be captured, the user can file the complaint without the picture by writing a detail description in a complain form.

5.4.3. Capturing Audio and Video

The user can file their complaints or suggestions in the form of audio or video. The customer Records their complaints or suggestions in the form of audio/video and select the concerned body and sends to the concerned body. This reduces time and effort expend for writing detail explanation about a situation. This feature encourages customer to provide their suggestions.

5.4.4. Lodge Complaints and Suggestions Process

- Open application m-CS, the home screen is active as shown on figure 5.23 pointed by ①.
- Write subject and detail description about the problem they have. It is not mandatory fields. If the problem is visual they can take a picture, audio and video for evidence.
- Then select the concerned public body (organization) which is mandatory. If you did not know the concerned body, search by the problem category such as water, electric, road, transport and so on. The full information about the service providers' information also available in the application.
- Click on send button

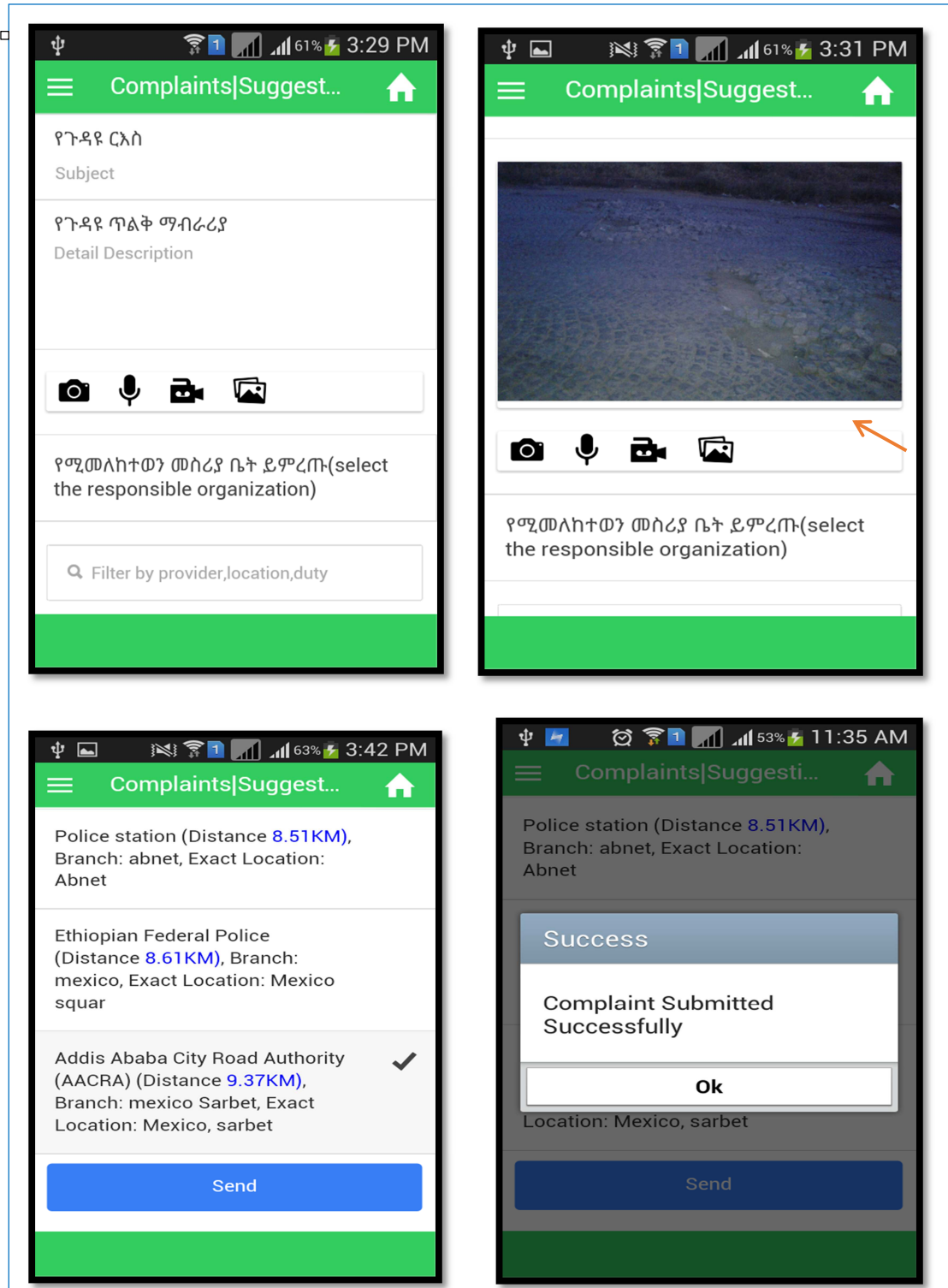


Figure 5.23 Sending Complaints and Suggestions Steps

5.4.5. Track Issues

When the complaint handling officer or the complaint handling unit tried to post the comment or response for a complaint, customers can follow the status of their complaints. The complaints that the user sent is stored in the local storage and remote storage (MSSQL). This helps the customer recall the problems easily to follow the issue. The only thing the customers need to do is just a single click to view the correspondence and status. Tap the menu Track Complaints then list of complaints that has been sent by the user will be shown. Select the complaints or suggestions to view the response provided by the authorized organization.

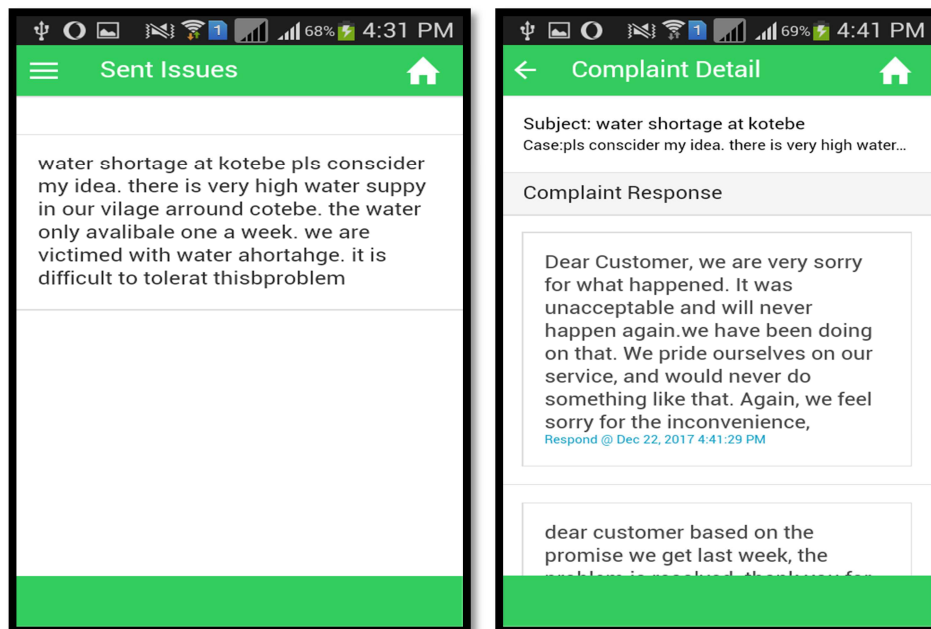


Figure 5.24 UI for Tracking Issues

5.4.6. Deliver Information

The customer who may not know the responsible body of the problem could get the service providers responsibilities. The users can filter service providers by key terms such as problems category (water, transport road, waste), provider name, location, and responsibilities. The customers who need to call to the service provider can also get the number. This helps citizens can get hotlines easily without any difficulties. To see particular organization information, select Organizations menu, then list of active organizations are shown. Select the specific organization that you need to see.

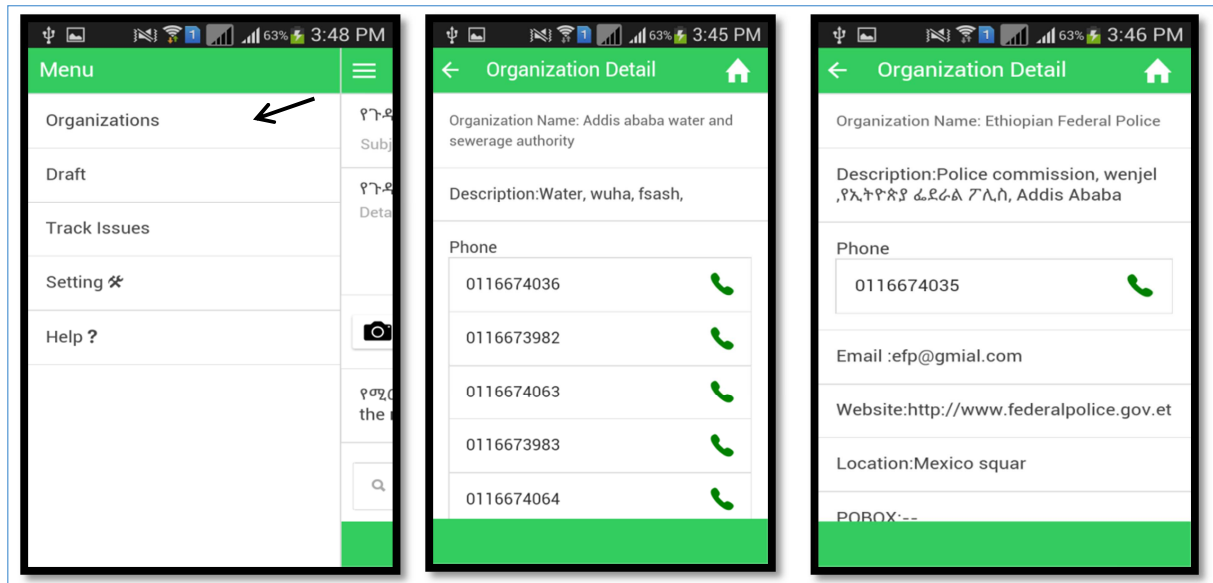


Figure 5.25 Organizations Information

5.5. E-CSMS Web Application

E-CSMS is an application used to manage service providers, users in the service providers, complaints and suggestions which are sent from m-CS mobile application. The system users are categorized into guests, administrator, complaint handling officers, and complaint handling units groups. The application has the following modules.

5.5.1. Service Provider Subscription

Any service delivery points could subscribe to receive complaints and suggestions from customers. During organization registration time the complaint handling officer user account information also provided. This user has complaint handling office authority. Once the subscription is completed you need to wait the authorized personal to validate and approve the information you have entered. If the authorized personal did not approve, service provider couldn't start receiving complaints and suggestions. Approved service providers can also unsubscribe. This module also used to manage mobile clients. This activity could perform by administrative role.

Complaints and Suggestions Management System

Aweke HaileMariam

Log out

Organization subscription [+ New Organization](#)

Search ...

#	Organization	branch	pobox	email	phone	Operations
1	Addis Ababa Water and Sewerage authority	Mexico	1170	aawsa@gov.et	0116674036, 0116673982, 0116674063, 0116673983, 0116674064,	
2	Addis ababa water and sewerage authority	Head office	1789	aawsa@gov.et	0116674036, 0116673982, 0116674063, 0116673983, 0116674064,	
3	Addis ababa water and sewerage authority	Megenagna	1789	dagim@gmail.com	0116674035,	
4	Addis ababa water and sewerage authority	Gurd Shola	1789	tsega@gmail.com	0116675508,	
5	Ethiopian Roads Authority(Head Office)	mexico	1770	tirsittamiru@gmail.com		
6	Addis Ababa City Road Authority (AACRA)	mexico Sarbet	1891	aacra@gmail.com	251-1-551 50 02,	
7	Ethiopian Federal Police	mexico	--	efp@gmial.com	0116674035,	
8	Federal Transport Authority	legahar	--	eta@gmial.com	011623456,	
9	Police station	abnet	--	aps@gmial.com	011123757,	
10	Megenagna Police station	Megenagna bole sub city	--	mpps@gmial.com	0116674036,	

1

2

3

4

Figure 5.26 Registered Service Providers

5.5.2. User Management

Public Service providers have staffs who handle complaints. The organizations complaint handing officers have a responsibility to create account for each staff who could participate in complaint handling process. User account could be managed by this module

Complaints and Suggestions Management System						Aweke HaileMariam	Log out		
New User									
Search ...									
#	Full Name								
1	Demeke Getan								
2	Zekeke Chekol								
3	ashenafi Gitu								
4	zewge Tekle								
5	Feyisa guteta								
6	demeke fr								
7	demeke fre								
8	Posta Bet								
9	Demeke get								

First Name *

Last Name *

Sex *

Select Gender

User Role *

Select Role

Phone *

Username *

Password *

Confirm Password

Save Cancel

Figure 5.27 User Account Management

5.5.3. Unit Management

The structure of the service provider is different from one organization to other. This module allows managing their available units in the organization. The complaint handling officer of each organization should create its complaints handling units in the organization. Unit contains staff members. The unit members are assigned to unit by complaint handling officer. The complaints and suggestions post from citizens are dispatched to unit. Unit members could access their complaints assigned to them by complaint handling officer. Unit members can take actions on complaints and suggestion.

