Customer Complaint Management System using SOA

G.I.U. Jayawickrama
2018

Customer Complaint Management System using SOA

A dissertation submitted for the Degree of Master of Computer Science

G.I.U. Jayawickrama
University of Colombo School of Computing
2018

UCSC

Declaration

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

Student Name: G.I.U. Jayawickrama

Registration Number: 2014/MCS/036

Index Number: 14440362

_____

Signature: Date:

This is to certify that this thesis is based on the work of

~~Mr.~~/Ms. G.I.U. Jayawickrama

under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

Certified by:

Supervisor Name: Dr. Chaminda Ranasinghe

_____

Signature: Date:

Abstract

Sri Lankan citizens who are seeking for government services are not always served as they expected. Therefore, there is a need of having a convenient way to make and handle customer complaints. When a government has many service providing centers or departments, customers should know what the issue related department is and then they should browse relevant department to make the complaint. When customer needs to view the status of the complaint, then again customer should visit and browse the relevant department. This has become very tedious and cumbersome for customers to visit various departments and make these complaints or view statuses since there is no standard process to submit their complaints. If there is only one common portal to make any complaint and get the solution, it is easier for their tight schedule.

The investigations regarding these issues in complaint management were carried out through web resources. Research was carried out phase by phase which consists of analysis, conceptual design and implementation design. A prototype was developed while achieving a set of defined objectives. Researcher conducted a study and analysis on the current processes in government departments. It found the common and specific details related to issue resolution and identified the specific inputs needed from users related to the issue. Then, it designed a solution that could be used to capture issues related to different departments. In here, it came up with a solution which users can interact with and submit their complaints without worrying about what the issue related department is. Other than that, developed web portal can capture common details as well as department specific details related to the issue. Finally, researcher developed a solution which is able to interact with different governmental departments to route and manage the overall issue resolution process using an algorithm designed in BPEL layer with BPEL engine.

In this research, it was investigated the benefits of a comprehensive complaint management system in e-government and proposed an e-complaint model based on SOA. There were some limitations as well in data capturing level and research level since some departments avoid exposing some sensitive data. This prototype can be further extended and developed in future.

Acknowledgement

Writing this thesis has been both hard and funny to do, it has also been a very interesting experience, especially the parts concerning and understanding of how real business works and interacts with society.

There have been many late night and early mornings, and after all finally I could achieve finishing the report. Through all I would like to express my deepest appreciation to all those who provided me the possibility to complete this report. A special gratitude I give to my supervisor Dr. Chaminda Ranasinghe, whose contribution in stimulating suggestions and encouragement, helped me coordinate my project especially in writing this report.

Furthermore, I would also like to acknowledge with much appreciation the support and courage of my family and friends who were always with me every step of the way.

Table of Contents

List of figures

List of tables

List of Abbreviations

SOA	Service Oriented Architecture
CRM	Customer Relationship Management
e-CRM	electronic CRM
e-Complaint	electronic Complaint
ICT	Information and Communication Technology
GIS	Geographic Information System
IT	Information Technology
BSOA	Business Service Oriented Architecture
G2B	Government to Business
SMEs	Small and Medium Enterprises
WSDL	Web Services Description Language
SOAP	Simple Object Access Protocol
UDDI	Universal Description, Discovery and Integration registry
DCOM	Distributed Component Object Model
ORBs	Object Request Brokers
CORBA	Common Object Request Broker Architecture
ESB	Enterprise Service Bus
BPS	Business Process Server
PFD	Process Flow Diagram
CHD	Complaint Handling Department
DB	Data Base
XML	Extensible Mark-up Language

Chapter 1: Introduction

1.1   Introduction

Sri Lankan citizens who are expecting government services are not always served as they expected. Therefore, they do have the necessity of complaining the deficiencies to the authorized parties. When there are many service providing centers or departments, customers should know what the issue related department to make the complaint. It is difficult for a customer to figure out the related department since most of them are not having a broader knowledge on department specific services. However, after deciding the related department, customer needs to visit relevant department web portal and make complaint. When customer needs to view the status of his complaint, then again visit the web portal of the relevant department. If customer faces another complaint with different type, then also he needs to decide the department and repeat the same steps. This has become very tedious and cumbersome for customers to visit various departments and make these complaints or view status since there is no standard process to submit their complaints. This is where it highlights the necessity of having single place to submit any type of complaint, view status and follow ups.

If there is only one common portal to make any complaint and get the solution, it is easier for their tight schedule. Users, wherever they are, can access the system and having one common portal with a simple interface is easy to use for customer. Using the IT environment saves time since the user does not need to refer to the service provider directly. These days, many governments including Sri Lanka offer their services through the Internet. Because of this, each government department has its own website and these departments individually offer the services to customers. Each department tries to develop its own web portal using its own software techniques; therefore, the different web portals with different interfaces confuse the customer.

Since customer satisfaction is a primary goal of a government, there should be a convenient way to make and handle customer complaints. The investigations regarding the mentioned issues in complaint management were carried out through internet resources. Research was carried out phase by phase which consists of analysis, conceptual design and implementation design.

In terms of web resource analysis, previous researches show that most complaint systems in government departments focus only on how to resolve and give the status back to the

customer, but none is related to the implementation of a complaint system based on one interface in electronic government. In this research, the researcher tried to work to reduce user dissatisfaction and confusion when making and following up complaints by showing the advantages of the complaints system in e-government based on one interface.

Finally, a prototype was designed and implemented with achieving a set of defined objectives. The main objective was to prototype the solution where customer no longer need to confuse on selecting departments, making complaints, following up complaints and viewing statuses. Researcher conducted a study and analysis on the current processes in government departments in Sri Lanka as well as in other countries. It found the common and specific details related to issue handling and identified the specific inputs needed from users related to the complaint. After a thorough analysis and study, it designed a solution that could be used to capture complaints related to various government departments using single interface. In this solution, users can interact with the system and submit their complaints without the hassle of deciding the issue related department. Other than that, developed web portal is able to capture common details as well as department specific details related to the issue. Finally, researcher developed a solution which can interact with various government departments to route and handle the overall issue resolution process using an algorithm designed in BPEL layer with BPEL engine. BPEL layer is the breath of the solution and it is where the core logic of the solution lives.

In this research, it was investigated the benefits of a comprehensive complain system in e-government and proposed an e-complaint model based on single interface. There were some limitations as well in data capturing level and research level since some departments avoid exposing some sensitive data. This prototype can be further extended and developed in future by adding feature to end users web portal. If any new department needs to be added, it is just a small configuration in BPEL layer and it is the beauty and the simplicity of the solution.

1.2   Motivation

Today's development cycles for web applications, such as portals and markets, are short and are becoming shorter with improvements and continuous improvements as new requirements and features appear. On the other hand, most user complaints are not apparent when a system has an inappropriate communication between the departments, their staff and their clients (citizens). Poor communication can cause the organization or the government to provide poor services or products.

If the government service provided to the customer is not what is exactly expected, it is a frustration and disappointment to the customer and it reflects a bad image of the government. Consequently, customer loyalty is fleeting and the customer no longer trusts the services provided by department. This ultimately does not support a long-term journey of a government and currently Sri Lankan government also faces the same issue. Resolving these problems has become a major challenge.

Sri Lankan citizens who are seeking for government services are not always served as they expected. Hence, having frustration and dissatisfaction in mind, they do have the necessity of informing this deficiencies to the relevant authority or department. Therefore, there is a need of having a convenient way to make these complaints, track or view the status of complaints made and obtain a solution.

When there are many service providing centres or departments and when a customer needs to make a complaint, he or she needs to physically visit that respective service centre or make a telephone call or make it through an email or centre's web portal. In Sri Lanka, some of the departments do not have web portals even and sometimes complainant should visit the department physically to make any complaint.

In case the departments having separate web portals for complaints, customers should know what the issue related department is and should go to the web portal of the relevant department to make the complaint. After that, whenever customer needs to view the status of his complaint, then again visit and browse the relevant department. If customer has made many complaint for different departments, he or she needs to browse each one separately to view or inquire on the status. This has become very tedious and cumbersome for customers to visit different centres and make these complaints or view status since there is no standard process to submit their complaints. Even the researcher experienced the same thing when it needed to complain about two different departments. If there is only one common portal to make any complaint and get the solution, it is an easier way for their tight schedule. This is the motivation behind this research project.

1.3   Statement of the Problem

With the growth of cities and the population, increase of services has become high. Changing of plans has become difficult. Therefore, governments and other organizations must obtain feedback from citizens to determine the changes and to verify the acceptability of the system to the user. Given that the first objective of electronic reporting is the satisfaction of citizens, in the electronic reporting system, they should consider more on this subject. The following are some important success factors to obtain the citizen satisfaction.

1. Citizens normally expect to get good services from the government/organization and good behaviour from organization staff and its departments.
2. They prefer to complain about services, staffs and organizations even if it's their own fault.
3. They expect government/organization to check their requests, suggestions and complaints and finally attend to them.
4. They like to get response from government/organization in terms of their complaint.
5. They prefer simple complaint process (most of them are not experts).
6. They like to be involved in controlling government organizations and staffs although it is one of the parliament duties.
7. They like to cooperate with government organization staff and to be staff investigators.

All these factors can be considered as a free high potential means for government or any other organization to check itself and reform its outfit. Therefore, many countries spend lot on this topic.

Sri Lankan citizens who are seeking for government services are not always served as they expected. Hence, they need to make complaints for the respective service providers or departments. Therefore, there is a need of having a convenient way to make these complaints and obtain a solution.

As there are many service providing centres or departments, when a customer needs to make a complaint he or she needs to visit that respective service centre or make a telephone call or make it through an email or centre's web portal. It is very tedious and cumbersome for customers to visit different centres and make these complaints since there is no standard process to submit their complaints. On the other hand, complaint process cannot be tracked or viewed by complainant. If there is only one common portal to make any complaint, track them and get

the solution, it is an easier way for their tight schedule. This is the problem going to be addressed and solve.

Customer complaint management is becoming a critical key success factor in today's business environment. Complaint management system is a system that can survey customer feedback about any organization. Organizations that follow best practices consider complaints as opportunities for improvement. These companies understand the link between complaint resolution and customer loyalty and work hard to act immediately on problems that can be easily resolved.

Customer complaint is important information reflecting customers' sound and is a primary measure of customer dissatisfaction. An effective and efficient response to these complaints is an essential index of organization's performance. On the other side, most of user complaints are apparent when a system has inappropriate communication between the service centres, their employees and customers. Poor communication can result in poor services being provided by the government. Whilst concentrating on the topic of complaint handling, service centres or departments can achieve an efficient success factor by increasing their user satisfaction and loyalty. Therefore, each centre needs to develop its internal and external communication towards its staff and customers to achieve success. Although appropriate communication can reduce user dissatisfaction, it cannot eliminate complaints. Every day citizens complain to staff of the service department because of the feeling of dissatisfaction. The above-mentioned problem is always there in the government departments. Addressing this problem and coming up with a solution is the main objective of this project.

In this dissertation, researcher has tried to analyse existing Sri Lankan governmental complaint websites and then has tried to cover their gaps by developing a compliant model providing solutions to each identified problem. The main gap which most of the complaint systems have is that complain system has been designed just for specific department or organization, therefore it cannot cover the whole government systems. In existing websites, complainer should refer to a specific website for each organization whenever need to make a complaint or view that status of complaint.

However, many investigations have been conducted on the topic of e-complaint system. Out of them only one researcher who is Najar et al. [5] has focused on using one interface for all departments in e-complaint system to improve relation between citizens and government. The

researcher believes this can bring more flexibility for complaint departments to change their complaint services.

1.4   Aims and Objectives

1   Study and analyse current processes related to complaints in government departments.

   - Find the common and specific details related to issue resolution.
   - Identify common and specific inputs needed from users related to the issue.
   - Prototype the solution using five government departments in Sri Lanka.

2   Design a solution that could be used to capture issues related to different departments.

   - Design a solution which users can interact with and submit their complaints without worrying about what the issue related department is.

3   Ability to capture department specific issue management criteria from users.

   - Web interface should be able to capture common details as well as department specific details related to the issue.

4   The solution should be able to interact with different governmental departments to route and manage the overall issue resolution process.

1.5   Research Questions

The main research questions of the study encompass the current initiative of e-government or any other e-organization, the benefit achieved from e-government complaint system based on single user interface, as well as the challenges being faced during implementation as listed below.

●   What is the relationship between e-government or e-organization effectiveness and e-complaint systems?

Method   : Public Survey found in web sites

Expected findings   : Outcome of the implementation of e-government complains system in terms of citizen loyalty and decreasing user dissatisfaction.

- What are the processes, needed for establishing complaint system based on single user interface?

Method   : Organization employee interviews in websites and survey from citizens in websites.

Expected findings   : A model for a complaint system based on single user interface for complaints related to any department.

- What is the status of complaint system in e-governments or e-organizations, and what is Sri Lanka's e-government (in terms of complaint system) standing compared to rest of the world (countries such as Malaysia, United Kingdom)?

Method   : Websites, archival research and journals study.

Expected findings   : The current status of complaint system and the currents standing of Sri Lankan e-organizations compared to Malaysia, United Kingdom.

1.6   Limitations of the Study

In data capturing level and research level, according to the web resources, it is said that some departments avoid getting permission for accessing their complaint system archive since they want to keep customers' information secured. In some cases, contents of complaints were classified as confidential, hence, access to a large number of this type of complaints became impossible.

1.7   Definitions of Terms

I. E-government/ E-organization

Many definitions about e-government are available in internet journals and websites. Researcher assumed that all these definitions are the same, but e-government in simplest terms can be defined as the use of ICT within the Government to make operations more efficient, improve quality of services and offer an easy access for citizens to government information and services [14]. Same scenario applies to any e-organization as well.

II. Service Oriented Architecture (SOA)

SOA is a designing architecture with services instead of procedures; therefore, it helps systems to be more flexible and easily changeable. With using SOA, the cost of change will be decreased enormously since administrator does not need to change the whole system when it needs to change or add any service which system needs [18]. In e-government system, researcher believes that the e-government based on SOA talks about designing a system based on departments' services with a common interface.

III. Complaint

Sworn statement filed by a party (the complainant, petitioner, or plaintiff) to a court to commence litigation against another party (the accused, defendant, or respondent) in a civil lawsuit. Complaint sets forth the alleged grounds (allegations) for the case and request for award of relief (damages) or recovery of some asset such as money or property. [19]. Complaint is an expression of displeasure, such as poor service at a store, or from a local government service centre.