5.5.4. Service Management

Service providers may have several responsibilities. These responsibilities should be known by citizens. This information is important for citizens to know the concerned body of the particular issue.

5.5.5. Complaint Management

This module is responsible for managing complaints and suggestions such as display received complaints, Respond to complaints or suggestions, assign to concerned unit, forward to other concerned organization, and plot the problem on the map. Forward complaints or suggestions to other concerned body intended to help the complainants who lodge or send their complaints mistakenly to an organization which is not its responsibility.

#	Full Name	Phone Number	Complaint	Evidence	Date	Assigned	Location	Operations
1	Wude Yohans	+25192323188	wude asteyayet	no image	Dec 5, 2017 11:07:46 PM	Not Assigned		
2	natinael Addisu	+251903456	nati keta		Dec 5, 2017 11:14:55 PM	Not Assigned		
3	Equbay g/hans	093321418	shint bet meltobgnal baakachihu metachihubtebaberugni		Dec 5, 2017 11:16:10 PM	Not Assigned		

Figure 5.28 Registered Complaints of a particular Organization

As shown in the figure 5.28; the complaint handling officer could observe the complaints location where the issue is happened using icon marked by ①.



Figure 5.29 Plot Issue on Google Map

- ② enable the authorized personal (CHO or Complaint Handling units) to provide a response to the complainants or customers who provide suggestions or lodge complaints
- ③ enable the complaint handling officers to assign the complaints or suggestions to the relevant unit.
- ④ enable the complaint handling officers and complaints handling units forward the complaints to the relevant body cross the organizations
- ⑤ used to close or resolved complaints.

The compliant handling unit members can access their complaints assigned to them by complaint handing officer. Complaint handling units can take action on the complaints assigned to them.

Complaints and Suggestions Management System



 Aweke HaileMariam

 Log out

Complaints assigned to your unit

#	Full Name	Phone Number	Complaint	Evidence	Date	Assigned	Location	Operations
Search ...								
1	Tamru Hallu	0920616352	welcome to ethio complaint		Oct 12, 2017 9:45:39 PM	Unit Two		  
2	Tamru Hallu	0920616352	tet teat hule wuha ytefal metthe stun bakachihi		Dec 6, 2017 4:02:54 PM	Unit Two		  

Figure 5.30 Complaints of a Particular Unit

Chapter Six: Evaluation, Result and Discussions

6.1. Overview

This section deals on the evaluation of proposed solution and discuss the result of the evaluation process. The framework evaluated from different perspectives to proof whether the study answers the research question, meet the research objectives, and software quality attributes of a compliant system.

6.2. Prototype Evaluation

To ensure whether the required goal achieved or not, the evaluation criterion have been prepared to appraise the prototype from the customer point of view. To accomplish evaluation, thirteen persons are participated. Two software experts are assigned to evaluate the web application prototype. Ten persons are involved on mobile app prototype evaluation which is selected purposefully who participated on questioner at the beginning. The evaluation criterions were defined well for mobile users. The evaluation criterion was prepared by referencing previous works. The procedures followed to conduct evaluation are:

- 1) Prepare Evaluation Criteria (see appendix G) to mobile app user.
- 2) E-CSMS web service and E-CSMS Web Application are published to IIS server.
- 3) The two persons assigned on web application prototype which considered as a service provider complaint handling unit and register their organization. The third person assigned as system administrator.
- 4) The third person approves these registered organizations.
- 5) Install m-CS mobile app to participants of mobile phone
- 6) Release WiFi from laptop, the customer connected to this WiFi
- 7) Request the user to send complaint or suggestions to any service provider. Follow the status of their complaints. Access detail information of the organizations.
- 8) The service providers get their complaints which sent from mobile users and responds to the complaints immediately.

At the end; they fill out the evaluation criterions. The evaluation result for mobile app is shown by table 6.1.

Table 6.1 m-CS App Evaluation Result

Criterion	Yes	No
Easy to use	10	0
Save time, money and effort	10	0
Feed full information about organizations	10	0
Help to easily know responsibility of organizations	8	2
Enable to send for multiple organization	10	0
Allow to track complaint status	10	0

An interview has been conducted with software experts. The two software experts could register their own organization and the third person administrator could approve these organizations to manage their complaints with this system. The customer or citizens could send the complaints and suggestions to these organizations. Based on the interview with experts(see appendix H); they can register organization, view complaints, create the complaint handling units, create user account, assign user to unit, look at the problematic area on the google map, reply to complaints and suggestions, and close completed complaints and view the completed complaints as a report. Let us discuss the respondent answer.

6.2.1. Cost, Time and Effort Savings

As discussed in chapter four many peoples thought lodging complaints and suggestions takes much time, money and effort. So people tend to ignore reporting issues as the channels for making a complaint is inconvenient. To reduce these difficulties this mobile application is a relevant solution as a result of customers expenses little cost for internet to send the complaints. Out of ten participants on prototype evaluation all said that the app saves cost, time and effort. The complainants are not expected to go at complaint handling office or service providers' office. They could file their complaints and suggestions from anywhere at any time.

6.2.2. Eliminate Information Gap

As shown in chapter four, many people said, they didn't know the responsible body of the problem. To lodge complaints and suggestions first of all they should know the responsible body. So the customer needs to ask others or find information about who is the responsible body from

different sources. Out of ten respondents 80% of them said they can get enough information about the responsibility of the service providers from the app. The customers are not expected to remember every service provider's information. The only thing they need to do is installing m-CS mobile application. This app let users get any service providers information such as responsibilities, phone, email, website address, POBOX and the physical location of the service provider office. Customers can also get service providers by their service category, location, brunch and so on.

The service providers displayed to user in the order of their distance from the current position of the mobile device. The distance is shown for user in kilometer measurement unit. This feature reduce information gap on customer about where they should report the problems, and which service delivery point is nearest to report. Even if the customer sends the complainants to none concerned body unknowingly, that complaints handling officer of the organization who received these complaints forwards to the concerned body.

6.2.3. Avoid Helpline Related Issues

As shown in chapter four, respondents have been mentioned several problems on phone call complaining mechanisms. No responding to phone call and hotline congestions at pick time are major problems. As a result people couldn't lodge their complaints immediately; they should wait for long time. In order to handle the load during the peak hours, a number of operators are required. But these man powers become idle during the remaining periods. There will be nothing as a peak hour in this framework. This framework let service providers receive multiple requests at a time than receiving complaints and suggestions via phone call.

6.2.4. Enhance Citizen Participation

Citizens are a surveillance camera to their city. So there should be reliable communication mechanisms among governments and citizens. Government body can continuously receive the complaints and suggestions from the community if there is convenient communication channel. The communication channel should be easy to use, require less cost, less effort and time. The evaluation result indicates that 60% of the participants' rate as excellent complaining mechanism to enhance citizen participations on quality improvement and 40% answered very Good communication mechanism. This convenient mechanism encourages customers to participate on civic issues.

6.2.5. Keep Organization Reputation

As discussed in chapter 4, the reason that refrained people from complaining is responsible bodies do not consider the user complaints and suggestions properly. Customer complaint management is a complex process. Automating the complete process is the efficient technique to resolve the customer queries on-time without any inconvenient. Utilizing mobile app for this process is the best fit to encourage customers with timely issue tracking and resolves. The system helps organizations to get active or unresolved problems easily. The organizations can inform complainants about the issue whether they can resolve in short time or take time to resolve. The proper response can calm people from damaging reputation. The resolved complaints could be closed with relevant reason.

6.2.6. Organization Cost Savings

The organizations could get suggestions and complaints early. These early feedback helps to fix the issue or take counter measures at the beginning. Early fix enable organizations control problems early before changed to big problems, this prevents organizations from expending huge cost and citizens from suffering. Developing applications for every service providers requires large amount of budget. Even developed application may not be use by customers as a result of installing applications to each service provider requires extra storages which are another cost. The integrated mobile application solves this big problem.

A mobile application also let peoples sends a visual evidences by capturing the problematic area, this helps the organizations to understand the situation easily. The geographical coordinate where image have been taken sent with an image to point the exact location of the problems which supports the organizations easily locate the exact location of the issue.

6.3. Discussions

6.3.1. Good Complaint Handling Principle

In this discussion we deal on how the framework underpins the organizations to fulfil ISO10002:2014 standards. This standard guides to the design and implement an effective and efficient complaints-handling which have been discussed on chapter two. Organizations and its customers get benefits while these standards are applied. This complaint handling framework enables the organizations to achieve these standards. The way how this framework could support organizations to achieve these principles would be discussed as shown below.

- **Customer Focused:** Organizations should be open to feedback. This framework allows organizations to receive complaints and suggestions 24 hour per a day. This indicates Organizations are always with customers.
- **Visibility:** Information about where to complain and how to complain can be prepared by organizations and customer can access these aggregated information with an easy manner.
- **Accessibility:** The framework allows all users easily to access the system. It allows the user to send complaints and suggestions with any language they can. The feature of sending picture, audio and video complaints and suggestions made the system convenient which enable the customer easily access via handheld device.
- **Responsiveness:** The organizations can respond to complainants about the complaints or suggestions. Then Complainants can easily tack the complaints and suggestions status.
- **Accountability:** This framework enables each organizations define their responsibilities then citizens easily get information from one window instead of navigating and searching different organizations websites.
- **Confidentiality:** The user confidential information is kept. Authorized personal only can see the information.
- **Objectivity:** Each complaint should be addressed equally and unbiased manner through the complaints-handling process. The decision or response provided by complaint handling units easily accessible to the top managements. The availability of well-organized complaints data to management allows controlling the organization staffs. These mechanisms enforce the complaint handling unit members to process complaints properly and impartially under the organization rules and regulations.
- **Continual improvement:** The availability of structured records of customers' complaints and suggestions provide an opportunity for organizations to review its services and procedures to improve their service quality and enhance customer satisfaction. The complaints process with form based is not easy to manipulate relevant and aggregate information.

In general; this framework underpins every service providers to achieve good complaints handling principles. As shown in table 4.8 in chapter four, most of the time user uses their

mobile to use internet. So everybody can use their mobile device for reporting complaints and suggestions without any difficulty.

6.3.2. Software Quality Attributes

Here the techniques used to achieve software quality attributes have been discussed. Software quality attributes are the factors that have an effect on system design, run-time behavior, and user experience [46] [47]. It is necessary to consider the potential impact of the requirements when designing applications to meet software quality attributes.

Interoperability: The chosen architecture is service oriented which enables complaints and suggestions system communicate easily with different information technology systems and software applications. An organization which has already deployed web application can get their own complaints from customer or citizens by requesting http request to a web API (service) and display on their web application.

Maintainability: The architecture follow a layered approach which the programs have been logically separated this logical separation increases maintainability which software can adapt to changes, improve maintainability. All service providers throughout a country share web server. Any business process change reflected to all service providers and clients.

Performance: The system implemented by considering the processing capability of mobile devices. Mobile devices have low processing capability. So to close this gap, most business logic algorithm is implemented in the server side. The client device only sends a request and receives JSON data. The selected web service implementation technology Asp.NET WEB API increases the performance of the system.

Efficiency: The mobile phones have limited resources such as storage, processing power, transmission costs. The design concedes these limited resources. The most data is stored in the remote server only little data is stored on local device. Most business logic algorithm implemented on the server side. This helps the application works within a minimum resource.

Learnability: Usability has the ability to increase user understanding. The user interface has been designed to be easily understandable. The application user interface is designed based on common user interface standards which are commonly used by most applications. The use of ionic framework make the application has native look and feel. The framework provides

common icons, input elements color and so on. The way of filing complaints and suggestions is the same for all organizations which helps the user adapt the app.

Portability: The mobile application m-CS is developed by ionic framework which is a combination of Cordova and AnularJS. This framework is cross platform development tool. The programming language is a standard web development tools HTML, CSS and JavaScript. Once the development completed the source code build into different packages like .apk(android), ipa(iPhone) and XAP(windows) without changing the source code for a specific platform.

6.3.3. Problem Resolution

Table 6. 2 Causes that refrain Customer to register Complaints with countermeasures

<i>Cause of not reporting CS</i>	<i>Countermeasures</i>
Lodging complaints and providing suggestion in person is inconvenient.	The framework should enable customer reporting issues without going to the office of service providers from anywhere and at any time. This eliminate the problem faced by in person reporting.
Unable to know nearest physical location of the office.	Register all service provider service delivery points with geographical location latitude and longitude which helps to feed information about the location of the service providers when they need reporting. Even if the complainants can file complaints without knowing the physical location.
Couldn't know the concerned public body.	The framework allows the service providers to define their responsibilities. The citizens can get this information on their mobile phone. Mobile client can get the responsible body by filtering the problem category.
Phone not answered by the responsible public bodies.	The framework should not wait person to accept complaints and suggestions from complainants unlike complain via phone.

Citizens may not have enough time to lodge Complaints or suggestions so they ignore registering complaints.	The solution should avoid waste of time to lodge complaints and provide suggestions by enabling customers to send and track complaints and suggestions from anywhere. Complainants also should not waste their time by writing complaints and suggestions. They could send snapshot of the problematic area, audio and video in addition to written text.
Hotlines may become congested at peak hours due to which the citizens have to wait for a long time to register the complaints and suggestions.	The solution may not be congested like phone. Multiple clients can lodge complaints and suggestion in parallel.
Difficult to remember different hotlines, emails and websites address of each service providers	The service providers' full information should be feed to the citizens. The system put aggregated service providers information to be made available and accessed on the internet. The mobile application allows citizens to gain all service providers full information through their phone.

In this study the research questions are properly addressed as shown table 6.3.

Table 6.3 Research Questions Answer

<i>Research Question</i>	<i>Answer</i>
What factors are hindering citizens from lodge complaints and provide suggestions?	There are many reasons which refrained customers from lodging complaints and provide suggestions as explained in table 6.2. The framework is designed to eliminate these problems.
What techniques could increase citizen engagement on public infrastructure controlling and quality of service delivery?	Convenient complaints and suggestions reporting mechanism encourages people to participate in service quality improvement. The

	mobile app is just solution on hand system. Every citizen can register his/her complaints and suggestions via phone number without investing any time, effort and money. Information about where to complain is available to citizens. This enhances citizens' participation on service quality control.
How to achieve principles of good complaints handling?	ISO 100014:2014 defined principles of good customer complaints handling such as Customer Focused, Visibility, Accessibility, Responsiveness, Confidentiality, Objectivity, Accountability and Continuous Improvement. The application is designed to be aligned with these criteria.
How to design a framework that is applicable for all service providers to manage complaints and suggestions?	Framework is designed that can work for all organizations and enables customers to lodge complaints to all service providers. The framework takes into consideration multiple organizations, multiple clients, and multiple client device platforms and internet users. Based on the evaluation result the framework is correct to achieve the required goal.

As discussed so far the complaints and suggestions handling system framework achieve the goal of the study. And the designed architecture could implement the framework with good software quality.

Chapter Seven: Conclusions and Recommendations

7.1. Conclusions

Complaints and suggestions are an information sources to improve service quality, and customer satisfaction, and safety. Every problem happen inside society so the citizens can watch before government body realizes it. The preferred alternative is a customer-focused complaints management solution. Handling complaints and suggestions is a complex process which needs the organizations rigorous commitment and customer involvement. To get complaints and suggestions from citizens; there should be convenient communication channel which citizens directly meet public bodies. Based on the survey collected, most of the customers did not report civic problems. The reason is lodging complaint and provides suggestion is inconvenient. The researcher has conducted a study to identity the causes that prevent customers from reporting the issues and to provide convenient complaints handling mechanism which is efficient, helpful, accurate and usable.

The researcher proposed effective complaints handling framework and system architecture which enable the service providers and customers communicate in smooth manner. The development of the prototype considers several software quality attributes. Selecting appropriate tools like development frameworks and programming technologies supports to achieve high quality solutions.

The implementation of e-CSMS will improve service providers' complaint management practices. All Organizations can manage and process customers' complaints and suggestions. More importantly the system enables efficient access to information regarding customers' complaints and suggestions. The information can be stored more systematically and can be retrieved at all the times. Public bodies could use one application to manage their complaints and suggestions received from customer or citizens. The customers can register their complaints and suggestions via a mobile application which is enable people to send complaints and suggestions, and track the status of their own complaints. People could directly communicate with all government bodies with a single application. One of the framework component mobile application which is installed on customer mobile device works with user current location which means location aware. It allows user to file complaints and suggestions primarily to the service

provider located near them and parent organizations or service providers of the nearest organization. Organizations should give weight to the significance of identifying customer complaint factors and complaint intents that significantly determine their business success. Finally the researcher believes that the presented framework can be helpful for service provider organizations in terms of enhancing citizen participation on service quality improvement, keep public infrastructure and environment, and improve customer satisfaction by eliminating the factors that refrain citizens to file complaints and suggestions.

7.2. Recommendations

The research provides an opportunity for service providers, governments and citizens on various perspectives as discussed throughout the document. According to the study several types of problems that have being appeared in the community like transport, water, road, crime, waste disposal, administration problems and so on. Each organization used different communication channels to handle customer complaints. The mechanisms they used to handle complaints and suggestions have many limitations. And also customers want to report to the concerned public body but they cannot do what they want due to inconvenient complaining mechanisms. We recommend that all public service provider organizations should use the proposed complaint handling framework to enhance customer engagements, improve customer satisfaction and improve service qualities. Furthermore, customers should enhance participation by providing complaints and suggestions to the service providers instead of ignoring their complaints and suggestions. And also the government could keep up its citizen's satisfactions and its reputations and ensure good governance in the country.

7.3. Future Works

However in this research we tried to develop integrated complaints handling solution which customers can make complaints and suggestions to all service providers located around them via their cell phone with an easy manner and all organizations can receive their complaints and suggestions without developing web application for them by share a single application. The complaints should have a defined time frame to be solved. The organizations that could not resolve complaints on defined time frame shall be reported to the higher authority. This requires automatic determined work flow process. The system automatically escalates to the upper layer authority. This feature encourages the organizations complaints and suggestions handling bodies'

serve complaints and suggestions in a specified time frame. Today is the era of advanced handheld devices. Citizens expend most of their time with mobile phones. To increase customer satisfaction a government organization's service requests also shall be integrated and delivered by one single window like complaints and suggestions handling. Citizens could send service request (mobile based service request) with their phone via one application instead of developing several independent apps by each organization or service providers.

References

- [1] "Significant milestone for Smart City development," International Electrotechnical Commission, 25 08 2016. [Online]. Available: <http://www.iec.ch/newslog/2016/nr2416.htm>. [Accessed 5 December 2016].
- [2] The Federal Democratic Republic of Ethiopia, "The National Information and Communication Technology (ICT) Policy and Strategy," The Federal Democratic Republic of Ethiopia, Addis Ababa, 2016.
- [3] M. Asmara, "A framework for complaints and suggestions management system (CSMS) and e-CSMS," 25 Aug 2008. [Online]. Available: <http://eprints.utm.my/6146/>. [Accessed 24 10 2016].
- [4] O. Khriyenko, "Customer Feedback System," in *International Conference on Web Information Systems and Technologies*, University of Jyväskylä, 2015.
- [5] "ISO 1002:2014 Quality management — Customer satisfaction — Guidelines for complaints handling in organizations," ISO, 07 2014. [Online]. Available: <https://www.iso.org/obp/ui/#iso:std:iso:10002:ed-2:v1:en>. [Accessed 24 4 2017].
- [6] The Parliamentary and Health Service Ombudsman, "Principles of Good Complaint Handling," 10 February 2009. [Online]. Available: <https://www.ombudsman.org.uk/about-us/our-principles/principles-good-complaint-handling>. [Accessed 14 May 2017].
- [7] B. S. .HOD, "Electronic Complaint Management System for Municipal Corporation," *Foundation of Computer Science FCS*, vol. 2, no. 8, 2015.
- [8] R. R. a. J. Jaafar, "Complaint Handling Theoretical Framework," in *International Conference on Computer & Information Science*, Tronoh, Perak, Malaysia, 2012.
- [9] R. P. S. B. P. A. S. Satish Kumar Prasad, "Civic Complaint Application under Smart City Project," *International Journal of Computer Science and Information Technologies*, vol. 7, no. 1, pp. 402-406, 2016.
- [10] M. Taleghani, "The Role of Customer Complaints Management in Consumers Satisfaction for New Industrial Enterprises of Iran," *International Journal of Business Administration*, vol. 2, no. 3, pp. 140-147, 2011.
- [11] A. O. T. ., R. A. C. A. Okediran O. O., "Mobile Operating Systems and Application Development Platforms: A Survey," *Int. J. Advanced Networking and Applications*, vol. 6, no. 1, pp. 2195-2201 , 2014.
- [12] V. Beal, "Mobile Operating Systems (Mobile OS) Explained," WEBOPEDIA, 1 February 2011. [Online]. Available:

- http://www.webopedia.com/DidYouKnow/Hardware_Software/mobile-operating-systems-mobile-os-explained.html. [Accessed 23 3 2017].
- [13] International Data Corporation(IDC), "Smartphone OS Market Share, 2017 Q1," International Data Corporation(IDC), may 2017. [Online]. Available: <https://www.idc.com/promo/smartphone-market-share/os>. [Accessed 12 9 2017].
 - [14] P. D. P. D. P. Bhargavi Padhya, "Comparison of Mobile Operating Systems," *International Journal of Innovative Research in Computer and Communication Engineering*, vol. 4, no. 8, pp. 15281-15286, 2016.
 - [15] "Comparative Study of Different Mobile Operating Systems," *International Journal of Advancements in Research & Technology*, vol. 2, no. 3, pp. 1-5, 2013.
 - [16] I. S. C. Manuel Palmieri, "Comparison of Cross-Platform Mobile Development Tools," in *16th International Conference on Intelligence in Next Generation Networks*, 2012.
 - [17] The Apache Software Foundation, "Cordova Application Architecture," Apache Software Foundation, [Online]. Available: <https://cordova.apache.org/docs/en/latest/guide/overview/#architecture>. [Accessed 25 7 2017].
 - [18] R. Patil, "Pros and Cons of Cross-Platform Mobile App Development," InfoQ, 13 sep 2016. [Online]. Available: <https://www.infoq.com/articles/mobile-cross-platform-app-development>. [Accessed 15 1 2017].
 - [19] A. G. H. Aarush Gupta, "Hybrid Application Development using Ionic Framework & AngularJS," *International Journal of Innovative Research in Computer Science & Technology (IJIRCST)*, vol. 4, no. 2, pp. 62-64, 2016.
 - [20] P. P. Snehal Mumbaikar, "Web Services Based on SOAP and REST Principles," *International Journal of Scientific and Research Publications*, vol. 3, no. 5, May 2013.
 - [21] A. Stringfellow, "SOAP vs. REST: Differences in Performance, APIs, and More," 28 Mar. 2017. [Online]. Available: <https://dzone.com/articles/differences-in-performance-apis-and-more>. [Accessed 13 4 april].
 - [22] Javatpoint Point, "What is Web Service," Javatpoint Point, 1 1 2011. [Online]. Available: <https://www.javatpoint.com/what-is-web-service>. [Accessed 4 2 2017].
 - [23] S. Chauhan, "What is Web API and why to use it ?," DotNetTricks, 04 Apr 2013. [Online]. Available: <http://www.dotnettricks.com/learn/webapi/what-is-web-api-and-why-to-use-it>. [Accessed 25 December ,2016].
 - [24] Jeremy Wilken, "The Three Types of Mobile Experiences," Developer.com, 8 6 2015. [Online]. Available: <http://www.developer.com/ws/proto/the-three-types-of-mobile->

experiences.html. [Accessed 20 4 2017].