1.8   Scope

Automating a solution for the problems in complaint management mentioned above 1.3 and providing a single interface for users to log complaints related to any government department is the   overall scope. To do this, it can define different departments, all the services provided by each department and allow user to fill a form with complaint details and submit. From this solution, citizens of Sri Lanka do not need to visit different sites or departments to make complaints, instead they can just go to one portal, put their complaint and it will get routed to the respective department.

High level scope in summary:

1. Propose a suitable architecture and design.
     - Conceptual architecture and workflow are in figure 3.2 and figure 3.4.

2. Analyse the current complaint handling process/ solutions in issue management centres/ departments.
     - Web search, department web portal analysis can be used as methods.

3. Develop a web portal as the prototype to make any complaint for any department (going to consider for two departments) for customers.

4. Develop complaint handling component to analyse customer inputs and route each to specific department connecting to web portal.

5. Develop a consolidated issue management system for all departments.
   - Testing and Evaluating the prototype.

This system will be able to handle complaints made by customers of government departments. The resolution of the complaint might be economic improving service being provided to the customer by the department. In this research project, goal is to develop a model in terms of electronic complaints. This model can support making complaints about poor service quality and delivery. The advantage behind this model is to have a simple method for handling citizens' complaints on the government services which make them dissatisfied.

1.9   Significance of the Study

To achieve all objectives of the project and to present a dissertation and a prototype ultimately are the expected contributions for the application. Customer complaints management is becoming a critical key success factor in today's business environment. Current systems are using non-SOA mechanism in their applications to serve customer feedbacks. However, e-complaint based on one interface talks about designing a system based on different services with a common interface.

In this study, the researcher tried to improve the relationship between citizens and government by focusing on the new model and considering the needs of users. By using the model presented through the government agency, governments will have the ability to minimize the dissatisfaction of citizens and, on the other hand, can encourage citizens to participate in the control of the government agency, such as employees and the organization of the government. This study can be useful in other fields of e-government in terms of citizen adoption and citizen loyalty. The results of this study can be a good reference to know the needs of users of e-complaint and the importance of the complaint in the governing body. In addition, the researcher addressed customer complaint behaviour and online customer satisfaction.

1.10   Methodology

This research project was conducted in two main stages:

1.   Literature review

In the literature review, researcher tried to focus on data capturing as well as using web resources to explore users' needs in terms of their e-complaint and e-government. In this part, related government and other organizational websites were investigated to find out what their advantages and disadvantages are. These inputs were based on the conceptual design of the system.

2.   Implementation

In implementation part, a prototype demonstrating the basic workflow for submitting a complaint and viewing complaint history and status is developed after the system analysis and design. Finally, the prototype is tested and evaluated with test data.

1.11   Structure of the Dissertation

First, in Chapter 1, introduction, motivation, statement of the problem, aims and objectives, research questions, significance of the study, definition of terms, scope, limitation of the study and methodology have been presented. Chapter 2 includes the review of research and literatures related to the problem being investigated. The methodology and approaches used for data and information collection, system development methodology, process flow diagrams, algorithmic design details are presented in Chapter 3. The results of investigation on websites, web resources, web journals and research papers, system analysis, system design, implementation diagrams and details are contained in Chapter 4. Apart from that, a new complaint handling model based on the design is also presented in this chapter. In Chapter 5, evaluation and test results are indicated. Finally, in Chapter 6, conclusion and future works are presented.

1.12   Overview of Subsequent Chapters

This thesis describes the complaint management system oriented by web-application which will be used by citizens to make complaints about their dissatisfaction on provided services. This thesis contains background of the project with the literature review, the analysis and design

which contains the UML diagrams and architectural diagrams. Because of the motivation factors mentioned, a need for a system that could detect citizens' problems and provide them with suitable feedback is raised. Also, this theses describes the complaint management system oriented by web-application which will be used by citizens to make complaints about their dissatisfaction on provided services. This system will be able to handle any kind of complaint through one web portal and giving feedback for each raised complaint. Results of the study can be a good reference to find out users' needs from e-complaint and the handling process of this complaint in the body of any organization.

Chapter 2: Literature Review

2.1 Introduction

In this literature review, researcher first briefly introduces electronic government or organization and the researcher explains the classification of e-government and advantages of e-government, afterwards it is followed up with the concept of SOA and the usage of SOA in e-government, the researcher includes example of e-government projects based on SOA. Researcher explains concept of complaints and significance of the complaint handling system in organization. Researcher also discusses electronic customer relationship management (e-CRM) and how complaint can be efficient in enhancing organizational performance.

2.2 Introduction on e-Government

With reference to a survey conducted by the International City/County Management Association [27] administered to Chief Administrative Officers(CAO) at government agencies, 74.2% of CAOs reported that their government agency had a website. However, 90.5 % of these agencies have not conducted a survey to see what online services citizens and businesses want [14].

According to study by West, Derrell .M [15] following are the online services that appear frequently on government websites:

- Publications available for online ordering

Publications can be ordered and delivered via a web portal.

- Online registration for events or seminars; send an e-card

Through an online service, event or seminar registration and payments can be done.
e-card can be ordered and sent online.

- Online booking services

Booking airline, accommodation, transportation can be done through a web portal.

- Apply for jobs and/or scholarships

Applying for jobs and scholarships, payments for the scholarships can be done via an online service.

- Various calculators (e.g., inflation calculator, fuel cost calculator and exchange rate calculator)

- Check status of application (e.g., check status of immigration case)

- Order products online Products can be browsed and ordered online.
- Apply for employment insurance benefits
- Apply for pension retirement plan
- Apply for passport
- Change address

If a customer needs an address change, a form can be submitted to the government department for approval.

- Park reservations

For public parks, reservations can be requested and got done.

- Insurance claim
- Abroad registration
- Personalized weather

Weather information can be got via an online service registration.

- Library access
- Tax slips
- Travel reports
- Firearm registration

2.3 The Advantages of e-Government / e-Organization

If e-government is properly implemented, it can improve current government services, increase accountability, generate more accurate and efficient services, reduce administrative costs and time spent on repetitive government employees, facilitate greater transparency in government administration and allow greater access to services due to the permanent availability of the Internet. E-government also allows governments to offer enhanced services by creating new methods to interact with the government, such as e-mail, online meetings and forums for expressing opinions, online transactions, online complaints and online voting. A positive relationship has been identified between participation on the Internet and participation in civic and political issues. By creating a viable Internet presence, a government can generate in the political process among young citizens who frequently use the Internet [16]. E-government is even used in some places as a method to reduce corruption in government functions, since a computer is not likely to request a bribe to do its job.

By using SOA in e-governments, these corruptions will be completely eliminated. More importantly, its objective is to help strengthen the government, which is promoting effective governance and greater transparency to better manage the social and economic resources of a country for development. The working group on e-government in the developing world has identified four broad categories of objectives commonly pursued for e-government. E-government is a means to achieve these broader social objectives, goals that go beyond the greater efficiency of government processes to that of reform and development in general. The objectives of existence of electronic government are not listed in any particular order of importance, since each country must determine its properties in its electronic government. Those objectives are illustrated below [15].

● Creating a better business environment: the use of ICT in government and the establishment of an e-government infrastructure help create a business-friendly environment by streamlining interaction and improving the interface between government and businesses, especially small ones and medium-sized enterprises (SMEs). By cutting redundancies in procedures and emphasizing the immediate and efficient delivery of services, e-government creates the conditions that attract investors and investment.

● Strengthening good governance and expanding public participation: promoting transparency and accountability in government through the proliferation of ICTs in management and operations also creates a good situation for citizens to participate in government policies and policies of decision making; the transparency of information not only democracy, but also install a sense of responsibility among government leaders and force an effective government [17].

● Improve the productivity and efficiency of government agencies: Re-engineering processes and procedures to cut and paste facilitate the delivery of services, increase the productivity of the bureaucracy and increase savings is inherent in electronic government.

● Increase the productivity of government personnel, reduce the general expenses of employees in agencies, reduce paper management, use tools and improve access to critical information (for example, using GIS in urban planning), improve planning the management.

- It can cause cost savings in the medium to long term. Although in the short term the cost will increase because the government in the early stages needs to offer both delivery and traditional platforms and electronic government.

- Streamline government operations. Most governmental processes have evolved over many years and, in general, involve many steps, tasks and activities. The rationalization of governmental processes through ICT eliminates redundant procedures and helps reduce bureaucracy.

- Improve the quality of life: ICT makes it possible for the government to reach marginalized groups and communities and improve their quality of life. This means empowering them through their participation in the political process, as well as delivering the much-needed public goods and services. Finally, the objective of electronic government is to improve the interaction between three main actors in society, government, citizens and businesses, in order to simulate political, social and economic progress in the country.

2.4 Previous Work

Out of the previous related work done concerning customer complaint, the most recent research was Razali et al. [6] who developed a new complaint management system called e-Aduan as a platform for UiTM Pahang's (MARA University of Technology Pahang Campus) customers to complaint and comment regarding the services and facilities provided by the university. The researcher found out that the most appropriate to the research topic handling customer complaint using SOA was: Najar et al. [5] who tried to improve relation between citizens and government by presenting a new model based on service oriented architecture (SOA). By using the model presented in the government body, on the one hand, governments will have the ability to minimize the dissatisfaction of citizens and, on the other hand, can encourage citizens to participate in the control of the government body, such as staff and government organizations.

2.5 Service Oriented Architecture (SOA)

Definition of service-oriented architecture (SOA): A service-oriented architecture can be defined as a group of services that communicate with each other. The communication process involves the simple transfer of data or could involve two or more services that coordinate an activity. Some means are needed to connect services between them.

There are many definitions for the SOA but the researcher deepens that all the definitions are the same in concept. In SOA-based systems we have different systems with different services that have to collaborate with each other through a common bus and a single data type, although each system has its own data type. SOA creates applications from software services.

Services are intrinsically associated units of functionality, which do not have calls to each other integrated in them [13]. Typically, they implement features that most humans would recognize as a service, such as filling out an online application for an account, viewing a bank statement online, or making an online reservation or ordering airline tickets. Instead of services that embed calls to each other in their source code, protocols are defined that describe how one or more services can communicate with each other. This architecture is then based on an expert in business processes for linking and sequencing services, in a process known as orchestration, to meet a new or existing business system requirement. Another example for SOA is the booking of train tickets, which is a request for a service to implement the reservation; On the other hand, this service can provide the transfer of customers from your home to the train station through collaboration with other services belonging to other agencies.

The service-oriented architecture (SOA) talks about how to design a service-based system beyond a common interface. SOA is a methodology for the development and integration of systems where functionality is grouped around business processes and packaged as interoperable services[11]. SOA also describes the IT infrastructure that allows different applications to exchange data with each other as they participate in business processes. The objective is a flexible coupling of services with operating systems, programming languages and other technologies that underlie the applications. SOA separates functions into distinct units, or services, that are accessible through a network to be combined and reused in the production of commercial applications. These services communicate with each other when passing data from one service to another, or when coordinating an activity between two or more services. SOA

concepts are often considered as developed and evolve from older concepts of distributed computing and modular programming.

Service-oriented architecture facilitates changes. Traditionally, the construction of IT infrastructure meant gathering a collection of hardware, software and networks. They are rigidly integrated, so changing is difficult, as if you had to wear the same outfit every day, but with a service-oriented architecture, your computer system is built, which facilitates the assembly and flexibility of configurable components, like the clothes in your cupboards. Just think that each clothes in your cupboards is not hardware or software, you can consider them as the service that the government or your company performs. How to check someone's credit, check their inventory, verify the status of the shipment, when using natural services, has many options to create a team that best suits the target market or government conditions [6]. If one of the conditions changes, instead of buying a new computer, you can find the service you need to add to your system. As an example, you can reuse what you already have in your cupboards to create a new look. You are saving time and money; You can buy a new cloth or borrow to complete your closets to do something new, therefore, you can help your business grow. SOA gives you flexibility to change easily. This capacity for change is making your business so innovative. There have been many investigations on SOA, research on concept, history, architecture oriented to commercial services (BSOA) and government to business (G2B).

XML is largely used by SOA to create data, nowadays XML is becoming part of standard IT infrastructure. The specifications mainly use XML as their alphabet [12]. According to survey conducted by Mcgovern and Sims [12], these are some reasons for why these specifications were successful in past years:

- Platform-independent
- Effectively, a single platform-independent type system
- International standards
- Relatively simple
- Freely available
- Supportive of loose coupling

In consequence, there are three standards utilized by web services:

1. WSDL (Web Services Description Language)
2. SOAP (Simple Object Access Protocol)
3. Universal Description, Discovery and Integration registry (UDDI): this standard is just being used for service publishing and discovery.

Service-oriented architectures are not new. The first service-oriented architecture for many people in the past was the use of the Distributed Component Object Model (DCOM) or Object Request Brokers (ORB) based on the CORBA specification (Common Object Request Broker Architecture).

BEA Systems, Inc. is a complement to Oracle Corporation, which specializes in enterprise infrastructure software products known as "middleware", which binds software applications to databases. The name of the company is an acronym for the names of the three founders of the company: Bill Coleman, Ed Scott and Alfred Chuang. Produces the Aqua Logic software package to run service-oriented architecture (SOA). The BEA system published two articles on SOA to explain how they established it in some government (for example, the Basque government in Spain), they began the article defining the problems of the government and how they solved it. Their problem was that they had thirteen departments in a single government and each department tried to develop its own website individually through its specific software, and the number of websites confused the citizens. In the end, they developed a unique SOA-based website to solve these problems.

In Ireland, Reach Agency is responsible for developing a strategy for the integration of public services. They developed PSB (Public Services Broker), which is an integrated set of electronic processes, systems and procedures based on a service-oriented architecture (SOA) approach to the e-government infrastructure [26]. However, none of these studies provides sufficient information on how the SOA-based complaint system should be used in e-government.

2.5.1   History of using SOA in e-Government

- **Basque government**

BEA System Company [18] defines business challenges in Basque government and how they solved it via a system based on SOA. The Basque Country received the status of historical region within Spain with the Spanish Constitution of 1978. The capital is Vitoria-Gasteiz (Vitoria is the name in Spanish, Gasteiz in Basque) and Bilbao is its largest city.

Before using the new system, all Internet activities of the Basque government were channeled through two websites. The first was "www.euskadi.net" that creates awareness of the Euskadi region and the second "www.ej.gv.net", was designed to provide services to citizens and companies. There were some hidden problems behind this system. The first problem was that both citizens and organizations found it difficult to find the appropriate website to communicate with the administrator. The second problem was who was related to the departments that provided services through "www.ej.gv.net"; Due to the variation of the interactions between departments, each department tried to raise the profile of its own area of interest online by providing services based on separate applications. This did additional work and resources for the administrator. To solve this problem, a government IT and telecommunications plan for the development of infrastructure is required in three models:

- Internet presence model
- Transaction processing model
- Citizens' support service model

For the first model, the Basque government must make its resources available to citizens and businesses through the self-service government environment; In the second model, it is important to know how users interact with the administrator in terms of processing or application procedure. To solve this, the government needed a framework for online registration and digital signature. Finally, the third model, the administrator must define how to communicate with citizens and businesses. As a result, the administrator needs a multi-channel support for communication.