- [25] S, "Considerations Regarding the Cross-Platform Mobile Application Development Process," *Economy Informatics*, vol. 13, no. 1, pp. 40-51, 2013.
- [26] S. H. Shaveta Bhatia, "A New Approach for Location based Tracking," *International Journal of Computer Science Issues*, vol. 10, no. 3, pp. 73-77, 2013.
- [27] S. A. B. A. Saed Tarapiah, "Smart On-Board Transportation Management System Geo-Casting Featured," IEEE, 2015.
- [28] K. N. A. H. J. Razulaimi Razali, "Quality Improvement of Services in Universiti Teknologi Mara Pahang from a Management Perspective," *Management Science and Engineering*, vol. 5, no. 1, pp. 71-80, 2011.
- [29] E. A. E.-A. A. E.-S. Afify, "A Model for Customer Complaint Management System using SOA," *Recent Researches in Computer Science*, pp. 291-296, 2011.
- [30] N. K. ., A. M. Anand Kulkarni, "Voice Enabled Android Application for Traffic Complaint and Pothole Notification System Using GPS and GSM-GPRS Technology," *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 3, no. 3, pp. 5704-5706, 2014.
- [31] P. K. U. N. R. Aditi Mehapsekar, "Voice Enabled Android Application for Vehicular Compliant System Using GPS and GSM-SMS Technology," in *World Congress on Information and Communication Technologies*, Indonesia, 2012.
- [32] K. R. Saranya, "Android Based Public Grievances Complaints," *Journal of Chemical and Pharmaceutical Sciences*, no. 10, pp. 205-208, 2015.
- [33] M. T. M. D. L. J. A. G. a. F. M. V. M. R. Penichet, "A Collaborative Web System to Improve Citizens-Administration Communication," *International Conference on Enterprise Information Systems*, Castilla-La Mancha University, 02071 Albacete, Spain, 2008.
- [34] Y. P. N. K. J. Y. Y. C. a. Y. Y. T. Kim Nee Goh, "Architecture of a GPS-Based Road Management System," *World Applied Sciences Journal 12 (Special Issue on Computer Applications & Knowledge Management)*, pp. 26-31, 2011.
- [35] M. B. a. S. M. Tejaswita Badhe, "Mobile Application for Grievance Registration," *IJCSET*, vol. 7, no. 4, pp. 28-31, 2017.
- [36] N. G. R. N. Devika Radhakrishnan, "Smart Complaint Management System," *International Journal of Trend in Research and Development*, vol. 3, no. 6, pp. 298-299, 2016.
- [37] D. P. P. a. D. M. M. Pandey, *RESEARCH METHODOLOGY: TOOLS AND TECHNIQUES*, Romania: Bridge Center, 2015.

- [38] U. Libraries, "Research Guide," University of Southern California, 4 2 2016. [Online]. Available: <http://libguides.usc.edu/writingguide/researchdesigns>. [Accessed 12 6 2017].
- [39] Center for Inovation in Reasearch and Teahing, "Basic Research Designs," Grand Canyon University, 2 May 2012. [Online]. Available: <https://cirt.gcu.edu/research/developmentresources/tutorials/researchdesigns>. [Accessed 23 5 2017].
- [40] Fisheries and Aquaculture Deparment, "DATA COLLECTION STRATEGY," FAO Corporate Document Repository, [Online]. Available: <http://www.fao.org/docrep/003/x2465e/x2465e08.htm#TopOfPage>. [Accessed 26 December 2016].
- [41] Lund Research Ltd, "Simple random sampling," Lund Research Ltd, 2012. [Online]. Available: <http://dissertation.laerd.com/simple-random-sampling.php#step2>. [Accessed 12 4 2017].
- [42] W. W. LaMorte, "Central Limit Theorem," Boston University School of Public Health, 24 July 2016. [Online]. Available: http://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/BS704_Probability/BS704_Probability12.html. [Accessed 27 Feb 2017].
- [43] M. G. Zainul Setyo Pamungkas, PhoneGap 4 Mobile Application Development Cookbook, BIRMINGHAM - MUMBAI: Packt, 2015.
- [44] Microsoft, Microsoft Application Architecture, 2009.
- [45] L. O. L. B. a. P. Merson, "Quality Attributes and Service-Oriented Architectures," Software Architecture Technology Initiative, Carnegie Mellon Universit, 2005.
- [46] G. Morgan, "Implementing System-Quality Attributes," Microsoft Corporation, March 2007. [Online]. Available: <https://msdn.microsoft.com/en-us/library/bb402962.aspx>. [Accessed 22 8 2017].
- [47] Gorton, "Software Quality Attributes," in *Essential Software Architecture*, Springer-Verlag Berlin Heidelberg , 2011, pp. 23-37.
- [48] Creative Research Systems, "Sample Size Calculator," Creative Research Systems, 23 1 2012 . [Online]. Available: <https://www.surveysystem.com/sscalc.htm>. [Accessed 12 4 2017].
- [49] J. E. Bartlett, "Organizational Research: Determining Appraite Sample Size in Survey Research," *Information Technology, Learning and Performance Journal*, vol. 19, no. 1, 2001.
- [50] M. Komori, "Thematic Analysis," [Online]. Available: <http://designresearchtechniques.com/casestudies/thematic-analysis/>.

Appendixes

Appendix A: Questionnaire

Questioner in Amharic

አዳማ ሳይንስ እና ቴክኖሎጂ ዩኒቨርሲቲ

በማህበራዊ አገልግሎት ተጠቃሚ ማህበረሰብ እና በአገልግሎት ሰጪ ተቋማት መካከል ያለውን ክፍተት ለማጥናት እና ክፍተቱን የምንሞላበትን መፍትሄ ለመፈለግ ይረዳን ዘንድ ይህንን ጥያቄ በመመላት እንድትተባበሩን በአክብሮት እንጠይቃለን። ይህ መጠይቅ ለሁለተኛ ዲግሪ ትምህርት ጥናታዊ ፅኑ ስራ አገልግሎት ብቻ የሚውል ነው። በሚሰጡት መልስ ምንም አይነት ጥርጣሬም ሆነ ስጋት እንዳይገባዎት ሙሉ ሚስጥርዎን የተጠበቀ ነው።

ተመራማሪ ፡ ደመቀ ጌታነህ

ለምታደረጉልን ትብብር በቅድሚያ ከልብ እያመሰገንን ጥያቄዎችን በጥንቃቄ አንብበዉ እንዲሞሉልን በትህትና አንጠይቃለን።

ከአንድ በላይ መልስ ለሚያስፈልጋቸዉ ጥያቄዎች ፣ ከአንድ በላይ መልስ መስጠት ይቻላል። ምክንያት ለሚያስፈልጋቸዉ ጥያቄዎች ግን በአጭሩ ይግለጹልን።

ይህ መጠይቅ ለትምህርት ጥናታዊ ጽሁፍ ስለሆነ ምንም አይነት ክፍያ የማያስገኝ መሆኑን በትህትና እንገልጻለን።

ዕድሜ.....ፆታ.....የትምህርት

ደረጃ.....ስራ.....

1. ኢንተርኔት ተጠቃሚ ነዎት?

ሀ. አዎ ለ. አይደለሁም

2. ጥያቄ ቁጥር 1ን “ሀ” ብለዉ ከመለሱ፤ ብዙ ጊዜ የሚጠቀሙት ከሚከተሉት ውስጥ በየትኛዉ ነው?

ሀ. በኮምፒውተር ለ. በሞባይል ሐ. በታብሌት

3. የስልክ ተጠቃሚ ከሆኑ የያዙት የስልክ አይነት?

ሀ. አንድ ሮይድ ለ. አይፎን ሐ. ብላክቤሪ መ. ዊንዶውስ ፎን

ሠ. ከተዘረዘሩት ዉጭ

4. የዉሃ ማስተላለፊያ ቱቦ ተሰብሮ ዉሃ ሲፈስ ወይም እየባከነ ብታዩ ምን ያደርጋሉ?

ሀ. ለሚመለከተዉ አካለ አመለካከታለሁ

ለ. ለማን ማመልከት እንዳለብኝ ስለማላዉቅ ዝም ብየ አልፋለሁ

ሐ. በአካል ቀርቦ ማመልከት ጊዜና ገንዘብ ስለሚያስወጣ ዝም ብየ አልፋለሁ

ሰ. ጥቆማዬን በአግባቡ የሚያስተናግድ አካል አይኖርም ብየ ስለማስብ ዝም ብየ አልፋለሁ

ረ. ሌላ መልስ ካልዎ

5. በምትኖሩበትም ሆነ በምትጓዙበት አካባቢ የተበላሸ መንገድ ወይም ለሰዎች፣ለእንስሳት፣ ለህፃናትና ለአረጋጂዎን አስጊ የሆነ ያልተዘጋ ቱቦ እና ያልተስተካከለ መንገድ ገጥሞዎት ያዉቃል?

ሀ. አዎ ለ. ገጥሞኝ አያዉቅም

6. ጥያቄ ቁጥር 5ን “ሀ” ብለው ከመለሱ፣ ምን እርምጃ ወሰዱ?
- ሀ. ለሚመለከተው አካል አሳውቂያለሁ
- ለ. ለማን ማመልከት እንዳለብኝ ስለማላውቅ ዝም ብዬ አልፋለሁ
- ሐ. በአካል ቀርቦ ማመልከት ጊዜና ገንዘብ ስለሚያስወጣ ዝም ብዬ አልፋለሁ
- መ. የመስሪያ ቤቱ ቅርንጫፍ የት አንደሚገኝ ስለማላውቅ ዝም ብዬ አልፋለሁ
- ሰ. ሌላ መልስ
7. በተንቀሳቀሱበት ጊዜ መብታችሁን የሚጋፉ ለምሳሌ በታክሲ ሲጓዙ ከታሪፍ ወጭ ማስከፈል ወይም ስድብ ቢገጥማችሁ ምን ያደርጋሉ?
- ሀ. በትግስት አሳልፈዋለሁ ለ. እከሳለሁ ሐ. ሀይል እጠቀማለሁ
- መ. ሌላ የተለየ መልስ ካልዎ
8. የቆሻሻ ቱቦ ፈንድቶ ወይም ቆሻሻ ያለአግባብ ተጥሎ አካባቢን ሲበክል ገጥሞዎት ያወቃል?
- ሀ. አዎ ለ. ገጥሞኝ አያወቅም
9. ጥያቄ ቁጥር 8ን “ሀ” ብለው ከመለሱ፣ ምን እርምጃ ወሰዱ?
- ሀ. ለሚመለከተው አካል አሳውቂያለሁ
- ለ. ታዝቤ ዝም ብዬ አለፍሁ
10. ጥያቄ ቁጥር 9ን “ለ” ብለው ከመለሱ፣ ምክንያትዎ ምንድን ነው?
- ሀ. ለማን ማመልከት እንዳለብኝ ስለማላውቅ
- ለ. በአካል ቀርቦ ማመልከት ጊዜና ገንዘብ ስለሚያስወጣ
- ሐ. የመስሪያ ቤቱ ቅርንጫፍ የት አንደሚገኝ ስለማላውቅ
- መ. ጥቆማዬን በአግባቡ የሚያስተናግድ አካል አይኖርም ብዬ ስለማስብ
- ሰ. ሌላ የተለየ መልስ ካልዎ
11. ወንጀል ሊፈጽሙ በዝግጁት ላይ ያሉ ሰዎችን ቢያዩ ወይም ቢሰሙ ምን ያደርጋሉ?
- ሀ. ለሚመለከተው አካል እጠቀማለሁ
- ለ. በአካል ቀርቦ ማመልከት ጊዜና ገንዘብ ስለሚያስወጣኝ ምንም አላደርግም
- ሐ. ለማን መጠቆም እንዳለብኝ ስለማላውቅ ምንም አላደርግም
- መ. ጥቆማዬን በአግባቡ የሚያስተናግድ አካል አይኖርም ብዬ ስለማስብ ምንም አላደርግም
- መ. ሌላ የተለየ መልስ ካልዎ
12. ህዝብ የሰጣቸውን ሀላፊነት ወደጎን ትተው የግል ጥቅማቸውን ሲያሳድዱ፣ ህዝብን አየቢደሉ የሚኖሩ የአገልግሎት ሰጭ ተቋማት ሰራተኞች ገጥሟቸው ያወቃል?
- ሀ. አዎ ለ. ገጥሞኝ አያወቅም

13. ጥያቄ ቁጥር 12ን “ሀ” ብለው ከመለሱ፣ ምን እርምጃ ወስዱ?