When the framework was established, the governmental IT organization in the Basque Government defined the tools and technology that was "Eusko Jaurlaritzaren Informatika Elkartea (EJIE)". EJIE is the public organization that is responsible for the execution of all information technology programs in the Basque Government. The main task of EJIE was to

facilitate the continuous exchange of information and services so that the 13 departments could work efficiently with each other and with other autonomous organizations and public organizations. As a result, Basque government departments are no longer developing their own customized digital administration services. This translates into a significant decrease in the Basque Government's general expenses [18].

When the researcher investigated the history of the Basque government website (http://www.ejgv.euskadi.net), he found some advantages and some disadvantages: first, when you try to navigate on this website, you will discover that this website is developed only for two languages, Basque and Spanish, none of which is English. Therefore, this website will not be useful for foreigners. On the other hand, this website is completely based on SOA. You will not see any difference between the pages of each department. It is an easy-to-use website where you can easily find the right department and service, even if you are not familiar with the Spanish language.

In conclusion, the researcher believes that adding the English language to the pages could be more efficient, although many Basque citizens can speak Spanish there may be some new migrated citizens who also need to obtain services. Hence why these few migrant citizens need to put English on most pages.

2.6   Background of Complaint management

Most user complaints are evident when a system has inappropriate communication between organizations, their employees and their customers or citizens. Poor communication can cause the organization or the government to provide poor services or products. While focusing on the issue of complaint management, organizations can achieve an efficient success factor by increasing user satisfaction and loyalty. Therefore, each organization needs to develop its internal and external communication towards its staff and clients to achieve a success factor. Although proper communication can reduce user dissatisfaction; it cannot eliminate the complaint.

From the researcher's point of view, complaints create an opportunity for systems to develop indirectly. Therefore, we can consider the handling of complaints as part of the development of the system.

According to a report published by the Better Business Bureau board [9] among the main reasons for consumer complaints, product services, for example, poor product quality, poor support services, late delivery, etc. In this study, they reveal that in some organizations, complaints are considered an opportunity to rectify their problems.

As a result, complaints should be used as a means to signal management procedures so that they can be improved; Personnel control and staff expectations are necessary, responding efficiently to cases of dissatisfaction, using the suggestions of users as a consultant.

2.6.1   Complaint definition

Each organization has its own definition of complaint; define the complaint related to the services provided to the user. Therefore, the definitions are different because of the variety of services between the organizations.

With reference to the Business Dictionary [19], a complaint is an affidavit filed by a party (the plaintiff, petitioner or plaintiff) before a court to initiate litigation against another party (the defendant, the defendant or the defendant) in a lawsuit civil. The complaint establishes the alleged grounds (allegations) for the case and the request for granting reparation (damages) or recovery of an asset, such as money or property. In criminal cases, the complaint is filed by the prosecutor or a government official; It is also called a petition.

In general, the complaint can be defined as an explanation of product dissatisfaction, services by the client or client. The purpose of any complaint process is to correct the reason for the complaint to turn the dissatisfied user into a satisfied user. For this purpose, the complaint management system must address the complaint as soon as possible.

Therefore, an adequate complaint management system is a system which can cater complaints quickly and, if possible, resolve the source of the complaint. The system also needs to increase the relationship between customers and suppliers. For this purpose, the system should improve the reliability of the service provider for the user and finally improve the level of user satisfaction.

According to complaint handling guidelines for trades [20] we have five important elements of complaint handling:

- Commitment: A good complaint management system must have a commitment at all levels of the organization. All levels of organization must accept that the client has the right to complain about what bothers them. They should consider the true complaints and respond to them.

- Fairness: The system must be fair and efficient, which is also fair for both parties. The complaint management system must be independent of both parties to the complaint and must respond to the complaint with all the details. In addition, the system must be fair in response and find reasons for complaint. Therefore, all opinions must be considered and taken into account with fair decision making.

- Effectiveness: to be efficient, all resources should be available to the system. For example, the person who answers is the one who makes the decisions and must have the appropriate capacity for this role. This can ensure that complaints are processed quickly and the complainant receives the answers quickly.

- Accessibility: the complaint information must be available and easy to understand. The system must be accessible to the client and must be easy to use for all users (easy to use). The method and policies of written complaints should be clear and should be publicized to clients and staff, should also be accessible and easy to understand. In addition, these methods and policies should avoid resistance or discourage the user from filing a complaint.

- Accountability: All complaints and their results must be recorded and stored in the system.

The operation of the complaint management system should be reviewed and adequate reports should be written or saved regularly. After that, the systematic problem must be recognized and resolved. Finally, the results should be viewed to see if they meet the community standards or not. The system must be clear and the decision-making or repair must be open. The responsibility for the proper functioning of the system should apply to both the plaintiffs and the organization.

2.6.2   Benefits of Complaint Management

How can complaints be effective in making decisions? Many organizations try to predict the challenges they will face when establishing a new system; consequently, they can avoid the unacceptability of the system by the users. It is obvious that it is impossible to predict all the challenges before they happen, since acceptance of the user's technology depends on many areas. The environment and culture are some examples that affect user acceptance. To be usable in line inputs to determine changes in urban subsystems, they must respond quickly and sensibly to the changing perception of the citizen of the gap between goals and actual achievements. Indicators aggregated over long time intervals, large physical areas or population groups tend to be slow and historical. It shows how unsolicited complaints and comments from citizens can help define such operationally useful social indicators [10].

In addition, the researcher believes that the government or any system needs feedback from users to discover the challenges after running the new system. The comments of the users can be considered as complaints and suggestions, which can be implemented in the organization to improve their services and products.

Ezra [10] believes that the signals that come from citizens exist in several ways. For example, in New York City, the mayor's action centre is a twenty-four-hour operation that processes 200,000 phone calls and 5,000 letters per year from citizens who complain.

How do companies respond to customer complaints effectively and how can they absorb user satisfaction with respect to the services or the system? The way in which companies resolve customer complaints behaviour has been considered a strategy of "defensive marketing" or a "strategy of zero defections", which can reduce customer dissatisfaction [21].

When we talk about the advantages of the system in terms of users, most of the research focuses on the concept of user satisfaction. However, many investigations deal with this issue, one of the important issues in terms of users is; User dissatisfaction that has rarely been investigated. According to research conducted by Cho and Hiltz [21], customer complaints online, such as web-enabled market feedback, have illuminated the origins and causes of online customer dissatisfaction. Also in terms of business and governments, an online customer complaint shows the importance of users for that organization or government. The importance of users to the system can make some users satisfied with the system. Therefore, through the complaints

of online customers we can increase user satisfaction and, on the other hand, by responding to complaints we can reduce dissatisfaction and increase loyalty.

Electronic customer relationship management (e-CRM) is gaining the attention of e-business managers who are interest in increasing repeat business and customer loyalty [4]. With reference to Cho and Hiltz [21], CRM has four key components which in figure 2.1 have been shown and following the figure, each component described in detail.
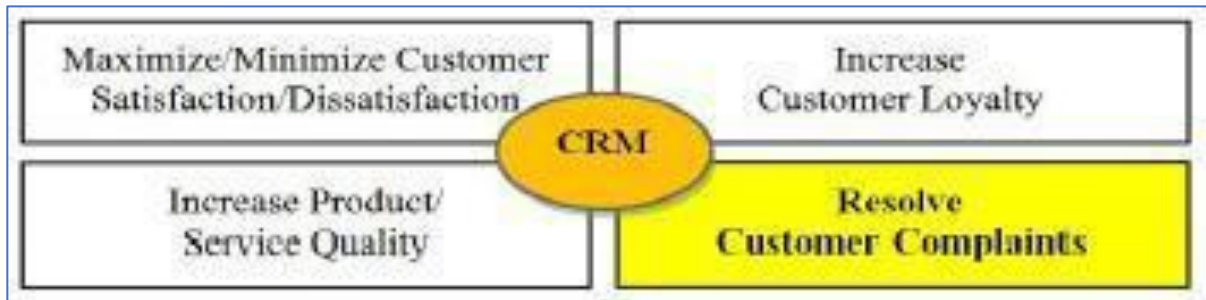

Figure 2. 1 Key components of e-CRM

i. Maximizing/minimizing customer satisfaction/ dissatisfaction:

In the real world, it is easier to think about how we can increase satisfaction than how to decrease dissatisfaction. In general, satisfaction and dissatisfaction are acquired when users are satisfied with the quality of the products and services. When users refer to a system, they are looking for some expectations within the product or service of the system, the way in which the systems respond to the users or the requests of the users can be a reason for satisfaction or dissatisfaction. Customer satisfaction or dissatisfaction depends in large part on how much the client's expectations differ from the actual performance of the product or service, what traditional marketing specialists call the degree of disparity resulting from the customer's lack of confirmation of expectations [22]. Cho and Hiltz [21] believe that the dissatisfaction of online customers is the result of unfulfilled expectations about a product, the problem of technology; and / or web evaluation factors, which include information content, personalized product information, convenient post-sale assistance, privacy issues, fast and accurate delivery. Similarly, according to customer metrics, customer satisfaction online depends mainly on delivery time, delivery speed, product or service introduction and convenience.

ii. Increase product / service quality:

It is stressed that the successful management of claims of a company requires a quality assurance department (QA) to provide quick information to improve the general perception of

the client about the quality of the product and the service [23]. Now the question is how online products and online services can evaluate the online business. It is obvious that with user satisfaction about online products and online services sales will increase and, on the other hand, if we have a complaint, sales will be reduced. For example, if users are satisfied with a product, they will not address the use of products from other producers to find a better one. However, if the product cannot satisfy the customer definitively, it will look for a better quality and price that as a consequence can diminish the systems ' client.

iii. Increasing customer loyalty:

Cho and Hiltz [1] encouraged the use of complaints to improve communication channels between buyers and sellers in general, and as a specific means to convert dissatisfied customers into loyal customers who repeat. Although the complaint shows dissatisfaction about the service or product, responding well can make the user satisfied and loyal. The point is that the user, who was satisfied after receiving a complaint response, is generally more loyal than the user who was satisfied from the first day. Complaints can be an advantage in business because proper handling of complaints can be a key factor in business.

iv. Resolving customer complaints:

In solving problems and increasing performance, the key component is the complaint, according to [21] the presentation of complaints is done in two ways:

1. Directly sent from the user to the organization or company.
2. Indirectly through public comment or non-profit websites, just as an example, the bbbonline.org site managed by the non-profit business office (BBB)

Based on a CRM researcher, it tried to generate a model with the establishment of a complaint system based on SOA in e-government. The government departments can get feedback from the user through suggestions or complaints. This can help the government improve itself and try to be more adopted with the citizens' expectations of e-government. However, to date some models of customer complaints behaviour have been proposed online, Cho and Hiltz [21] have identified a model to analyse the study of online complaint behaviour. These technological factors were identified as the performance of the system; They believe that web evaluation factors and other media characteristics are the main causes of the behaviour of customer complaints. When considering the model below (figure 2.2), it can see that the web evaluation

contains information, agreement, and settlement components that can be used to evaluate customer claims online.
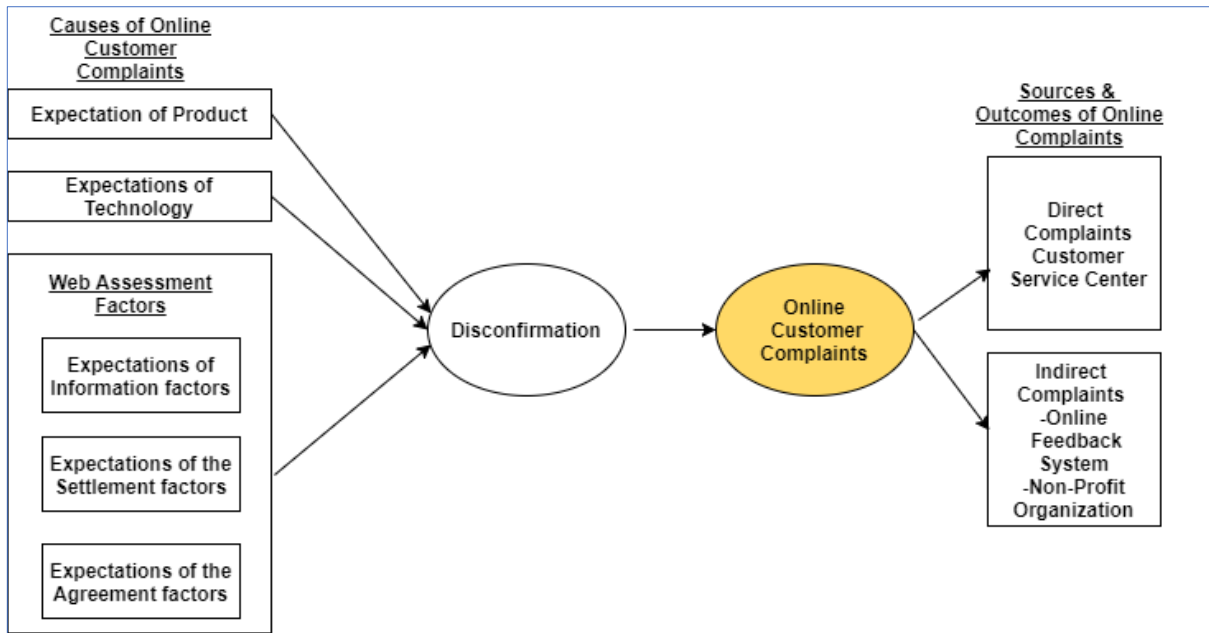

Figure 2. 2 Complaint handling model [21]

Follow-up research by Cho and Hiltz [21] causes customer complaints online is more likely to be triggered by problems with customer service rather than product failure. In addition, online customer complaints based on information failures are greater for sensory products than for non-sensory attributes. Therefore, Cho and Hiltz did an analysis on the feedback system complaint that the result is surprising; in table 2.1 below, results can be seen.