ሀ. ለበላይ አካል አሳውቂያለሁ

ለ. ታዝቤ ዝም ብዬ አልፊያለሁ

ሐ. በአስተያየት መስጫ ሳጥን ጠቁሟልሁ

መ. ሌላ የተለየ መልስ.....

14. በመኖሪያ አካባቢ፣ በምትጓዙበት፣ በመስሪያ ቤት ወዘተ... የኤሌክትሪክ ፖል፣ የኤሌክትሪክ ገመድ አደጋ በሚያደርስ ሁኔታ ወድቆ ቢያዩ ምን ያደርጋሉ? (ከአንድ መልስ በላይ መምረጥ ይቻላል)

ሀ. ለሚመለከተው አካል አሳውቃለሁ

ለ. ለማን ማመልከት እንዳለብኝ ስለማላውቅ ዝም ብዬ አልፋለሁ

ሐ. በአካል ቀርቦ ማመልከት ጊዜና ገንዘብ ስለሚያስወጣ ዝም ብዬ አልፋለሁ

መ. የመስሪያ ቤቱ ቅርንጫፍ የት አንደሚገኝ ስለማላውቅ ዝም ብዬ አልፋለሁ

ሰ. ሌላ የተለየ መልስ ካልዎ

15. ብዙ የአገልግሎት ሰጭ ተቋማት የህዝብን ቅሬታና አስተያየት ለመቀበል ነፃ የስልክ መስመር አዘጋጅተዋል. እርስዎ ምን ያህሎችን ያወቃሉ? ለምሳሌ የወሃና ፍሳሽ፣ የመብራት ሃይል፣ የፖሊስ፣ የመንገድ ተራንስፖርት፣ የመንገዶች ባለስልጣን፣ የእሳትና ድንገተኛ አደጋ፣ ፀረ-ሙስና፣ ወዘተ... መካከል ሚያወቁትን ብቻ ይፃፉ ::

.....

16. ሌላ ተጨማሪ አስተያየት ካልዎ ይጻፉልን?

Questionnaire in English translation

This questionnaire is used to study the gap between service providers and service consumer (citizens) and find out a solution that bridges the gap to improve service quality delivery and increase customer satisfaction. We respectfully request that you fill out this survey. This survey used for only academic research purpose. Your anonymity is completely kept.

Researcher : **Demeke Getaneh**

Thank you for your kind cooperation. Please read and answer questions carefully.

More than one answer can be given. If you have reason write on a space provided.

Age.....Sex..... Educational Level.....

Job.....

- Are you internet User?
 - Yes
 - No
- If your answer for question number one is ‘A’, which device you use?
 - Computer
 - Mobile
 - Tablet
- If you are cell phone user, what is your phone type?
 - Android
 - Iphone
 - Other_____
 - Blackbary
 - Windows Phone
- What will you do if you see loss of water from a broke water pipe?
 - I will suggest to the concerned body
 - I couldn’t take any action because I don’t know responsible body
 - I couldn’t take any action because lodging complaints takes time and money
 - I do not think there will be any party that consider the suggestion
 - Other_____
- Have you ever seen pothole, damaged roads, and open tubes that are risky for human, animal, children and elders?
 - Yes
 - No
- If your answer for question number 5 is “A”, what have you do?

- A. I have reported to the responsible body
 - B. I couldn't take any action because I don't know responsible body
 - C. I couldn't take any action because lodging complaints takes time and money
 - D. I don't know where the concerned body office located.
 - E. Other_____
7. While traveling, if you face right violation for example you asked to pay above tariff or insult you, what will you do?
- A. tolerate it
 - B. complain to the concerned body
 - C. Use force
 - D. Other_____
8. Have you seen broken Sewer or improper waste disposal that pollute the environment?
- A. Yes
 - B. No
9. If your answer for question number **8** is "**A**", what have you do?
- A. I have reported to the responsible body
 - B. I just passed.
10. If your answer for question number **9** is "**B**", what is your reason?
- A. I don't know to whom I report the problem
 - B. reporting in person takes time and money
 - C. I don't know where the concerned body office located.
 - D. I do not think there will be any party that consider the suggestion
 - E. Other_____
11. What do you do when you see or hear someone working over the crime?
- A. I will suggest to the responsible body
 - B. Reporting in person, takes time and money
 - C. I don't know where the problem reported
 - D. I do not think there will be any party that consider the suggestion
 - E. Other_____
12. Have you seen employees who pursuing their own personal benefits instead of committing their responsibilities in service provider organizations?
- A. Yes
 - B. No, I haven't
13. If your answer for question number **12** is "**A**", what have you do?

A. I have reported to the responsible body

B. I didn't take any action.

C. I have suggested in the suggestion box.

D. Others _____

14. What will you do if you see fallen electric poll, electric wire anywhere you go which may injure people?

A. I have reported to the responsible body

B. I couldn't take any action because I don't know the responsible body

C. I couldn't take any action because lodging complaints takes time and money.

D. I don't know where the concerned body office located.

E. Other _____

15. Many public service providers have prepared hotlines to receive complaints and suggestions from citizen. I.e. Water and sewerage, electric power corporation, police, Road transport, fire and emergency. How many of them you know?

16. If you have comment leave here? _____

Appendix B: Interview

Research Title: Mobile Based Complaints and Suggestions System with Geospatial Data

This is an interview question to get information from organizations that provides public service to the citizens. It helps to understand current business process and to analyses existing problems in the organization associated with the service provision. This information helps me to propose a good framework.

Researcher: **Demeke Getaneh**

1. What are the mandates of this organization?
2. What mechanism you have being used to accept Suggestions and Complaints from citizen?
-phone call, website, in person, SMS, email, post office
3. Is there a unit that accepts and process customer complaints on services, and service provision?
4. How to create awareness about the responsibilities, and rule and regulations of the organization to the pubic?
5. What are the difficulties that affect the organization to deliver the service properly?

Appendix C: Environment Configuration

Cross platform application development environment Configurations

- 1) Install **Node.js** Whether you are using Windows, Linux or Mac the first step is to make sure you have **Node.js** installed on your machine. As an asynchronous event driven JavaScript runtime, Node is designed to build scalable network applications.
- 2) to install cordova and ionic packages globally, open command window and run the following command
 - npm install -g cordova ionic
- 3) To create ionic project on windows with a name **mythesis**, create a folder that will contain the ionic project. Hold shift key and write click then select “**open command window her**” action. Run the following command.
 - ionic start **mythesis** --type ionic1
- 4) Add platforms such as iOS, windows and android, and browser based on your need.
 - cordova platform add android ios windows

- 5) add cordova plugins which you could used for application development
 - cordova plugin add cordova-plugin-camera
 - cordova plugin add cordova-plugin-device-orientation
 - cordova plugin add cordova-plugin-dialogs
 - cordova plugin add cordova-plugin-file
 - cordova plugin add cordova-plugin-file-transfer
 - cordova plugin add cordova-plugin-geolocation
 - cordova plugin add cordova-plugin-media
 - cordova plugin add cordova-plugin-media-capture
 - cordova plugin add cordova-plugin-network-information
- 6) to view installed cordova plugin run the command
 - cordova plugin ls
- 7) to run the application
 - ionic cordova run android (to run on real device)
 - ionic cordova emulate android (to run on emulator. First of all you need to set up android emulator via sdk manager)
 - ionic serve (to emulate on browser)
 - ionic serve --lab (to emulate on browser with mobile size)
 - cordova run browser -- --port=8001 --target=Firefox (to run browser platform)
- 8) to build the application based on the platform type
 - ionic cordova build android
 - ionic cordova build windows

Web Application Development Environment Configuration

- 1) Install NodeJS setup by downloading from official site <https://nodejs.org/en/>. Once the installation completes, restarts the system.
- 2) Install **Grunt CLI, Bower, and Yeoman**. Open the command window and execute the following command
 - `npm -g install grunt-cli bower yo generator-angular generator-karma`
- 3) Create angular project by running the following command
 - `yo angular`
- 4) To run the application, run the command below
 - `grunt server` (to view the application on the browser on development time)
 - `grunt build` (to build an application to be published on the web server)

Web API Development

Microsoft provides an IDE visual studio to develop application with C# language.

1. Install visual studio IDE
2. Then Open it
3. Click on **file** menu
4. Click on **Visual C#**
5. Select on **Web** and Provide project name and solution name i.e **eCEMS.WebAPI**, **and eCEMS** respectively in my case.
6. Select **Web API** from the list
7. The project structure could be created
8. To create three separated code layer, **right click on solution name >add> new project> visual C#> class library**. Then write the name (like **eCEMS.Business**, **eCEMS.Data**). Click **ok**.
9. Set project dependencies: right click on the project that need other project for example **eCEMS.WebAPI** layer needs **business** layer; right click on **WebAPI** layer then build dependencies >project dependencies> select project by checking the check box.
10. Write the code on each layer and run the project

Appendix D: Sample Code

m-CS Mobile application sample code

Mobile App Controller Sample code

```
(function () {
    'use strict';
    angular.module('starter.controllers')
        .controller('SuggestionController',
            SuggestionController);
    SuggestionController.$inject = ['$cordovaSQLite',
        '$ionicLoading', '$cordovaGeolocation', '$scope',
        '$state', 'suggestionService', '$cordovaCamera',
        '$cordovaFile', '$cordovaFileTransfer', 'localService',
        '$cordovaDialogs'];
    function SuggestionController($cordovaSQLite,
        $ionicLoading, $cordovaGeolocation, $scope, $state,
        suggestionService, $cordovaCamera, $cordovaFile,
        $cordovaFileTransfer, localService, $cordovaDialogs) {
        var vm = this;
        vm.title = 'Suggestion controller';
        var image = "";
        vm.hideHome = true;
        $scope.hideHome = true;
        activate();
        function activate() {
            vm.saveSuggestion = saveSuggestion;
            vm.sendComplaints = sendComplaints;
            vm.getCurrentIssuePosition =
                getCurrentIssuePosition;
            vm.audioCapture = audioCapture;
            vm.videoCapture = videoCapture;
            vm.browsePhoto = browsePhoto;
            vm.uploadFile = uploadFile;
            vm.registerClient = registerClient;
            vm.SaveToBufferDraft = SaveToBufferDraft;
            vm.SaveToBuffer = SaveToBuffer;
            vm.user = {
                FirstName: "", LastName: "", Phone: "",
                Subject: "", MessageBody: "", Latitude: 0,
                Longitude: 0, SenderID: 0, OrganizationID: 0,
            };
            vm.items = [];
            vm.stablishDBConnection =
                stablishDBConnection;
            vm.UploadFile = UploadFile;
            vm.getClient = getClient;
            vm.getOrganizations = getOrganizations;
            vm.problems = [];
            vm.takePicture = takePicture;
            vm.getNearbyOrganizations =
                getNearbyOrganizations;
            vm.hideLoading = hideLoading;
            vm.showLoading = showLoading;
            getClient();
            getCurrentIssuePosition();
        }
        function getOrganizations() {
```

```
// stablishDBConnection();
vm.Organizations = [];
var organization = {id: 1}
vm.loading = true;
suggestionService.getOrganizations()
    .then(function (result) {
        vm.Organizations = result;
        console.log("vm.Organizations",
            vm.Organizations)
        var query2 = "INSERT INTO ORG1 (ID,
            Name, Description) VALUES (?, ?, ?)";
        }, function (error) {
        });
    }
    function getNearbyOrganizations() {
        vm.showLoading();
        var currentUserLocation = {Latitude:
            vm.user.Latitude, Longitude: vm.user.Longitude};
        vm.OrganizationsList = [];
        suggestionService.getNearbyOrganizations(currentUser
            Location)
            .then(function (result) {
                vm.OrganizationsList = result;
                vm.hideLoading();
                var query = "INSERT INTO Organizations (ID
                    , Name , Description ,Location , Branch , Latitude
                    ,Longitude ) VALUES (?,?,?,?,?,?)";
                for (var i = 0; i < vm.OrganizationsList.length; i++) {
                    var row = vm.OrganizationsList[i];
                    $cordovaSQLite.execute(db, query, [row.ID,
                        row.Name, row.Description, row.Branch, row.Location,
                        row.Latitude, row.Longitude])
                        .then(function (res) {
                            }, function (err) {
                                var message = "Network Related Error";
                                vm.hideLoading();
                                $cordovaDialogs.alert(message, "error", "cancel");
                            });
                        }
                    }, function (error) {
                        vm.hideLoading();
                    });
                }
            }
        function showLoading() {
            $ionicLoading.show({
                template: 'Loading...'
            });
        }
        function hideLoading() {
            $ionicLoading.hide();
        }
    }
```

```

function registerClient() {
    var promise =
    suggestionService.subscribeMobileClient(vm.client)
    promise.then(function (result) {
        console.log(result);
        if (result.Status) {
            var query = "INSERT INTO Client
(ID,FirstName, LastName,Phone) VALUES
(?,?,?,?)";
            var ID = result.ID;
            var firstname = result.FirstName;
            var lastname = result.LastName;
            var phone = result.Phone;
            $cordovaSQLite.execute(db, query, [ID, firstname,
lastname, phone]).then(function (res) {
                }, function (err) {
                    console.error(err);
                });
            } else {
            }, function (error) {
            });
        }
    }
    function stablishDBConnection() {
        if (window.cordova) {
            db = $cordovaSQLite.openDB({name:
"myDB.db"}); //device
        } else {
            db = window.openDatabase("myDB.db", '1',
'myDB', 1024 * 1024 * 1000); // browser
        }
        $cordovaSQLite.execute(db, "CREATE TABLE IF
NOT EXISTS Client (ID integer primary key,
FirstName text, LastName text, Phone text");
        $cordovaSQLite.execute(db, "CREATE TABLE IF
NOT EXISTS ORG1 (ID integer primary key, Name
text, Description text");
    }
    function saveSuggestion() {
        vm.showLoading();
        vm.user.FirstName = clientInfo.FirstName;
        vm.user.LastName = clientInfo.LastName;
        vm.user.Phone = clientInfo.Phone;
        vm.user.SenderID = clientInfo.ID;
        console.log("clientInfo", clientInfo);
        var promise =
        suggestionService.saveSuggestion(vm.user);
        promise.then(function (result) {
            vm.hideLoading();
        }, function (error) {
            SaveToBufferDraft(vm.user);
            $cordovaDialogs.alert('Unable to save Suggestion
or complaint', 'Error', 'Cancel');
        });
    }
    function getCurrentIssuePosition() {
        var posOptions = {timeout: 10000,
enableHighAccuracy: false};
        var promise =

```

```

$cordovaGeolocation.getCurrentPosition(posOptions)
.then(function (position) {
    vm.user.Latitude = position.coords.latitude;
    vm.user.Longtude = position.coords.longitude;
    vm.user.SenderID = clientInfo.ID;
    latitude = position.coords.latitude;
    longitude = position.coords.longitude;
    getNearbyOrganizations();

    }, function (err) {
        });
    return promise;
}
function browsePhoto() {
    var options = {
        quality: 50,
        destinationType:
Camera.DestinationType.FILE_URI,
        sourceType:
Camera.PictureSourceType.PHOTOLIBRARY,
        encodingType: Camera.EncodingType.JPEG,
        saveToPhotoAlbum: true,
        correctOrientation: true
    };
    navigator.camera.getPicture(onSuccess,
onFail, options);
    function onSuccess(imageURI) {
        vm.imagefile = imageURI;
        var index = vm.imagefile.lastIndexOf("?");
        if (index > 0) {
            var filepath = vm.imagefile.substring(0, index);
            vm.imagePath = filepath;
        } else {
            vm.imagePath = vm.imagefile;
        }
        var image = document.getElementById('image1');
        vm.imageSource = "data:image/jpeg;base64," +
vm.imagePath;
        image.src = vm.imagePath;
    }
    function onFail(message) {
    }
}
function takePiture() {
    var options = {    quality: 50,    destinationType:
Camera.DestinationType.FILE_URI,
    sourceType: Camera.PictureSourceType.CAMERA,
    allowEdit: false,
    encodingType: Camera.EncodingType.JPEG,
    popoverOptions: CameraPopoverOptions,
    saveToPhotoAlbum: true,
    correctOrientation: true
    };
    $cordovaCamera.getPicture(options).then(function
(imageData) {
        var image = document.getElementById('image1');
        vm.imageSource = "data:image/jpeg;base64," +
imageData;
        image.src = vm.imageSource;
        vm.imagePath = imageData;
    }

```

```

        image.src = imageData;
    }, function (err) {
        // error
    });
}
function audioCapture() {
    var options = { limit: 1, duration: 10 };
    navigator.device.capture.captureAudio(onSuccess,
onError, options);
    function onSuccess(mediaFiles) {
        var i, path, len;
        for (i = 0, len = mediaFiles.length; i < len; i += 1) {
            path = mediaFiles[i].fullPath;
            vm.audioPath = path;
            alert("audio")
            console.log(mediaFiles);
            vm.videoPath = null;
            vm.imagePath = null;
        }
    }
    function onError(error) {
        navigator.notification.alert('Error code: ' +
error.code, null, 'Capture Error');
    }
}
function videoCapture() {
    var options = { limit: 1, duration: 60
    };
    navigator.device.capture.captureVideo(onSuccess,
onError, options);

    function onSuccess(mediaFiles) {
        var i, path, len;
        for (i = 0, len = mediaFiles.length; i < len; i += 1) {
            path = mediaFiles[i].fullPath;
            alert("path" + path)
            console.log(mediaFiles);
            vm.videoPath = path;
            vm.audioPath = null;
            vm.imagePath = null;
            alert(vm.videoPath);
            vm.t = path;
        }
    }

    function onError(error) {
        navigator.notification.alert('Error code: ' +
error.code, null, 'Capture Error');
    }
}

function uploadFile(fileTobSent, options) {
    var url = server_url2 +
"MobileDevice/PostCompliant";
    var targetPath = fileTobSent;
    //target path may be local or url
    var param = vm.user;
    options.params = param;
    alert(JSON.stringify(options));
    $cordovaFileTransfer.upload(url, targetPath,
options).then(function (result) {

```

```

        var message = result.response.Message;
        $cordovaDialogs.alert("Thank you!! Your
Complaints/Suggestions Sent", "Success", "Ok");
        SaveToBuffer(result.response);
    }, function (err) {
        var message = "Error occured!! "
        $cordovaDialogs.alert(message, "Success", "Ok");
        var draftmodel = vm.user;
        draftmodel.Attachments = targetPath;
        SaveToBufferDraft(draftmodel);
    }, function (progress) {
        $timeout(function () {
            $scope.downloadProgress = (progress.loaded /
progress.total) * 100;
        })
    });
}
function SaveToBuffer(row) {
    var query = "INSERT INTO SentComplaints (ID,
Subject, MessageBody, Attachment , SenderID ,
OrganizationID ) VALUES (?,?,?,?,?)";
    var attachmentPath = "";
    if (row.Attachments.length > 0)
        var attachmentPath =
row.Attachments[0].AttachmentPath;
    $cordovaSQLite.execute(db, query, [row.ID,
row.Subject, row.MessageBody, attachmentPath,
row.SenderID, row.OrganizationID])
    .then(function (res) {
    }, function (err) {
        console.error(err);
    });
}
function SaveToBufferDraft(row) {
    var query = "INSERT INTO DraftComplaints
(ID, FirstName, LastName, Phone, Subject,
MessageBody, Attachment , SenderID ,
OrganizationID, Latitude, Longitude ) VALUES
(?,?,?,?,?,?,?,?,?)";
    var evidencePath = row.Attachments;
    if (row.Attachments) {
        evidencePath = row.Attachments;
    } else {
        evidencePath = "";
    }
    $cordovaSQLite.execute(db, query, [0,
row.FirstName, row.LastName, row.Phone,
row.Subject, row.MessageBody, evidencePath,
row.SenderID, row.OrganizationID, row.Latitude,
row.Longitude])
    .then(function (res) {
    }, function (err) {
        console.error(err);
    });
}
vm.deleteAllfromBuffer = deleteAllfromBuffer;
function deleteAllfromBuffer(tableName) {
    var querydelete = "DELETE FROM " +
tableName + "";
    $cordovaSQLite.execute(db,
querydelete).then(function (res) {

```

```

    }, function (err) {
        console.error(err.message);
    });
}
function sendComplaints() {
    vm.user.FirstName = clientInfo.FirstName;
    vm.user.LastName = clientInfo.LastName;
    vm.user.Phone = clientInfo.Phone;
    vm.user.SenderID = clientInfo.ID;
    if (vm.imagePath) {
        var targetPath = vm.imagePath;
        var filename = targetPath.split("/").pop();
        var options = {
            fileKey: "file", fileName: filename,
            chunkedMode: false, mimeType: "image/jpg",
            headers: {Connection: "close"},
        };
        vm.uploadFile(vm.imagePath, options);
    } else if (vm.audioPath) {
        var fileURL = vm.audioPath;
        var options = {};
        options.fileKey = "file";
        options.fileName =
fileURL.substr(fileURL.lastIndexOf('/') + 1);
        options.mimeType = "audio/mp3";
        vm.uploadFile(fileURL, options);
    }
    else if (vm.videoPath) {
        var fileURL = vm.videoPath;
        var options = { fileKey: "avatar",

```

```

fileName: fileURL.substr(vm.videoPath.lastIndexOf('/')
+ 1),
        chunkedMode: false,
        mimeType: "video/mp4"
    };
    vm.uploadFile(fileURL, options);
} else {
    if (vm.user.MessageBody == "") {
        $cordovaDialogs.alert('Please Enter the Detail',
'Validation', 'Ok')
            .then(function () {
            });
    } else {
        console.log("user model", vm.user);
        var promise =
suggestionService.saveSuggestion(vm.user);
        promise.then(function (result) {
            if (result.Status) {
                SaveToBuffer(result);
                var message = result.Message;
                $cordovaDialogs.alert(message, "Success", "Ok");
            } else {
            }
        }, function (error) {
            SaveToBufferDraft(vm.user)
        });
    }
}
})();

```

m-CS Mobile App Sample Service Code

```

(function () {
    'use strict';
    angular
        .module('starter.controllers')
        .factory('suggestionService', suggestionService);
    suggestionService.$inject = ['$q', '$http'];
    function suggestionService($q, $http) {
        var service = {
            saveSuggestion: saveSuggestion,
            getOrganizations: getOrganizations,
            subscribeMobileClient: subscribeMobileClient,
            getSuggestions: getSuggestions,
            getNearbyOrganizations: getNearbyOrganizations,
            getResponsibilities: getResponsibilities,
            getCorrespondence: getCorrespondence,
            trackComplaintStatus: trackComplaintStatus,
        };
        return service;
        function getNearbyOrganizations(location) {
            var deferred = $q.defer();
            $http.post(server_url +
'MobileDevice/GetOrganizationsByLocation',
location).then(
                function (d) {
                    deferred.resolve(d.data);
                },
                function (err) {
                    deferred.reject(err);
                }
            );
            return deferred.promise;
        }
        function getOrganizations(userCoordinate) {
            var deferred = $q.defer();
            $http.post(server_url2 +
'MobileDevice/GetOrganizationsByLocation', userCoor
dinate).then(

```

```

                },
                function (err) {
                    deferred.reject(err);
                }
            );
            return deferred.promise;
        }
        function saveSuggestion(suggestionModel) {
            var deferred = $q.defer();
            $http.post(server_url +
'MobileDevice/SaveSuggestion',
suggestionModel).then(
                function (d) {
                    deferred.resolve(d.data);
                },
                function (err) {
                    deferred.reject(err);
                }
            );
            return deferred.promise;
        }
        function getOrganizations(userCoordinate) {
            var deferred = $q.defer();
            $http.post(server_url2 +
'MobileDevice/GetOrganizationsByLocation', userCoor
dinate).then(