Causes of complaints	Classification in	Example of actual responses*	# of reviews

	Web CCB model		(%)
Customer service (i.e. contact possibilities, after-sale services, technical support)	Settlement factor	Unresponsive to requests for assistance; longer than average waiting time; unfriendly technical support	169 (33.8%)
Product (e.g. quality performance, etc)	Product factor	Product changed/ poor quality; freezes occasionally; poor video acceleration; underwhelming performance, speakers stop speaking periodically	131 (26.2%)
Price	Product factor	Expensive, pricey, be vary of their financing program, interest rates are insanely high	89 (17.8%)
Delivery problems	Agreement factor, Settlement factor	Long delivery time; shipping contributes a lot to the cost.	75 (15.0%)
Misleading information	Information factor	Hardware was not as good as advertised	10 (2.0%)
Security and trust issues	Agreement factor	Believe that this company rips people off	9 (1.9%)
Tracking and tracing	Settlement factor	The site did not provide the order status	9 (1.9%)
Promotion	Information factor, Agreement factor	Very fes "buy computer-get printer" offers	8 (1.6%)

Table 2. 1 Analysis on complaint results

Taking into account the previous results, it can easily discover that the majority of complaints come from customer services (33.8%). This shows the importance of the complaint in e-government, especially in the e-government websites of the service base. In a system like the government, we have two main parts, the governing body (departments and personnel) and electronic websites. However, a large part of citizen complaints is related to the government's electronic services, some complaints come from government personnel who have interacted with citizens to provide services. On the other hand, many citizens prefer to send their complaint to the reliable department where they can follow their complaints safely. Therefore, it reveals the importance of online complaints from government personnel in the electronic government system, a web-based service that sends complaints to a specific department to investigate or inform the department of staff complained about and hold them accountable. respond to complaints.

2.6.3   Complaint Handling System Procedure

In general, there is no single way to develop the systems, since the complaint handling procedure of each organization depends on the nature of that organization and, on the other hand, its nature has been affected by its services and products or the patron of the client. Therefore, organizations try to reveal new methods to improve the system and its impartiality on a regular basis.

The complaint management system needs to be structured, efficient and easy to use. The most essential factor to increase or decrease customer dissatisfaction is the speed of response. The plaintiff must be sure that his claim will be investigated fairly and quickly. Therefore, the system must be monitored to ensure that complaints are handled appropriately and fairly.

According to office of consumer affairs [24], compliant handling system procedure can be identified as below:

1.   Designate the location to receive the complaint: at this level, you must specify the strategy and the environment (place) to receive complaints from users. Clients should be informed about where and how they can file a complaint; the system should encourage the user to express their claim and should also have a good view of the organization by the user.

2.   Develop a record keeping system: the organization should prefer the standard forms to register the classification and complaint database.

3.   Logging Data: The detail of the complaints and any data that is related to the complaint should be included to correct the problem in a better way. Just as an example, the time or place where the problem has accumulated must be included in the complaint.

4.   Investigating: A full investigation and review of the details based on the complaint must be conducted. In addition, the investigation can follow up the client if more information is needed.

5.   Acknowledging: Recognition should point especially when the process of investigation of complaints and response will take a long time. In this case, it is better informing the client about the time the complaint process will take. Also, when the problem cannot be solved, it is important to send an acknowledgment to the user.

6.   Formulating Solution: This level describes the ability to make a solution. The solution must be compatible with the department's policies.

7.   Responding: the answer must be understandable to the claimant. In addition, it must be clear and appropriate. All the problems that remained in the original complaint should be addressed in it. The answer must be an educated and understandable description of the decision; therefore, it is capable of preserving goodwill, even the decision is not pleasant. It is advisable to avoid specialized extra language.

8.   Following up: This is an important step to guarantee the effectiveness of the system. The customer can contact us to inform their level of satisfaction of the repair problem. Normally the customer not satisfied will send direct comments. Hence, the initial screening is activated immediately and then perform some actions.

9.   Report Preparation: The data of the complaint must be analysed and evaluated temporarily. Therefore, the complaint statistics and the action proposal can be distributed in the corresponding departments or it can also make an action plan for the prevention of complaints.

2.6.4 Importance of Complaint System in Organization

In most cases of dissatisfaction, customers do not complain about what bothered them, this can happen for these reasons:

- They do not have time
- It will cost them more to make a complaint, than the organization will reimburse them (if their complaint is accepted)
- They think they are not so valuable to the organization to address their complaints
- They do not know how to complain
- Cultural problem (in some countries people are more patient)
 - Fear from vengeance (in case of complain from person)

Refer to a survey conducted by the International Technical Assistance Research Programs Inc.in Customer Complaint Handling in United State [25]:

- About 50% of the time, customers who face a problem with a product or service prefer not to inform the company what are the faults with the product or services.

- Nine out of ten of these customers (Silent Critics) will take their future business to another competitor's company.

- Even when a customer complaints, one in two will not be completely satisfied with the company's effort to solve the problem.

- The dissatisfied customer usually has between seven and nine people when they have had an unsatisfactory experience with a company.

- Negative feedback has twice the impact of positive comments on purchase decisions. (In general, clients prefer to pay attention to negative advice instead of positive advice).

- Word of mouth is one of the best forms of advertising to influence the customer's decision to buy from a company.

In this investigation, they proved that clients generally do not complain because they believe they do not have enough time to spend in the claim process; they do not know the grievance

procedure (how and where to complain); They think that complaints cannot change anything since they do not have faith in the company. These average customers are not sure of the value of their claim and the ability of the company to solve the problem fairly. Hence, consumers prefer to withdraw their purchases from that company and start criticizing other companies or organizations. In short, the vision of the company will change and, consequently, the loss of the market.

In conclusion, the complaint can be considered as a valuable management tool for the organization to verify the performance of its personnel, services and products. The organization can use the information of complaints in the structuring of educational programs and develop strategies to cover the defects in terms of providing services and professional actions. Therefore, the handling of complaints is one of the success factors for effective systems and organizations. If the system could sustain complaints and then respond effectively, the system could increase your vision and customer loyalty. Generally, in government services, these advantages appear in the form of public trust.

2.7   E-CRM

Electronic Customer Relationship Management (e-CRM) is gaining the attention of e-business managers who are interested in increasing repeat business and customer loyalty [4]. CRM has four key components [1] as shown in above figure 2.1:

Information about complaints should be shared among the departments within a company and even other companies throughout the supply chain. The companies of best practices have realized that the use of the CRM strategy solves the problems expected in the implementation, such as the management of all the information of the complaints and the definition of the relationships between the different complaints.

2.8   E-complaint

Each organization has its own definition of complaint. They define the complaint related to the services they provide to users. Therefore, the definitions are different because of the variety of services between organizations [5]. The customer complaint behaviour defined as the consequences of customer dissatisfaction [7] has long been considered an important form of market feedback [2]. In other words, the management of customer complaints is becoming a

key factor of key success in today's business environment. The complaint management system is a system that can survey the comments of customers about any organization. Best practice organizations consider complaints as opportunities for improvement. These companies understand the link between the resolution of complaints and customer loyalty and work hard to act immediately on problems that can be easily solved. In addition, the researcher believes that the government or any system needs feedback from users to discover the challenges after running the new system. The comments of the users can be considered as complaints and suggestions, which can be implemented in the organization to improve their services and products.

2.9   Conclusion

In this chapter, the researcher tried to explore past research and efforts on e-government, SOA and e-complaints. In terms of e-government, most of the research focused on the advantages of e-government and how to develop good e-government. There was some research related to the application of SOA in electronic government, although none of these investigations pointed to the application of SOA in the electronic reporting system.

In this review, the researcher also explored past research on the complaint system and success factors to increase user satisfaction. The researcher discovered that most of these success factors are based on increasing user satisfaction instead of minimizing user dissatisfaction, although the electronic claim system can play an important role in minimizing user dissatisfaction. In reviewing the complaint management literature, the researcher found some complaint management models, but none of these models was based on SOA [5]. Therefore, this study is significant to decrease the dissatisfaction of citizens when using SOA in the electronic reporting system. SOA can help make the electronic complaint system easier and more efficient. Therefore, with SOA we can easily change the interface of our electronic claim system in minimum time and cost.

Chapter 3: Innovative Application: Methodology

3.1 Introduction

This research project is an innovative type application which provides solutions to the current deficiencies in complaint handling process of government departments. This chapter explains the aspects relating to the proof of concept specification which includes process flow diagrams, design assumptions relating to the scope of the proof of concept, prototype architecture and algorithmic design details.

The management of customer complaints is becoming a key factor of measuring success in today's business environment. A complaint management system is a system that can survey the comments of customers about any organization. Organizations that follow best practices consider complaints as opportunities for improvement. These companies understand the link between the resolution of complaints and customer loyalty and work hard to act immediately on problems that can be easily solved. Since customer complaint management is a large area to improve, a large amount of research must be done to arrive at an adequate solution. This chapter presents the methodology adopted by this dissertation. The research project has been conducted in two stages; literature review and implementation.

In literature review part, the concept of e-CRM, e-complaint and SOA are explored. It was stressed that not only Sri Lanka but also other countries are investing a lot in this issue. There are some websites researched in Appendix B (Investigations in other countries) that are outside of Sri Lanka, including the Basque Country, Ireland, the United Kingdom, the United States and Iran. No complaint system based on a single user interface was offered to customers to complain about government services. However, many of these websites have developed some methodologies to get suggestions from users, it is completely different from the concept of complaint management that has a single interface. Web resources, web publications, web journals, e-books, online forums, online discussions and web site surfing have been utilized for collecting data and gathering information.

In implementation part, a new model is presented, the implementation of new model is discussed, testing and evaluation of the prototyped model is discussed. Figure 3.4 demonstrates the prototype architecture; prototype consists of four parts; web portal for customers (citizens) to make complaints, BPEL layer with SOA orchestration routing to different departments, SOAP based mocked web services for selected departments which are tracing complaint handling, mocked web portal for department staff to update or interact with complaints made

by citizens. The front end of mocked web portals was implemented and tested with Spring framework, Java EE, JSP and JavaScript. BPEL layer with SOA orchestration, the core logic of the prototype is the SOA architecture which has been developed using WSO2 BPEL (Business Process Execution Language), deployed in WSO2 BPS (Business Process Server). Using web portal of BPS, all the BPEL workflows are tested.

For the selected department SOAP based mocked services, Java language used and for the data tier MySQL used to save, update user data and complaint data in databases. By using SOAPUI, SOAP based mocked services are tested.

3.2   Process Flow of Complaint Handling

First, this section describes the process flow diagrams (PFDs) of the proposed model in terms of conceptual design. There are two PFD levels described; PFD level 0 which is the context level and PFD level 1 which is the whole system view. In PFD level 0, it describes the system using the component diagram and the conceptual diagram. In PFD level 1, it describes the whole system which consists of four pars; User process, User complaining process, Complaint routing process and Department complaint handling process. Secondly, it describes the design assumptions of prototype developments. Thirdly, it is the prototype architecture being described.

3.2.1   Conceptual Design -Process Flow Diagrams of Presented Model

1. PFD Level 0 (Context Level)

Following figure 3.1 describes conceptual model which consists of three main areas of system; end users' web portal, common complaint handling component and separate government departments.
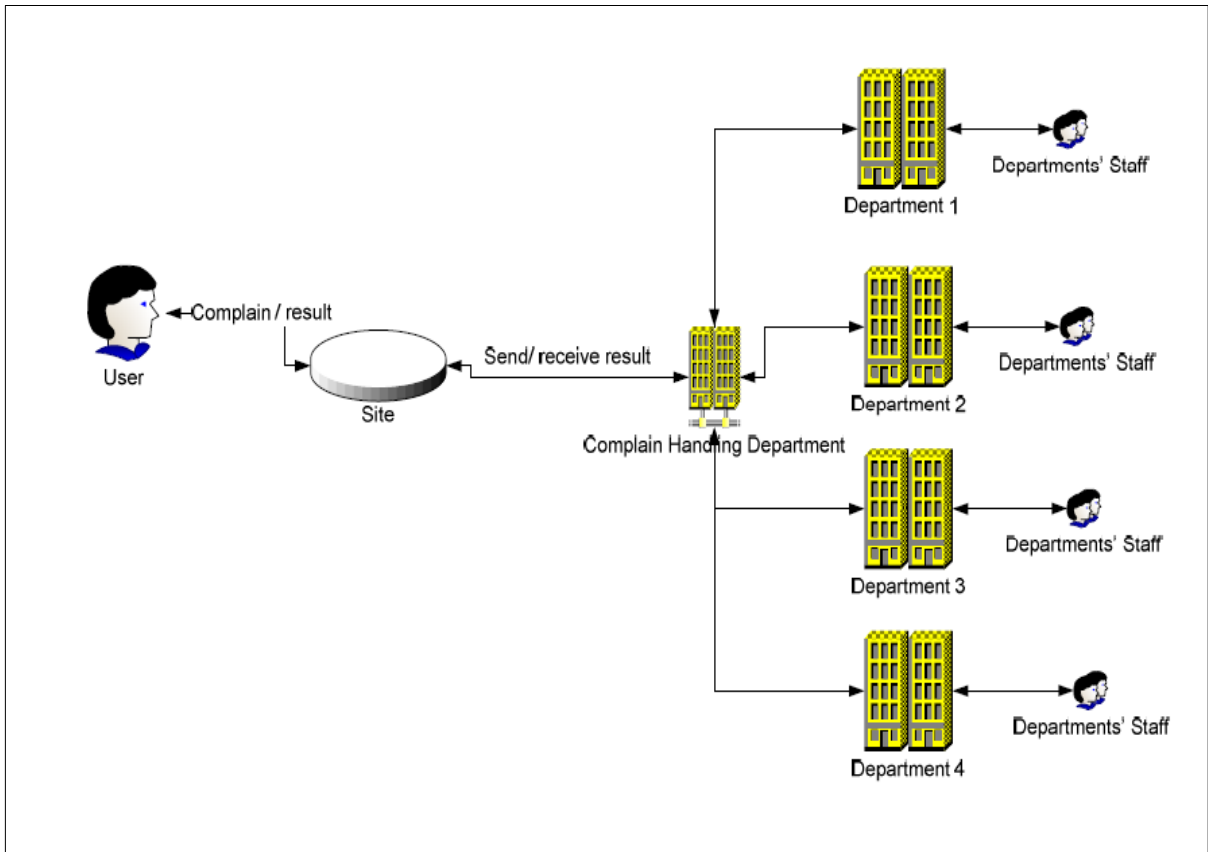
Figure 3. 1 Conceptual diagram of complaint handling process