```

```

function (d) {
    deferred.resolve(d.data);
},
function (err) {
    deferred.reject(err);
});
return deferred.promise;
}
function trackComplaintStatus(complaintModel) {
    console.log(complaintModel);
    var deferred = $q.defer();
    $http.post(server_url2 +
'MobileDevice/TrackComplaintStatuses', complaintM
odel).then(
    function (d) {
        deferred.resolve(d.data);
    },
    function (err) {
        deferred.reject(err);
    });
    return deferred.promise;
}
function getResponsibilities(organizationModel) {
    var deferred = $q.defer();
    $http.post(server_url2 +
'MobileDevice/GetOrganizationResponsibilities', orga
nizationModel).then(
    function (d) {
        deferred.resolve(d.data);
    },
    function (err) {
        deferred.reject(err);
    });
    return deferred.promise;
}
function getCorrespondence(complaintModel) {
    var deferred = $q.defer();
    $http.post(server_url2 +
'MobileDevice/GetOrganizationResponsibilities', com
plaintModel).then(
    function (d) {
        deferred.resolve(d.data);
    },
    function (err) {
        deferred.reject(err);
    });
    return deferred.promise;
}
function subscribeMobileClient(clientModel) {
    var deferred = $q.defer();
    $http.post(server_url2 +
'MobileDevice/SubscribeMobileClient',
clientModel).then(
    function (d) {
        deferred.resolve(d.data);
    },
    function (err) {
        deferred.reject(err);
    });
    return deferred.promise;
}
function getSuggestions(clientModel) {
    var deferred = $q.defer();
    $http.post(server_url +
'MobileDevice/GetComplaintsByUser',
clientModel).then(
    function (d) {
        deferred.resolve(d.data);
    },
    function (err) {
        deferred.reject(err);
    });
    return deferred.promise;
}
}
})();

```

e-CSMS Web Application Sample Service Code

```

(function () {
    'use strict';
    angular
        .module('webUi3App')
        .controller('ComplaintCtrl', ComplaintCtrl);
    ComplaintCtrl.$inject = ['$log', '$scope',
    'complaintFactory', '$state', '$uibModal',
    'authService'];
    /* @ngInject */
    function ComplaintCtrl($log, $scope,
    complaintFactory, $state, $uibModal, authService) {
        var vm = this;
        vm.title = 'ComplaintCtrl';
        activate();

        function activate() {
            vm.webserver=web_Server;
            vm.openReplyModal = openReplyModal;
            vm.openAssignmentModal =
            openAssignmentModal;
            vm.closeComplaintModal =
            closeComplaintModal;
            vm.reply = reply;
            vm.getComplaints = getComplaints;
            vm.viewAttachments = viewAttachments;
            vm.viewLocation = viewLocation;
            vm.openForwardtModal =
            openForwardtModal;
            $scope.authentication =

```

```

authService.GetAuthenticationStatus();
    getComplaints();
}
function getComplaints() {
    vm.complaintList = [];
    var organization = {ID:
$scope.authentication.organizationID};

complaintFactory.getComplaints(organization).then(function (data) {
    vm.complaintList = data;
    vm.CollectioncomplaintList = data;
}, function (err) {
    vm.result = {Status:false, Message:"Network
Related Error"};
})
}

function viewAttachments(attachmentList) {
    vm.Attachments = attachmentList;
    $('#imageView').modal('show')
}

function reply(attachmentList) {
    vm.Attachments = attachmentList;
    $('#myModal').modal('show')
}

function openReplyModal(complaint) {
    vm.records = {Complaint: complaint, reply:
true};
    vm.newModalInstance = $uibModal.open({
        size: 'md',
        templateUrl: 'views/complaint-reply.html',
        controller: 'ComplaintReply',
        controllerAs: 'vm',
        resolve: {
            item: function () {
                return vm.records;
            }
        }
    });
    vm.newModalInstance.result.then(function (data) {
        vm.result = data;
    }, function (error) {
    });
}

function openAssignmentModal(complaint) {
    vm.records = {Complaint: complaint, reply:
false};
    vm.newModalInstance = $uibModal.open({
        size: 'md',
        templateUrl: 'views/unit-assignment.html',

```

```

namespace eCEMS.WebAPI.Controllers
{
    [Authorize]
    [EnableCors(origins: "**", headers: "**", methods: "**")]
    public class ComplaintsManagementController :
        ApiController
    {
        IComplaint complaintService;
        IUserAccount userService;
        MessageLitrals message;
        int OrganizationID;
        public ComplaintsManagementController()
        {
            complaintService = new Complaints();
            userService = new UserProfile();
            message = new MessageLitrals();
            var userdata = RequestContext.Principal;
        }
        [HttpPost]
        public async Task<RecordCount>
            GetComplaintsByOrganizationCount(OrganizationModel
            organization)
        {
            RecordCount Recordcount = new RecordCount();
            Recordcount.Count =
            complaintService.GetComplaintsCount(organization.ID);
            ;
            return Recordcount;
        }
        [HttpPost]
        public BaseResultModel
            CloseComplaint(ComplaintModel complaint)
        {
            BaseResultModel result = new BaseResultModel();
            ComplaintEntity complaintEntity = new
            ComplaintEntity();
            if (complaint != null)
            {
                complaintEntity.ID = complaint.ID;
                complaintEntity =
                complaintService.CloseComplaint(complaintEntity);
                result.Status = complaintEntity.Status;
                result.Message = complaintEntity.Message;
                CorrespondenceModel correspondence = new
                CorrespondenceModel();
                correspondence.ComplainID = complaint.ID;
                correspondence.Response = complaint.Message;
                if (complaintEntity.Status == true)
                this.CreateCorrespondance(correspondence);
            }
            else
            {
                result.Status = false;
                result.Message = message.modelEmpty;
            }
            return result;
        }
    }

```

```

[HttpPost]
public List<ComplaintModel>
    GetComplaintsByOrganization(OrganizationModel
    organization)
{
    List<ComplaintModel> result = new
    List<ComplaintModel>();
    List<ComplaintEntity> compEntity = new
    List<ComplaintEntity>();
    compEntity =
    complaintService.GetComplaintsByOrganizationID(orga
    nization.ID);
    foreach (var comp in compEntity)
    {
        result.Add(new ComplaintModel(comp));
    }
    return result;
}

[HttpPost]
public List<ComplaintModel>
    GetComplaintsByParentOrganization(OrganizationMode
    l organization)
{
    List<ComplaintModel> result = new
    List<ComplaintModel>();
    List<ComplaintEntity> compEntity = new
    List<ComplaintEntity>();
    compEntity =
    complaintService.GetComplaintsByParentOrganizationI
    D(organization.ID);
    foreach (var comp in compEntity)
    {
        result.Add(new ComplaintModel(comp));
    }
    return result;
}

[HttpPost]
public List<ComplaintModel> GetComplaintsByUnit1()
{
    int unitID = 4;
    List<ComplaintModel> result = new
    List<ComplaintModel>();
    List<ComplaintEntity> compEntity = new
    List<ComplaintEntity>();
    compEntity =
    complaintService.GetComplaintsByUnitID(unitID);
    foreach (var comp in compEntity)
    {
        result.Add(new ComplaintModel(comp));
    }
    return result;
}

[HttpPost]
public BaseResultModel
    AssignComplaintsToUnit(UnitAssignmentPostModel
    comp)
{

```

```

BaseResultModel result = new BaseResultModel();
ComplaintEntity compEntity = new ComplaintEntity();
compEntity.ID = comp.ComplaintID;
var resultEntity =
complaintService.AssignComplaintsToUnit(compEntity,
comp.UnitID);
result.Status = resultEntity.Status;
result.Message = resultEntity.Message;
return result;
}
[HttpPost]
public ComplaintModel
ForwardComplaint(ComplaintModel comp){
ComplaintModel result = new ComplaintModel();
var resultEntity =
complaintService.ForwardComplaint(comp.MapToEntity<ComplaintEntity>(), comp.OrganizationID);
result = new ComplaintModel(resultEntity);
result.Status = resultEntity.Status;
result.Message = resultEntity.Message;
return result;
}
[HttpPost]
public ComplaintModel
GetComplaintsByClient(ComplaintModel comp) {
ComplaintModel result = new ComplaintModel();
return result;
}

[HttpPost]
public List<ComplaintModel>
GetClosedComplaintsByOrganization(ComplaintReportModel comp)
{
List<ComplaintModel> result = new
List<ComplaintModel>();
var closedComplaintsList =
complaintService.GetComplaintsReport(comp.StartDate,
comp.EndDate, comp.OrganizationID);
foreach(var complaint in closedComplaintsList)
{
result.Add( new ComplaintModel(complaint));
}
return result;
}
[HttpPost]
public List<ComplaintModel>
GetComplaintsByUnit(UserProfileModel user)
{
var userentity =
userService.GetUsersProfile(user.Username);
List<ComplaintModel> result = new
List<ComplaintModel>();

if (userentity.UnitID != 0)
{
var complaintsList =
complaintService.GetComplaintsByUnitID(userentity.U
nitID);
foreach (var complaint in complaintsList)
{
result.Add(new ComplaintModel(complaint));
}
}
return result;
}
[HttpPost]
public List<CorrespondenceModel>
GetCorrespondence(ComplaintModel correspondence)
{
List<CorrespondenceModel> result = new
List<CorrespondenceModel>();
if (correspondence != null)
{
var correspondenceEntityList =
complaintService.GetCorrespondance(correspondence.M
apToEntity<ComplaintEntity>());
foreach (var item in correspondenceEntityList)
{
result.Add(new CorrespondenceModel(item));
}
}
return result;
}
[HttpPost]
public CorrespondenceModel
CreateCorrespondance(CorrespondenceModel
correspondence)
{
CorrespondenceModel result = new
CorrespondenceModel();
int createdBy = 1;
var correspondenceEntity =
correspondence.MapToEntity<CorrespondenceEntity>();
correspondenceEntity.IsStaff = true;
var correspondence =
complaintService.CreateCorrespondance(correspondenceE
ntity, createdBy);
result = new CorrespondenceModel(correspondence);
result.Status = correspondence.Status;
result.Message = correspondence.Message;
return result;
}
}
}

```

Appendix E: Applications Screenshot

The organization than need to handle complaints via this application could complete the following form.

Organization Profile

Organization Name *

Description

Latitude *

8.5263486

Longitude *

39.2583293

Location *

Branch

Is there child service providers under this organization?

☐ Yes

☐ No

Select parent Organization

Select parent organization

Next >>

Step 2

Organization Address

POBOX *

Email *

Website *

Phone

Remove

+ Add More Phone

<< Previous

Next >>

Step 3

Complaint Handling Office

First Name *

Last Name *

Sex *

Select Gender

Phone *

Username *

Password *

Confirm Password

Previous Finish

Figure 8.1 Organization Subscription Form Wizard

The registered organizations are viewed to administrator to be managed.

Complaints and Suggestions Management System

25 Aweke HaileMariam Log out

Organization subscription + New Organization

Search ...

#	Organization	branch	pobox	email	phone	Operations
1	Addis Ababa Water and Sewerage authority	Mexico	1170	aawsa@gov.et	0116674036, 0116673982, 0116674063, 0116673983, 0116674064,	  
2	Addis ababa water and sewerage authority	Head office	1789	aawsa@gov.et	0116674036, 0116673982, 0116674063, 0116673983, 0116674064,	  
3	Addis ababa water and sewerage authority	Megenagna	1789	dagim@gmail.com	0116674035,	  
4	Addis ababa water and sewerage authority	Gurd Shola	1789	tsega@gmail.com	0116675508,	  
5	Ethiopian Roads Authority(Head Office)	mexico	1770	tirsiltamiru@gmail.com		  
6	Addis Ababa City Road Authority (AACRA)	mexico Sarbet	1891	aacra@gmail.com	251-1-551 50 02,	  
7	Ethiopian Federal Police	mexico	--	efp@gmial.com	0116674035,	  
8	Federal Transport Authority	legahar	--	eta@gmial.com	011623456,	  
9	Police station	abnet	--	aps@gmial.com	011123757,	  
10	Megenagna Police station	Megenagna bole sub city	--	mps@gmial.com	0116674036,	  

1 2 3 4

Figure 8.2 Subscribed Service Providers

The complaint handling officer can create complaint handling units with this user interface. The available units are listed on the grid as shown.

Complaints and Suggestions Management System

Aweke HaileMariam Log out

Unit Create

Complaint Handling Unit Name *

Description *

Save Cancel

List of Units

+ New Unit

#	Unit Name
1	Humane reso
2	Road mainte

Figure 8.3 Create Unit User Interface

The complaint handling officer can assign organization users (employee) to different units based on their responsibilities.