According to Figure 3.2 below, citizens in the first step must log in to the system. Then he would request for making complaint against government department service. If the citizen has got the permission to make a complaint, then system will send a complaint form and plaintiff must fill up complaint form with all details and send it to Complaint Handling Department (CHD). CHD will ultimately route the complaint based on its type to a relevant department.
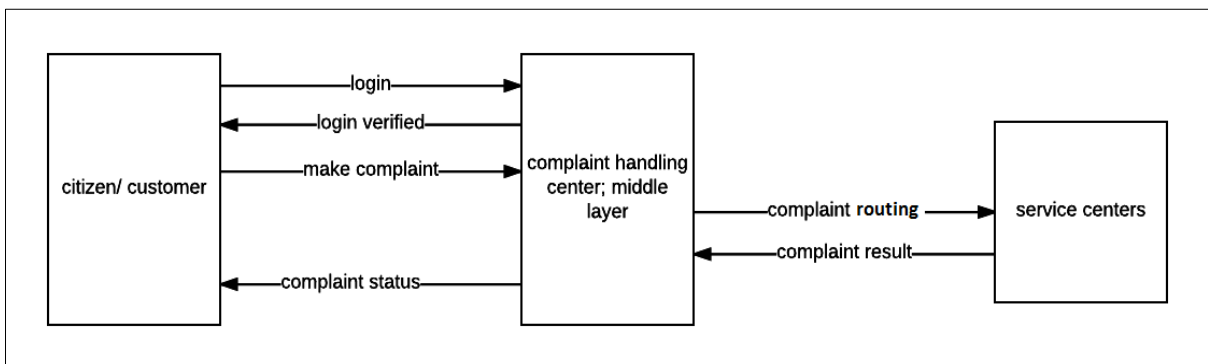
Figure 3. 2 Component diagram with high-level flow

2. PFD Level 1 (Whole System View)

This level shows the whole system view. As the figure 3.3 shows, this model involves in four main processes:

1. User process
2. User complaining process
3. Complaint routing process
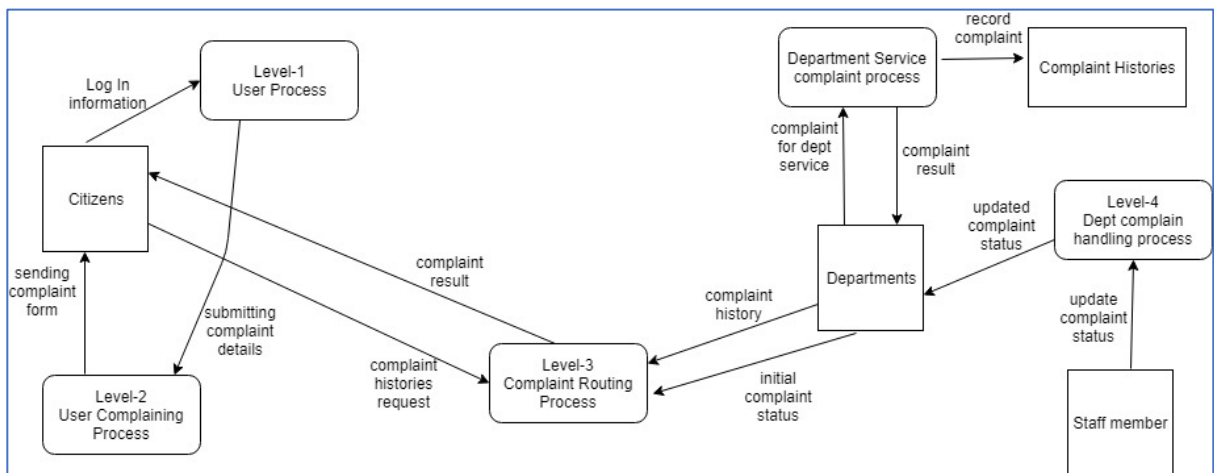4. Department complaint handling process.

Figure 3. 3 PFD level 1

1. Level 1-1 (User Process)

This level considers the user's initial step to the web portal. Before beginning actual process, user should sign in to the system. User enters username and password, after that user will be authenticated and permitted to proceed with complaining.

2. Level 1-2 (User Complaining Process)

After user has logged in, user will get permission to get complaining services. In home page, user will be shown the complaint history where it can see all the complaints it has lodged so far. User can also lodge a new complaint and just after submitting, it will see the submitted complaint's details with complaint number and status.

3. Level 1-3 (Complaint Routing Process)

When a complaint is submitted, they are classified according to the complaint area which the customer has chosen and based on that it determines the related government department. Each complaint will be sent to specified department for resolving.

This level is also responsible for getting the status of complaint upon the status change from the department end. When it receives the complaint result, it will inform customer about the result. While the complaint is under process, user can request the complaint status by viewing all complaints. Complaint process will send complaint process status viewing request to department and after receiving complaint result, it will be sent to citizen.

4. Level 1-4 (Department Complaint Handling Process)

When a complaint is received to the department, it initially set the status as pending, assign a reference number to the complaint and persist the complaint details in department database. After that, it returns the complaint reference number and status back to the client. Then, the complaint is analysed, investigated and staff member will update the complaint status from department web portal. Finally, customer will see the updated status through the web interface.

3.2.2 Design assumptions related to the scope of the Prototype

In this prototype, it has addressed only the mocked web services of government departments, but it is assumed that all government departments have exposed separate web services to handle complaints individually so that those services can be consumed via SOA. It is assumed that all the dissatisfaction matters of customers regarding government services can be addressed and solved by this system.

3.2.3 Prototype Architecture

According to the below figure 3.4, apart from the end users' web portal and department SOAP based web services, SOA layer is the core of this architecture. Service orchestration happens in SOA in support of complaint routing. For a better understanding, following figure 3.4 shows the service orchestration which happens in the proposed system.
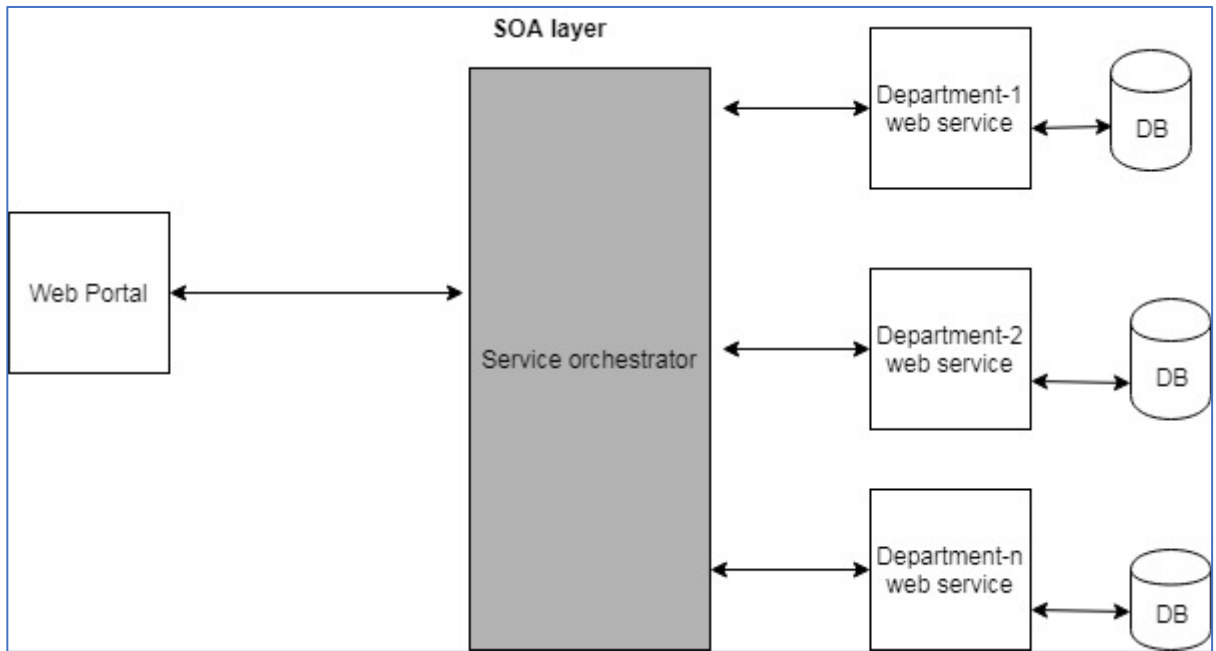
Figure 3. 4 Prototype architecture

Let us say a customer wants to make a complaint. As shown in below figure 3.5, customer accesses the complaint handler web portal to make the complaint by filling a form and submitting, which is sent to the orchestrator (the central BPEL engine) that then calls and invokes the relevant government department service. After orchestrator returns the response to web portal and user will ultimately see the response.
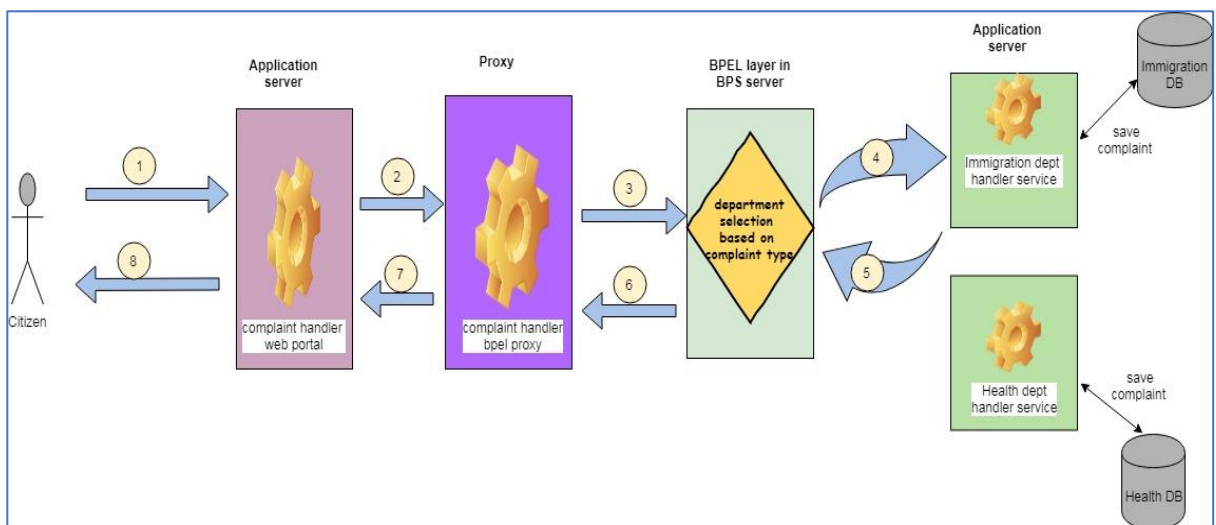

Figure 3. 5 Implementation flow for complaint submitting and handling

When viewing all complaints, as the below figure 3.6 describes, the request with user identification number goes to the orchestrator where it invokes all the departments' services to get complaints of that specific user. Since user might have a complaint history of many departments, it needs to invoke all the departments' web services to get the user's history. Complaint getter response in SOA comprises all the individual responses received from each government department. Orchestrator processes all individual responses from departments and make single response to be sent to the web portal who made the original request. Customer will ultimately be displayed all his complaint history.
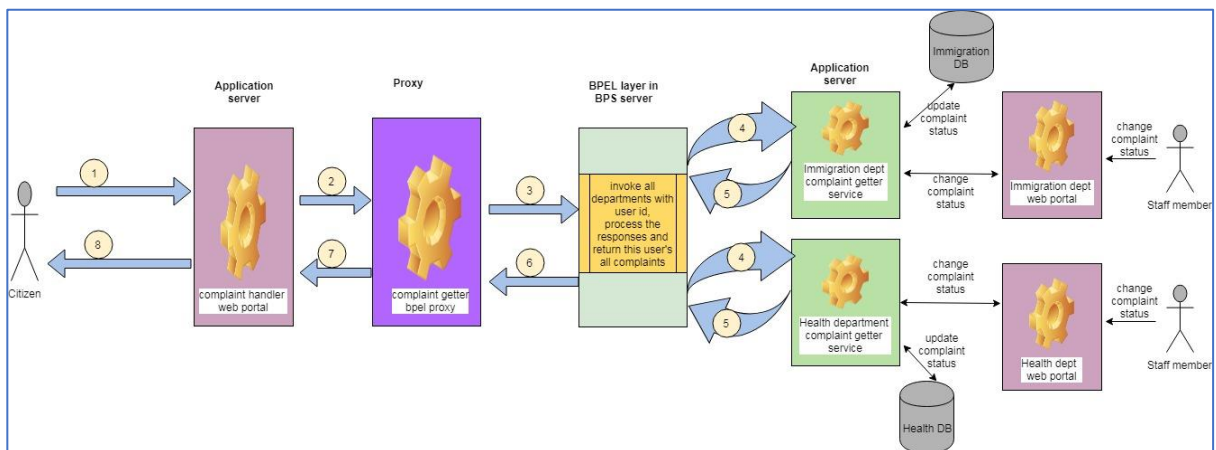

Figure 3. 6 Implementation flow for getting complaint history

3.3   Algorithmic Design Details

The past several years, there was an increase in the number of organizations including governments that use IT systems to execute and monitor their business processes in an automated fashion. It is believed that one of the key drivers behind this accelerating adoption of business process management (BPM) is the emergence of broadly accepted standards such as WS-BPEL for implementing and executing business processes.

Various activities are executed to implement the runtime lifecycle of the business process of complaint handling. BPEL is a Web services orchestration language. Process orchestration is when a central process coordinates the execution of different Web services operations. The central conductor (as in an orchestra) is aware of the overall goal of the orchestration, the operations involved, and the order of the operation invocation. This centralized management allows Web services to be added or removed without each being aware of its effect on others, as well as compensatory processes to be implemented in case of faults and exceptions. When

42

using BPEL for orchestration, the BPEL language provides a standard for controlling the overall sequence of operations, invoking services and executing on a BPEL server.