Complaints and Suggestions Management System

Aweke HaileMariam Log out

users Assign to unit

Search

- ☒ Demeke Getaneh
- ☒ Zeleke Chekol
- ☒ ashenafi Gitu
- ☐ zewge Tekle
- ☐ Feyisa guteta
- ☐ demeke fr
- ☐ demeke fre
- ☐ Posta Bet
- ☐ Demeke get

Save Cancel

List of Units

+ New Unit

#	Unit Name
1	Humane reso
2	Road mainte

Figure 8.4 User to Unit Assignment User Interface

Appendix F: Database Script

/****** Object: Table [dbo].[Addresses] Script Date: 12/5/2017 7:55:44 PM *****/

```
CREATE TABLE [dbo].[Addresses](
    [ID] [int] IDENTITY(1,1) NOT NULL,
    [OrganizationID] [int] NOT NULL,
    [Phone] [nvarchar](20) NULL,
    CONSTRAINT [PK_Address] PRIMARY KEY CLUSTERED
(
    [ID] ASC
)WITH (PAD_INDEX = OFF, STATISTICS_NORECOMPUTE = OFF, IGNORE_DUP_KEY = OFF,
    ALLOW_ROW_LOCKS = ON, ALLOW_PAGE_LOCKS = ON) ON [PRIMARY]
) ON [PRIMARY]
```

/****** Object: Table [dbo].[Complain] Script Date: 12/5/2017 7:55:44 PM *****/

```
CREATE TABLE [dbo].[Complain](
    [ComplainID] [decimal](18, 0) IDENTITY(1,1) NOT NULL,
    [Subject] [varchar](100) NULL,
    [Message] [nvarchar](max) NULL,
    [Latitude] [decimal](12, 9) NULL,
    [Longitude] [decimal](12, 9) NULL CONSTRAINT [DF_Complain_Longtude] DEFAULT ((0)),
    [OrganizationID] [int] NOT NULL,
    [SenderID] [int] NOT NULL,
    [RecievedDate] [datetime] NOT NULL,
    [IssueStatus] [bit] NULL,
    [IsVisited] [bit] NULL,
    [VisitedBy] [int] NULL,
    [VisitedOn] [datetime] NULL,
    [Escalated] [bit] NULL,
    [IsSuggestion] [bit] NULL,
    [TeamID] [int] NULL, CONSTRAINT [PK_Complaint] PRIMARY KEY CLUSTERED
(
    [ComplainID] ASC
)WITH (PAD_INDEX = OFF, STATISTICS_NORECOMPUTE = OFF, IGNORE_DUP_KEY = OFF,
    ALLOW_ROW_LOCKS = ON, ALLOW_PAGE_LOCKS = ON) ON [PRIMARY]
) ON [PRIMARY] TEXTIMAGE_ON [PRIMARY]
```

/****** Object: Table [dbo].[ComplainAttachment] Script Date: 12/5/2017 7:55:44 PM *****/

```
CREATE TABLE [dbo].[ComplainAttachment](
    [AttachmentID] [numeric](18, 0) IDENTITY(1,1) NOT NULL,
    [ComplainID] [decimal](18, 0) NOT NULL,
    [AttachmentName] [nvarchar](550) NULL,
    [AttachmentPath] [nchar](500) NULL,
    [FileType] [nvarchar](50) NULL,
    CONSTRAINT [PK_ComplainAttachment] PRIMARY KEY CLUSTERED
(
    [AttachmentID] ASC
)WITH (PAD_INDEX = OFF, STATISTICS_NORECOMPUTE = OFF, IGNORE_DUP_KEY = OFF,
    ALLOW_ROW_LOCKS = ON, ALLOW_PAGE_LOCKS = ON) ON [PRIMARY]
) ON [PRIMARY]
```

/****** Object: Table [dbo].[Correspondence] Script Date: 12/5/2017 7:55:44 PM *****/

```
CREATE TABLE [dbo].[Correspondence](
    [CorrespondenceID] [decimal](18, 0) IDENTITY(1,1) NOT NULL,
    [ComplainID] [decimal](18, 0) NOT NULL,
    [Response] [nvarchar](max) NULL,
    [IsStaff] [bit] NOT NULL,
    [CreatedBy] [nvarchar](50) NULL,
```

```

        [CreatedOn] [datetime] NULL,
CONSTRAINT [PK_Correspondence] PRIMARY KEY CLUSTERED
(
        [CorrespondenceID] ASC
)WITH (PAD_INDEX = OFF, STATISTICS_NORECOMPUTE = OFF, IGNORE_DUP_KEY = OFF,
ALLOW_ROW_LOCKS = ON, ALLOW_PAGE_LOCKS = ON) ON [PRIMARY]
) ON [PRIMARY] TEXTIMAGE_ON [PRIMARY]

```

***** Object: Table [dbo].[MobileClient] Script Date: 12/5/2017 7:55:44 PM *****/

```

CREATE TABLE [dbo].[MobileClient](
        [CitizenID] [int] IDENTITY(1,1) NOT NULL,
        [FirstName] [nvarchar](50) NOT NULL,
        [LastName] [nvarchar](50) NOT NULL,
        [Phone] [nvarchar](50) NOT NULL,
        [IsActive] [bit] NOT NULL CONSTRAINT [DF_MobileClient_IsActive] DEFAULT ((1)),
        [SubscriptionDate] [datetime] NOT NULL,
CONSTRAINT [PK_MobileClient] PRIMARY KEY CLUSTERED
(
        [CitizenID] ASC
)WITH (PAD_INDEX = OFF, STATISTICS_NORECOMPUTE = OFF, IGNORE_DUP_KEY = OFF,
ALLOW_ROW_LOCKS = ON, ALLOW_PAGE_LOCKS = ON) ON [PRIMARY]
) ON [PRIMARY]

```

***** Object: Table [dbo].[Organization] Script Date: 12/5/2017 7:55:44 PM *****/

```

CREATE TABLE [dbo].[Organization](
        [OrganizationID] [int] IDENTITY(1,1) NOT NULL,
        [Name] [nvarchar](200) NOT NULL,
        [Description] [nvarchar](1000) NULL,
        [Location] [varchar](250) NOT NULL,
        [Longitude] [decimal](12, 9) NOT NULL,
        [Latitude] [decimal](12, 9) NULL,
        [ParentOrganization] [int] NULL,
        [Branch] [nvarchar](500) NULL,
        [POBOX] [nchar](10) NULL,
        [Email] [nvarchar](50) NULL,
        [Website] [varchar](100) NULL,
        [IsActive] [bit] NOT NULL,
        [IsParent] [bit] NOT NULL,
        [CreatedOn] [datetime] NOT NULL,
        [CreatedBy] [int] NOT NULL,
CONSTRAINT [PK_Organization] PRIMARY KEY CLUSTERED
(
        [OrganizationID] ASC
)WITH (PAD_INDEX = OFF, STATISTICS_NORECOMPUTE = OFF, IGNORE_DUP_KEY = OFF,
ALLOW_ROW_LOCKS = ON, ALLOW_PAGE_LOCKS = ON) ON [PRIMARY]
) ON [PRIMARY]

```

***** Object: Table [dbo].[Responsibility] Script Date: 12/5/2017 7:55:44 PM *****/

```

CREATE TABLE [dbo].[Responsibility](
        [ResponsibilityID] [int] IDENTITY(1,1) NOT NULL,
        [OrganizationID] [int] NULL,
        [Responsibility] [nvarchar](550) NOT NULL,
        [Description] [varchar](max) NULL,
        [IsActive] [bit] NOT NULL CONSTRAINT [DF_Responsibility_IsActive] DEFAULT ((1)),
CONSTRAINT [PK_Responsibility] PRIMARY KEY CLUSTERED
(
        [ResponsibilityID] ASC
)WITH (PAD_INDEX = OFF, STATISTICS_NORECOMPUTE = OFF, IGNORE_DUP_KEY = OFF,
ALLOW_ROW_LOCKS = ON, ALLOW_PAGE_LOCKS = ON) ON [PRIMARY]

```

```
) ON [PRIMARY] TEXTIMAGE_ON [PRIMARY]
```

```
/****** Object: Table [dbo].[Team] Script Date: 12/5/2017 7:55:44 PM *****/
```

```
CREATE TABLE [dbo].[Team](  
    [TeamID] [int] IDENTITY(1,1) NOT NULL,  
    [TeamName] [varchar](50) NOT NULL,  
    [OrganizationID] [int] NOT NULL,  
    [Description] [nvarchar](max) NULL,  
    [IsActive] [bit] NOT NULL CONSTRAINT [DF_ComplainHandlingTeam_IsActive] DEFAULT ((1)),  
    CONSTRAINT [PK_ComplainHandlingTeam] PRIMARY KEY CLUSTERED  
(  
        [TeamID] ASC  
    )WITH (PAD_INDEX = OFF, STATISTICS_NORECOMPUTE = OFF, IGNORE_DUP_KEY = OFF,  
    ALLOW_ROW_LOCKS = ON, ALLOW_PAGE_LOCKS = ON) ON [PRIMARY]  
) ON [PRIMARY] TEXTIMAGE_ON [PRIMARY]
```

```
/****** Object: Table [dbo].[TeamMember] Script Date: 12/5/2017 7:55:44 PM *****/
```

```
CREATE TABLE [dbo].[TeamMember](  
    [TeamMemberID] [int] IDENTITY(1,1) NOT NULL,  
    [TeamID] [int] NOT NULL,  
    [UserID] [int] NOT NULL,  
    [IsActive] [bit] NOT NULL CONSTRAINT [DF_TeamMember_IsActive] DEFAULT ((1)),  
    CONSTRAINT [PK_TeamMember] PRIMARY KEY CLUSTERED  
(  
        [TeamMemberID] ASC  
    )WITH (PAD_INDEX = OFF, STATISTICS_NORECOMPUTE = OFF, IGNORE_DUP_KEY = OFF,  
    ALLOW_ROW_LOCKS = ON, ALLOW_PAGE_LOCKS = ON) ON [PRIMARY]) ON [PRIMARY]
```

Appendix G: Mobile App Evaluation Criterion

- 1) How easy the application to make complaints and provide suggestions?
 - A. Yes
 - B. No (please tell us the reason) _____
- 2) Does the application feed enough information about service providers?
 - A. Yes
 - B. No (tell us reason) _____
- 3) Do you think this app saves time, money and effort to report problems and provide feedback?
 - A. Yes
 - B. No (tell us reason) _____
- 4) Does the application help you to know the concerned body of the issues?
 - A. Yes
 - B. No (tell us the reason) _____
- 5) Does the app let you to provide suggestions to multiple organizations without any difficulty?

- A. Yes
B. No
- 6) How do you rate this complaining channel compared to others like phone call, email, website, and in person complaints reporting, in terms of user encouragement to make complaints and suggestions?
- A. Excellent
B. Very good
C. Good
D. Poor
- 7) Could you track the status of your complaints?
- A. Yes
B. No
- 8) If you have any comment on the application, please leave a comment _____
-

Appendix H: Web Application Prototype Evaluation Criterion

The experts evaluate the system based on the following criterions. The software experts interviewed together the responses are shown in figure 8.1.

<i>Criterion</i>	<i>Yes</i>	<i>No</i>
Could you register your organization?	✓	
Does the app allow you to create complaint and suggestion handling units?	✓	
Could you define your organization responsibilities and duties?	✓	
Could you receive your organization complaints from customers?	✓	
Could you respond to customer complaints of your organization?	✓	
Could you respond to customer complaints?	✓	
Could you get the complaints and suggestions after resolved?	✓	

Table 8.1 Software Evaluation Criterion and Results

Appendix I: Observation Checklist

This form is used to collect data while observation is conducted.

	<i>Observed problem on Services</i>				
<i>Places in Addis Ababa</i>	<i>Electric</i>	<i>Water</i>	<i>Transport</i>	<i>Policing</i>	<i>Road</i>
Kotebe					
Semit					
Ayat					
Bole					
Mexico					
Kality					
Gerji					
Shiromeda					
Kazanchis					
Torhailoch					
Saris					
Sarbet					
Keranio					

Table 8.2 Observation Checklist