BPEL processes were constructed to coordinate the execution of steps. When a customer submits a complaint via the web portal, it comes to the SOA layer where the orchestrator routes that complaint to the relevant department based on the complaint type which the complaint belongs to and once the response is received orchestrator then process the response and send back to the web portal. This flow is demonstrated in below figure 3.7.
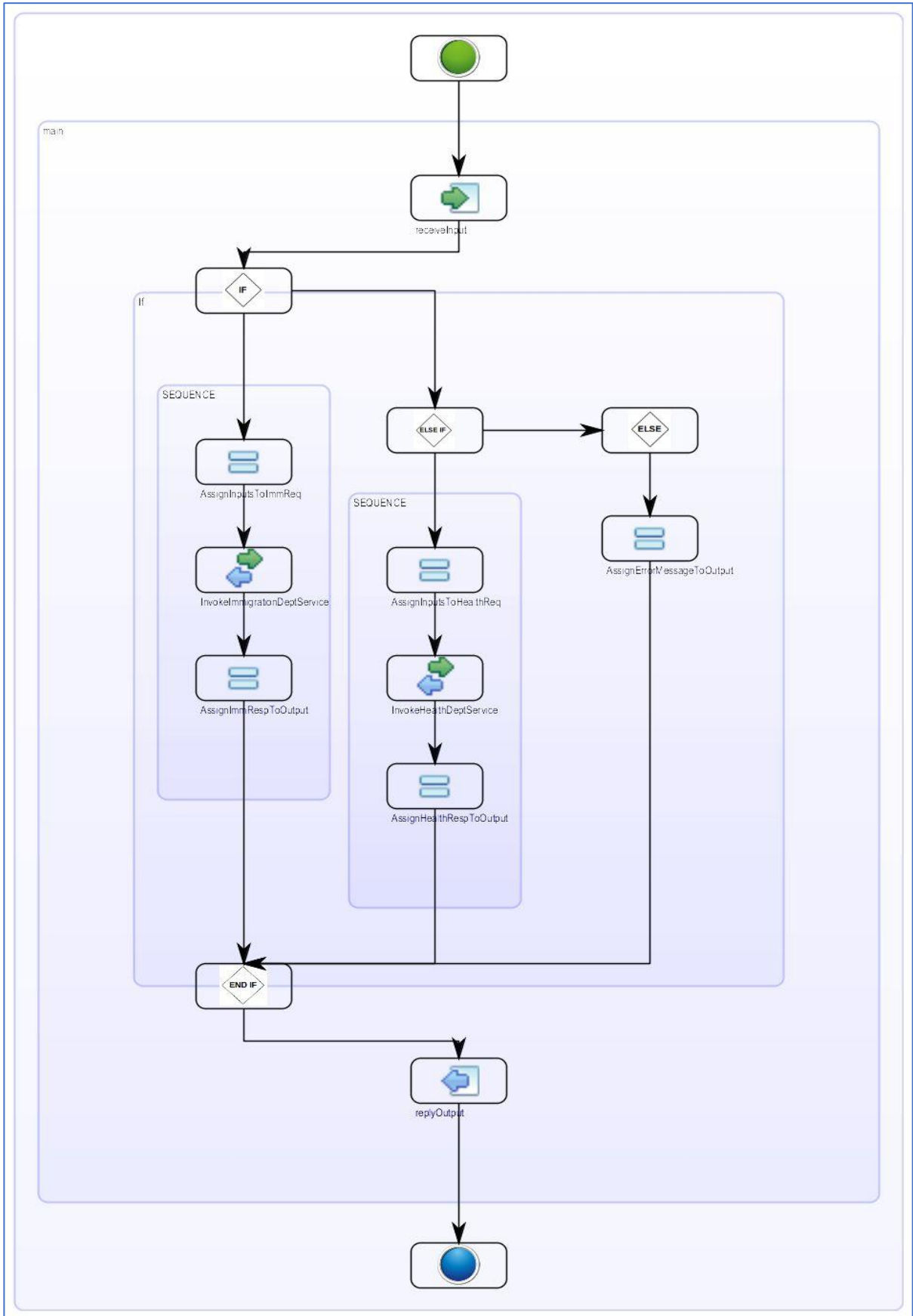
Figure 3. 7 BPEL algorithmic flow for routing complaints

When getting all the complaints of a particular user, the request comes to the SOA layer where the orchestration then process the request and invokes department services, receives the responses, process all of them and send back to the portal all the complaints of that user. the orchestration passes the data to the web portal. Figure 3.8 illustrates the flow. This orchestration assures that all activity happens in the expected sequence.
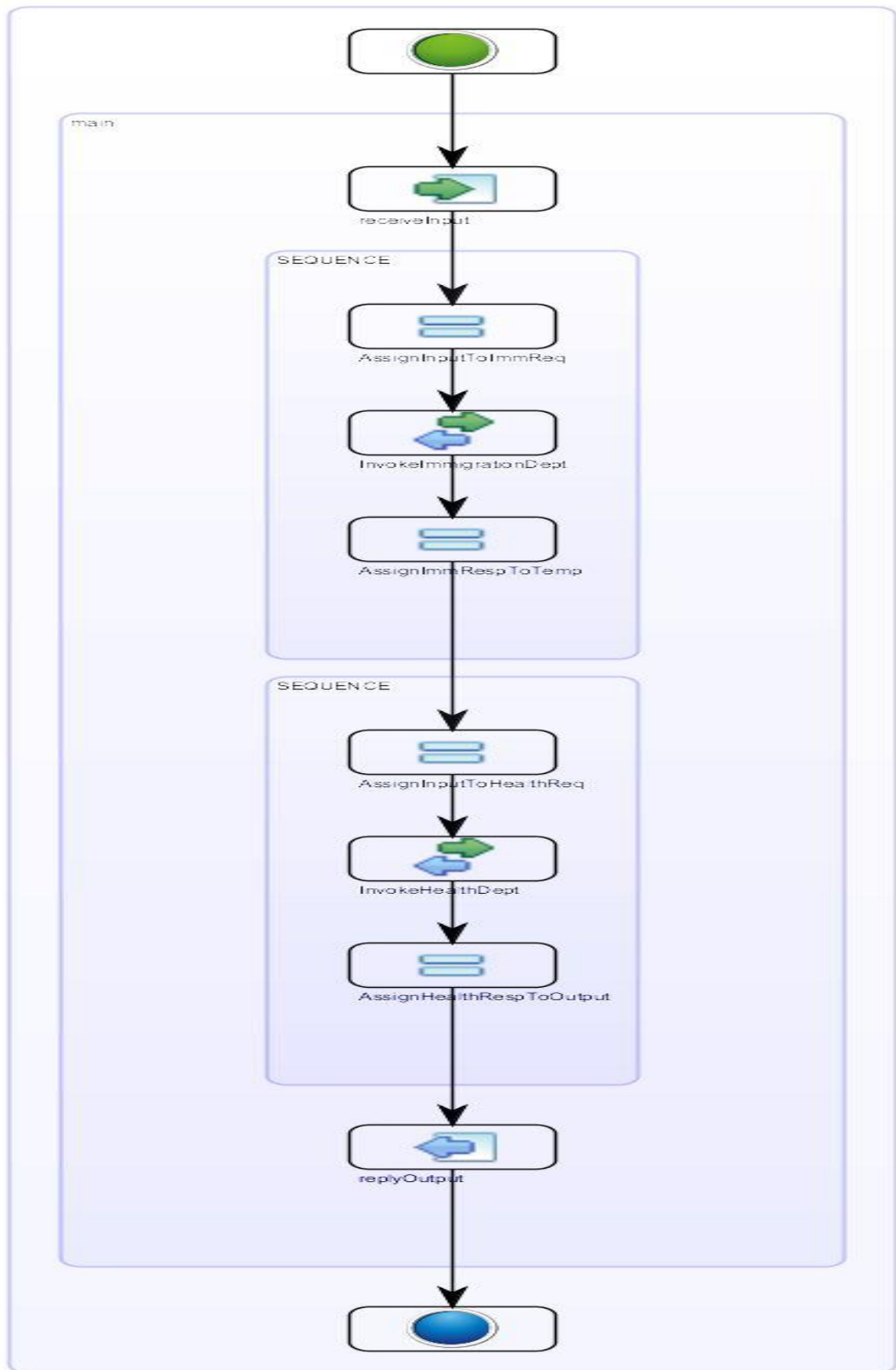
Figure 3. 8 BPEL algorithmic flow for getting complaint history

To manage and execute the flow of the complaint system, BPEL in SOA layer has some strengths over other system architectures. BPEL is a language which executes business processes. It provides orchestration services for the business processes. BPEL has been designed for long running processes and it has the built-in support for asynchronous interaction. BPEL is capable of fault handling and compensating transactions. BPEL is extensible; when a new department requires to be added, it just needs to add another if control structure within which service invocation and request response assigning happen. It uses a global link and departments WSDL to invoke services. For the citizens' web portal, it just needs to add the department to the dropdown with department code. Other than that, no changes required. This shows the simplicity of this model. If SOA does not there, then it may need to write clients to invoke the new department's service, to return to front end whatever the response receiving, to do the manipulations and lots of other work and configurations. In here, SOA takes care of all the work and it is the power of BPEL engine which can make the best use of orchestration. The system is loosely coupled and there is no any interruption to the current flow when configuring a new department to the existing system. In addition, BPEL can execute parallel flows and in complaint routing, it is executing conditional branching based on the complaint type

The breath of the system lives in the SOA layer which is designed and implemented with BPEL. BPEL is a powerful language that allows the development of complex business processes in government using Web services components. The BPEL process species which Web services should be invoked and the sequence in which they are invoked. The BPEL server tracks the business processes that are involved in a transaction; ensures that the steps are executed in the correct order; and manages transactions, compensation, and exceptions.

SOA layer is responsible for complaint routing to the relevant department. For complaint routing, it uses control structures in BPEL. BPEL supports all the control flow structures expected from orchestration: conditionals, variables, assigning data values, defining fault handlers and service invokers. The BPEL receive activity is used to define the events or messages that will create an instance of a business process when a client invokes it for the first time through a service interface. The process will then invoke other services, which are the activities in the defined business process sequence. Finally, a response will be generated to be returned to the caller.

In this system, according to the area of the of complaint which customer has selected through the drop-down list in complaint submit form, it will route the complaint handling to the relevant department; after that it invokes department's web service for complaint adding; then it receives the response form department web service and return to the web portal. Routing will be handled using if-else logic, and if the complaint area or type is not mapped with any condition, SOA will return a message saying no type mapped.

Apart from the main execution flows, along the way, the BPEL process manipulates data variables (assign), handle faults and exceptions (throw), or wait for a set period. Finally, the process can end (terminate) at any time. Structural activities include a BPEL orchestration that performs activities sequentially (sequence) or that performs activities in parallel (flow). If condition is one of the control flow activities used in BPEL in this SOA layer.

In SOA, it needs to invoke web services of different departments. BPEL supports service invocations of external parties. BPEL processes orchestrate services (partner links), which define the interfaces to the parties like service departments with which the process interacts. These partner links include both services that are invoked by the BPEL process and the interface through which clients invoke the BPEL process itself. Flexible binding of BPEL processes to the physical service endpoints can be done at design, deployment, or runtime. For the services described above, immigration department and health department are key partner links.

BPEL has rich support for asynchronous events. A BPEL process can wait to receive a message, or request, from a client (the same BPEL receive activity as used to initiate a new process instance) at any time [28]. The BPEL engine will handle the overhead of persisting the state of the process until the message comes in and correlating the message to a particular instance of the process, through either standard WS-Addressing or custom correlation mechanisms.

BPEL processes themselves can expose synchronous or asynchronous interfaces to their clients. Synchronous BPEL process operations block the client until the process returns a response to the client. Asynchronous BPEL interfaces can be one-way ("fire and forget") or return a response to a client via a call back. Asynchronous processes are more commonly used for longer-running operations, and synchronous processes are more commonly used for shorter-running operations.

In the implementation of the system, researcher used the available service orchestration pattern which is implemented in SOA layer. Orchestration Engine is the core worker of the SOA layer which coordinates the external service invocations and response manipulations. This engine

specifies the control and data flow associated with an orchestration explicitly, using a standard language such as BPEL that can run on an orchestration engine. The orchestration engine provides infrastructure services such as audit trails, persistence of long-running flows, common exception handling patterns, and so on. This infrastructure is helpful in trouble shooting and monitoring the process flow.

3.4 Information Gathering

For the meaningful building of the project, gathering of information was an essential item. This was achieved by surfing the web resources; web journals, web sites, research papers and blogs. The total information gathering was conducted in two phases:

First phase: Research was carried out to find out what citizens expect from a complaint system in terms of e-complaint. Aim of this part is to explore citizens' needs from a complaint system as a main target for decreasing citizens' dissatisfaction.

Second phase: This part represents state of e-complaint in Sri Lanka compared to other countries e-organization websites. This section looked at various surveys on governmental/ organizational websites in Sri Lanka, Malaysia and United Kingdom. This was then followed by probing Sri Lankan e-government websites.

3.5 System Development Methodology

After series of review on available research methodologies, researcher found that a web portal with simple interfaces would be appropriate for any customer regardless of the social and education level.

Total system development includes two phases:

First phase: Researcher tried to represent a model based on SOA for e-government in this section. This phase also included a front-end development while concentrating on the user's needs in order to show a sample interface for this complaint system.

Second phase: When data and information collection phase started, set of needed information was decided and data capturing commenced. Then, back-end development started. MySQL was used for database transactions. For back-end of the mocked department services, researcher used Java. For front-end tasks, researcher used Spring MVC and JSP.

The reason for using MySQL was its advantages in security and portability, because in MySQL all password traffic is encrypted connecting to a server, therefore it has high security which is critical in as such projects, also MySQL works on many different platforms; APIs for C, C++, Eiffel, Java, Perl, PHP, Python, Ruby, and Tcl. The researcher is familiar with Java and JavaScript therefore this advantage in portability could help researcher to use different languages for resolving the problem. Having scalability and limits, easy connectivity, support for localization, high availability of clients and tools are some other advantages of MySQL.

Chapter 4: Analysis, Design and Implementation

In this dissertation researcher developed a model in terms of electronic complaint system based on SOA which can support governments' complaint handling process. In this model, researcher created a separate organization as a main department (Complaint Handling Department) to get, process and follow up complaint response. The main advantage of this model is simplicity of making a complaint for users to complain from what has irritated them. It can also cover any part of government which wants itself or its staffs to be complained about.

4.1   System Analysis

Complaint handling process of Sri Lankan departments was thoroughly analyzed and further it was extended to other countries as well. There are some websites investigated by researcher in Appendix B (Investigations in other countries) which are out of Sri Lanka including Basque country, Ireland, UK, USA and Iran. Through these researches, the answers for the following questions were analyzed before the design.

1. What is the relationship between e-government or e-organization effectiveness and e-complaint systems?
2. What is the benefit gained by citizens when there is only one web portal for complaints handling over separate web interfaces for each department?
3. What are the processes, needed for establishing complaint system based on one single user interface?
4. What is the status of complaint system in e-governments or e-organizations, and what is Sri Lanka's e-government (in terms of complaint system) standing compared to rest of the world (countries such as Malaysia, United Kingdom)?

Upon the analysis, it was revealed that there was no any complaint system based on single user interface which is offered in support of complaining about government services. However, many of these websites have developed some forms to get users suggestions, it is completely different from the concept of complaint handling having single interface.

Based on the findings, following are the use cases identified by the researcher.
I.   Complainant or plaintiff - Login to the web portal, make complaints, view all complaints with status.

II.   Department staff member **-** Login to the department web portal, manage complaints' causes and actions then provide solutions and update them in the system.

Use case diagram will further be discussed in detail in 4.2 system design section. To cater to the use cases identified, conceptually system was designed with the components in the diagram shown in figure 3.2 in chapter 3 – innovative application methodology.

The development of the proposed model does not only depend on how the system works but also depends on the working flow process that being identified and need to be implemented and followed. The proposed complaint handling model is a method, platform or web-application to ensure that the complaint process is addressed and handled properly.

The proposed work flow process is shown in figure 3.2 above in chapter 3. As shown in the diagram, in complain part, firstly plaintiff submits his complaint form filling all the required details about the complaint, then is received by Complaint Handling Department (CHD) and then related organization, the organization must investigate on complaint and while complain is under investigation process, plaintiff can see complaint status being updated in view section of all complaints in his home page. After investigation resulted, plaintiff will be informed about the result.

Figure 3.2 shows the main processes in the working flow process of the proposed model. As shown in the diagram, in complain part, verifying the citizen validity firstly plaintiff submits his complaint form filling all the required details about the complaint, then is received by Complaint Handling Department (CHD) and then related organization where it launches a quick handling procedure for finding a solution with the contribution of the responsible staff who will be dedicated to identifying the rules on how to solve and get appropriate solution., the organization must investigate on complaint and while complain is under investigation process, plaintiff can see complaint status being updated in view section of all complaints in his home page. After investigation resulted, plaintiff will be informed about the result.

Upon submission of complaints for any department using single interface, users can view all the complaints made by them so far with their statuses. This is one of major advantages since they can take further actions based on complaint status. For an example, if a complaint is still in progress, citizen can inquire the reasons and escalate it. Single interface for doing these actions is the key factor and advantage of this model.

In this thesis, researcher tries to develop a model in terms of electronic complaints, which can support complaining from poor service quality and delivery. The advantage behind this model is the simple method for handling the citizen's complaints about what dissatisfies them.

4.2   System Design

In this phase, researcher tried to design appropriate web portal for citizens to complain about services they consume. Therefore, this phase started with use case diagram and continued with status diagram and sequence diagrams. In this thesis, it centralized the complaint management system, as shown in figure 3.1 in chapter 3.

The proposed model is divided into 3-tiers that consist of the following:

1. Web portal

This is to customer who are dealing with complaint system to make complaints and view their status and history of complaints.

2. Complaint Engine – BPEL layer

This is the core part of complaint handling which analyses and routes the received complains to related department.

3. Department services

This contains web services exposed to handle complains. Department wise complaint handling process vary so that each department exposed its own web service which can be consumed by SOA. On the other hand, each department has its own web portal where its staff members can log in and change complaint status when the complaint is being processed.

The proposed system could be generally applicable for any web-based e-complaining system. The proposed complaint handling model is a method, platform or web-application to ensure that the complaint process is addressed and handled properly. As shown in above figure 3.2, user can access web portal where he/she can submit the complaint, then it goes through a common complaint handling which routes the complaint to the related department. Upon the submission, user will get to know the complaint status.

4.2.1 Use-case Diagram

In use case diagram in figure 4.1 below, we have two Actors first plaintiff and second organization staff. Both actors have generalization relation with citizen because both are also citizen. In this diagram plaintiff can complain and follow his or her complain, also complainant can login into the system and system will respond plaintiff, with complaint results or status.
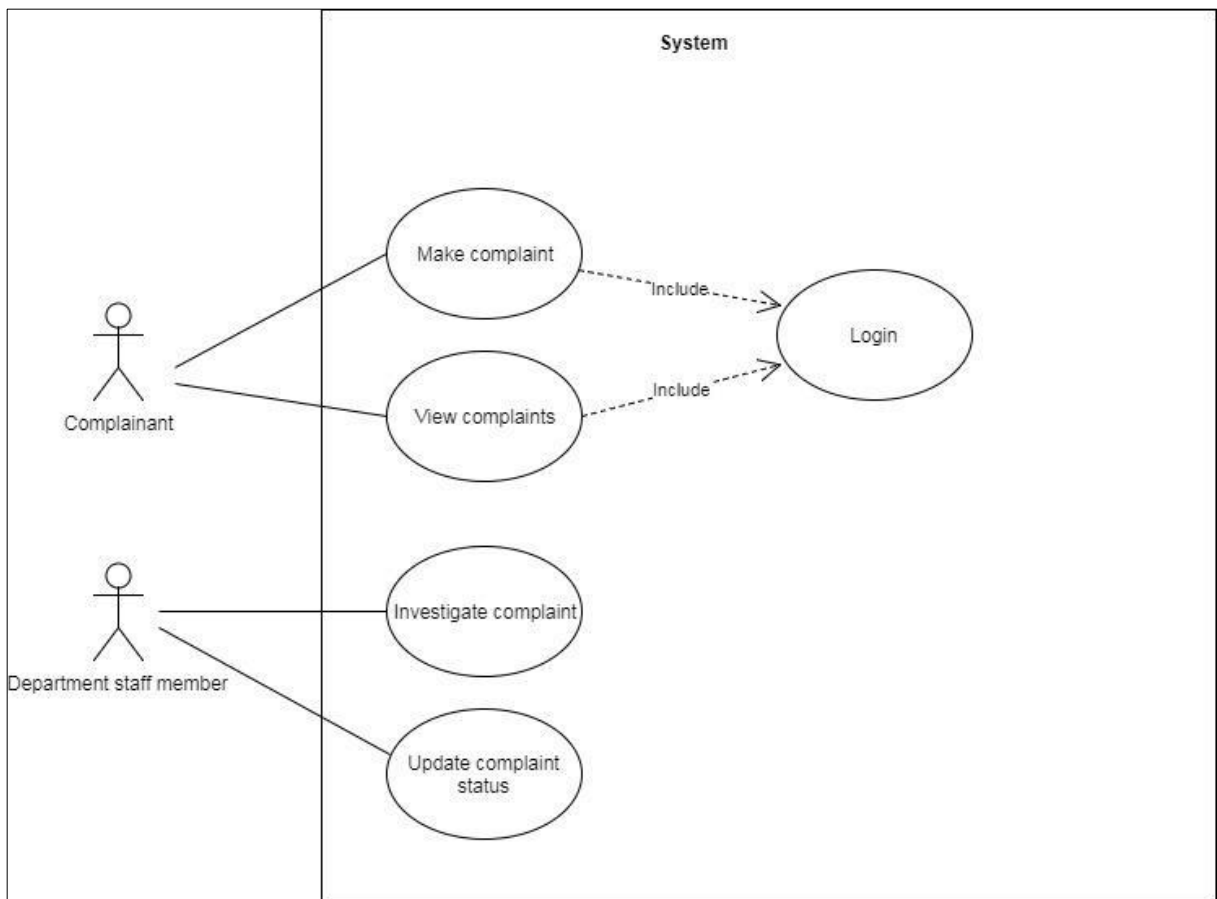

Figure 4. 1 Use case diagram

Actor details

Complainant- Make complaints

Department staff member- Manage the Complaints causes and actions in the system then provide solutions

4.2.2 Sequence Diagram

For more understanding, the researcher summarizes the flow of the major functions of the system using the sequence diagram to show how processes operate one with another and in which order. The major functions of this system need to answer the following questions as: Which type of users deal with it? Who make the complaint? Who deal with each complaint and according to which criteria? Who solve the complaint? Who follows up each complaint?

According to the figure 4.2, it shows the flow for the two main system users dealing with the system.

First *user*: The Citizen (complainant) who makes complaint and check for existing complaint status.

Second user: the responsible staff of the service department who deals with the waiting complaints by identifying and analysing the causes and actions for each complaint then resolving it according to the management rules and propose a preventive action to ensure that this complaint will not be raised again. Then finally, back the complaint case to the agent to follow it up. After that, the agent updates the complaint status or closes the complaint case if it resolved.

According to the figure 4.2, overall flow of the system can be described as follows. First, citizen tries to log into the web portal. Web portal verifies the login and gives the verification result to the citizen and citizen will be displayed the home page with complaint history. Citizen needs to make a complaint, then clicks on Add Complaint button. Web portal sends the complaint form to the citizen. Citizen fills up the complaint form and submits the complaint. Web portal sends complaint details to CHD which is the BPEL engine. CHD figures out the relevant department to route the complaint. Then CHD sends case details to the selected government department. Government department saves complaint details in its DB with reference number and status. Government department sends the complaint reference number and initial status to CHD. CHD sends them back to web portal and user is displayed complaint details.

Then, complaint is being investigated by the department authorities and staff. Staff member accesses the department web portal. Staff member updates the status of the complaint via the department web portal and complaint gets updated in department DB. Citizen accesses web portal and get to home page to view history. Web portal sends get all complaint request to

CHD. CHD invokes department's complaint getter service. Government department get complaint details from its DB. departments returns all complaints of the user to CHD. CHD processes the response and returns it to web portal. Web portal displays results to user and user will see the complaint history. If user has made many complaints to multiple departments, then CHD will invoke complaint getter service of each department and process each response and return a single response to web portal where user will see all the complaints made so far.

Sequence flow in text form.

title Complaint handling process

Citizen->WebPortal:Try to login
Citizen<--WebPortal:Login in verification result, home page with complaint history
Citizen->WebPortal: Click on Add Complaint button
Citizen<--WebPortal: Send Complaint form
Citizen->Citizen: Fill up complaint form
Citizen->WebPortal: Submit complaint
WebPortal->CHD: Send complaint details
CHD->CHD: Figure out the relevant department
CHD->GovernmentDepartments: Send case details
GovernmentDepartments->department DB: Save complaint with reference number
CHD<--GovernmentDepartments:Send complaint reference and initial status
WebPortal<--CHD: User displayed complaint details

department web portal <- Staff member: Access web portal
Staff member-> department web portal: change status of a complaint
department web portal-> department DB: update complaint status

Citizen->WebPortal:Access home page to view history
WebPortal->CHD: Send get all complaint request
CHD->GovernmentDepartments: Invoke departmens complaint getter service
GovernmentDepartments->department DB: Get complaint details from DB
GovernmentDepartments->CHD: Return all complaints of the user
CHD->CHD: Process responses of each department
CHD->WebPortal: Return the response
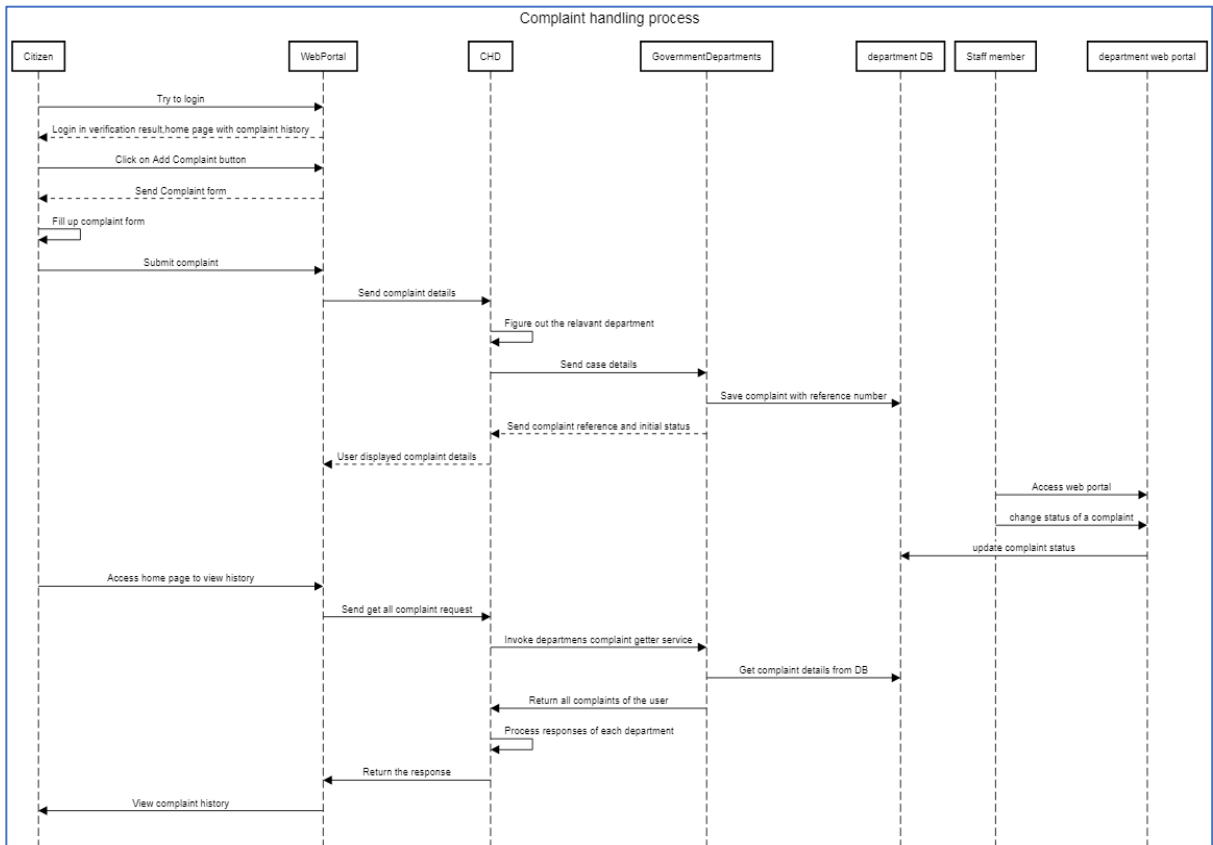*WebPortal->Citizen: View complaint history*

Figure 4. 2 Sequence Diagram

4.2.3 Status Diagram

Following figure 4.3 represents the behaviour of the system, which comprises a finite number of states. In this diagram researcher shows how the process of complaining in this system starts, with plaintiff decision for complaining. And it is then carried on with procedure of completing complaint details. After that investigation on complaint will be started and whenever department staff updates status of the complaint, user can see it in complain list in parallel way. Finally, plaintiff will be informed about the result.
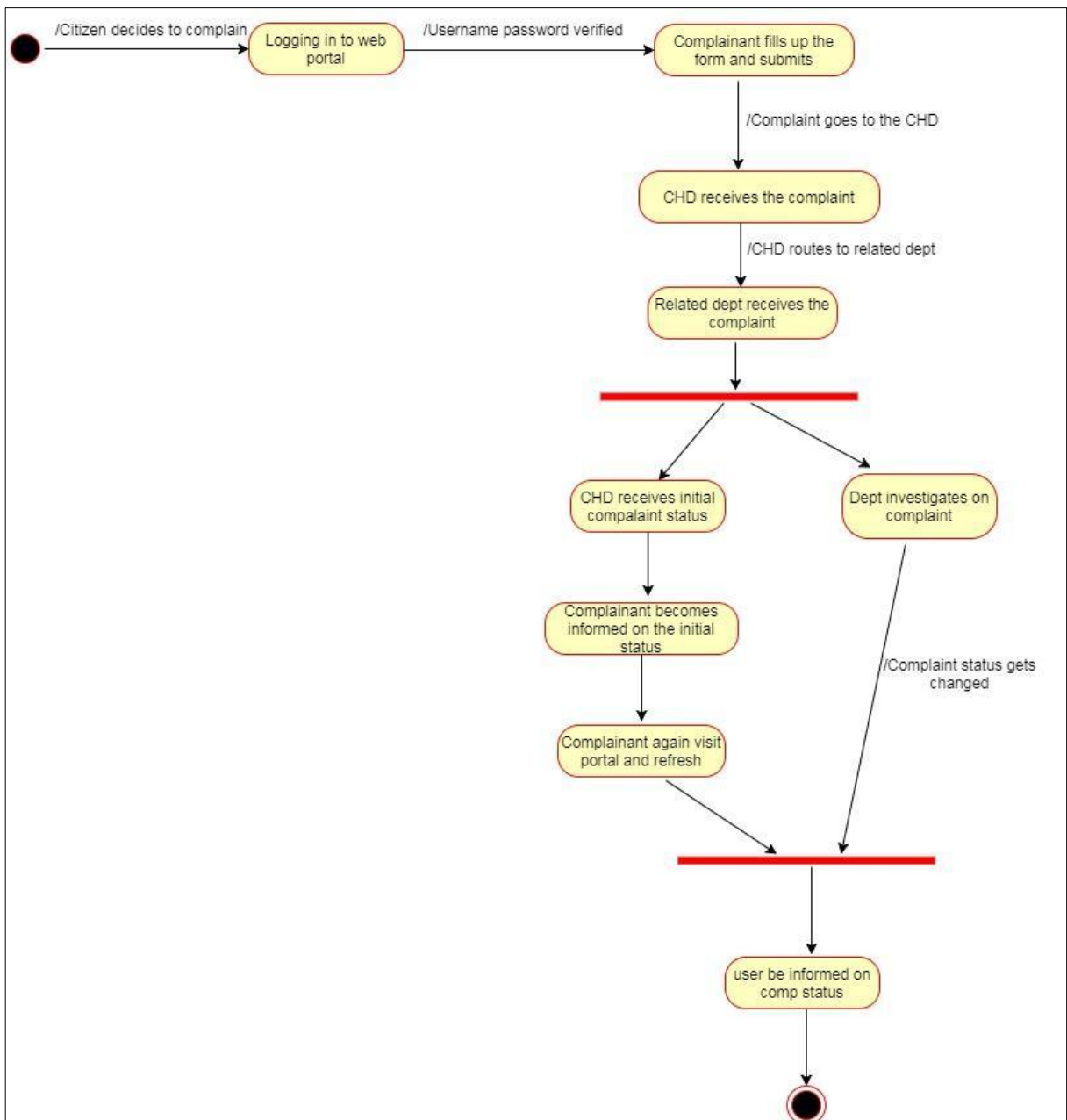
Figure 4. 3 Status diagram

4.3 Implementation

Researcher tried to develop a web portal to exhibit ability of handling complaints and being efficient in E-governments. Basically, this whole system consists of four components. These components were implemented separately and then integrated to come up with an end to end flow. Components are as follows.

1. Complaint handler web for citizens

This is the front-end prototype for the citizens. The technologies used in the implementation are Spring framework, Java EE, JSP and JavaScript. After the implementation, manual testing was executed.

Once the citizen logs into the portal, he or she can view his complaint history in the home page as below figure 4.4. History is received from a BPEL process. History contains complaint id, subject, incident date time, incident location, description and complaint status for each complaint of the logged in user.
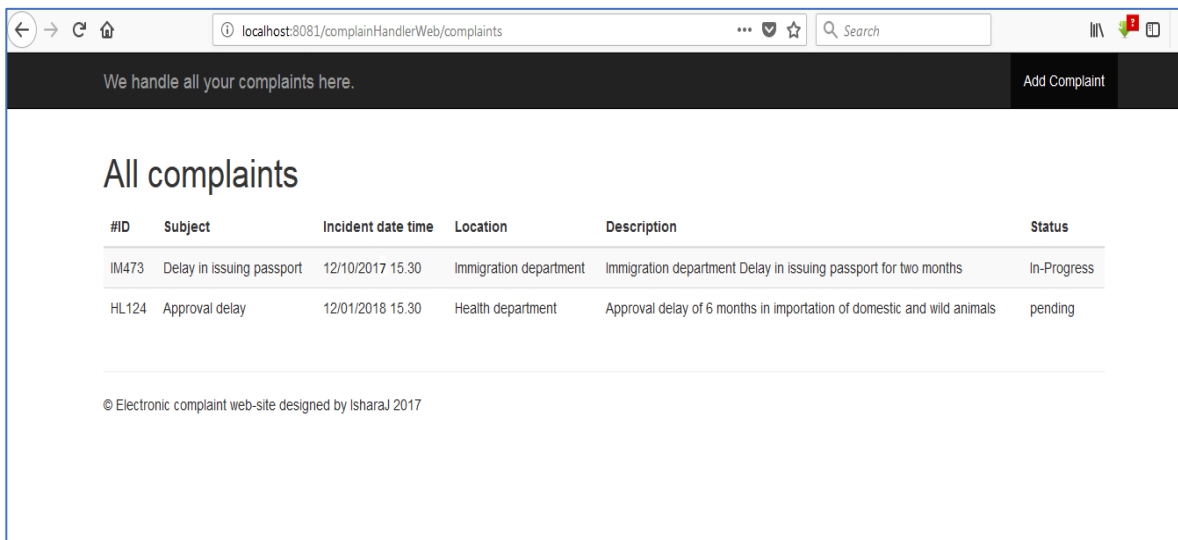

Figure 4. 4 Complaint history view

Also, citizen can add a complaint with add complaint button in home page as in following figure 4.5. There is a separate BPEL process to process the complaint submitting process.

Figure 4. 5 Complaint add form

Again, user coming back to the home page can view history including the newly added complaint.

This application runs in a tomcat server and is accessible to clients. For the front layer to interact with BPEL layer, it used WSDL file of BPEL attached in Appendix C (WSDL files used) and make client classes to interact with BPEL. Frontend has proxy classes to invoke BPEL process.

2. SOA layer with BPEL

The BPEL layer with SOA orchestration was implemented. The core logic of the prototype is the SOA architecture which has been developed using WSO2 BPEL (Business Process Execution Language), deployed in WSO2 BPS (Business Process Server). Using admin web portal of BPS, all the BPEL workflows are deployed, overviewed, monitored and tested in component level.

BPEL logics are configured with xml. When invoking government department web services, it used WSDL files exposed by these departments, made partner links and did the service invocation. Algorithmic process happened as described in 3.3 Algorithmic design details

section. Request and response processing was also carried out in this layer. All complexity of the system includes here in the BPEL layer.

3. Department web services

For the selected department (this prototype includes two departments), SOAP based mocked web services were implemented with functionalities of complaint submitting and complaint history receiving. Java language is used for logics, for the data tier, MySQL is used to save and update user data and complaint data in databases. By using SOAPUI, SOAP based mocked services are tested.

These department web services have WSDL files exposed to outside and the service descriptions are included in these files. BPEL layer consumed these services by using WSDL files exposed by departments. Department based complaint handling logic is included in these SOAP based services. A database is attached to each service, complaint handling and updating are basically implemented here. For prototyping, mocked services were implemented for these SOAP based services. There are separate web services for each department and complaint handling process is also different from department to department.

4. Department web portals

This is also a mocked web portal as the front end for departments. This portal is accessed by staff member to view complaints and update the statuses of complaints upon the investigations as in figure 4.6. When staff member updates the status, it updates the department DB and it reflects the updates status in department web portal as well as in customers' web portal. For the demonstration easiness, one web portal is developed and it routes for selected two departments.
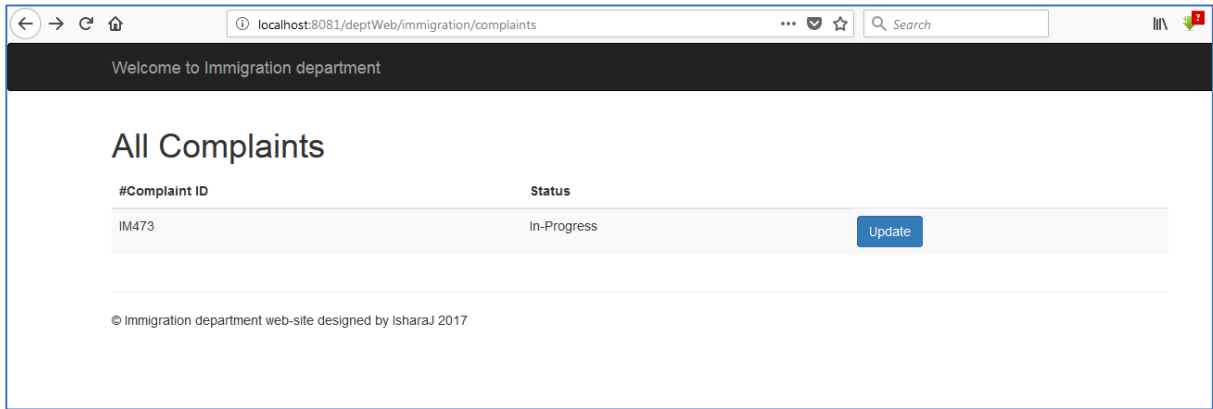
Figure 4. 6 Department web portal home screen

4.3.1 Tools and Technologies Used

1. Development tools and technologies

- WSO2 BPEL

Core logic of the prototype is the SOA architecture which has been developed using WSO2 BPEL (Business Process Execution Language), deployed in WSO2 BPS (Business Process Server). Using web portal of BPS, all the BPEL workflows are tested.

- SOAP based web services

For department mocked services, SOAP based web services used and tested in component level.

- Spring web MVC

For end user, exposed web portal and departments' web portals, spring MVC was used and tested individually.

- MySQL

For the departments, to save user data and complain data in databases, MySQL was used and tested related to data insertions and updating.

- Apache Tomcat Server

Customers' web portal, departments' staff web portals, Java clients of SOAP based web services were deployed in the tomcat server.

- WSO2 BPS server (Business Process Server)

BPEL processes were deployed and run in BPS server.

2. Testing tools

- SOAP UI

For testing SOAP based web services with WSDLs.

- BPS admin web portal

For monitoring, testing, tracing and viewing the BPEL flows.

- Java client applications

For testing SOAP based web services in a programmatic manner by generating Java code using the WSDLs.

Chapter 5: Evaluation and Results

In testing and evaluating the implemented prototype, both functional and nonfunctional test scenarios were carried out. Evaluating such a system means to ensure that the end user who is the citizen can browse the web portal, select the issue category where system will display issues with departments, fill the form and submit the complaint and receive the complaint reference number and status. Again, visiting to the system, citizen should be able to view his history of complaints with statuses. Functional testing can be carried out in two ways where component testing and integration testing.

Proposed system has following components.
1. Complaint handling web portal
2. SOA system
3. SOAP based web services of departments
4. Departments' web portals

These four components were tested individually using mocks and some hard-coded values. It was considered that if the component level testing is successful, it is easier to conduct integration testing. Manual testing was conducted using testing tools like SOAPUI, WSO2 BPS admin portal and creating some Java client applications. Component level testing assures that the functions are working fine separately and it helps isolate an error when an issue comes in future.

Upon the completion of component testing, integration testing conducted. All the possible scenarios with dynamic data were tested. In case of nonfunctional testing, simplicity, language accuracy, clearness, easy access and easiness were considered.

5.1   Evaluation Scenarios and Results

For this system, it used an experiment based evaluation approach which carried out an identified set of end-to-end test scenarios to be evaluated. Component level testing and functional testing were carried out.

Component testing

Following are the testing and evaluation scenarios of component level testing in the system which consists of four components. These scenarios were tested and evaluated.

1. Complaint handler web portal

Functional test scenarios
- Citizen should be able to login to the system.
- Citizen should be able to fill the complaint form and submit.
- Citizen should be able to view submitted complaint reference number and status with a message saying successfully complaint added.
- Citizen should be able to view all his complaint history with newly added complaint also.

Non-functional scenarios
- Language mistakes are not displayed to the citizen.
- Citizen can browse to add complaint, view complaints via the home page.
- Citizen is welcome to the web portal.
- Citizen is displayed list of issue related areas under each department that his complaint may be related to than just displaying only the department or complaint parent category.
- Citizen is not asked too much details about the complaint.

2. SOA system

Using BPS server SOA is deployed. Through WSO2 admin portal, SOA processes can be accessed and tested in case of functional testing. By inputting vivid values, SOA orchestration was tested, viewed the SOA logs and process flow. Additionally, using SOAPUI and Java client application also SOA layer was tested with its WSDL. Logs of each SOA transaction were also monitored through admin portal.

3. SOAP based web services of departments

These are mocked services for simulating department related complaint handling functionality. For each department, there is a complaint handling service which is receiving the submitted complaints by user and save them to the database and return the complaint reference number and status. other service is complaint getter service which returns the complaint history of each citizen against user id. These services are having WSDL files and services were tested individually using SOAPUI and Java client application.

4. Departments' web portals

When accessing department web portal, it was tested that whenever updating the status of the complaint of a citizen via the web portal, whether it is reflected in the department database. As a component, this was tested individually.

Integration testing

After the completion of component level testing, integration testing was carried out. A set of end-to-end scenarios were prepared and tested. Following use cases were evaluated. They were tested and evaluated to ensure the end to end functionality of the proposed solution.

1. Citizen should be able to submit a complaint related to a complaint type using web portal.
2. Citizen should be able to submit another complaint related to a different complaint type using the same web portal.
3. Citizen should be able to see the complaint reference number and status with a message saying complaint added successfully upon the submission of the complaint.
4. After Citizen finishes with the complaint submission, submitted complaint should be listed down in complaint history view in home page.
5. Department staff member should be able to view all the complaints submitted to the department in the department's web portal.
6. Department staff member should be able to change the complaint status using department's web portal.

7. Once the complaint status is updated by staff member, it should be reflected to the citizen in complaint history view via web portal.

8. Citizen should be able to view his or her complaint history to any department once he logs in to the web portal.

Full end-to-end test scenarios and results with screenshots is included in Appendix D (End to end test scenario of complaint handling).

Chapter 6: Conclusion and Future Work

In this chapter, the result for this study, lessons learned from the study, achievement of the objectives set at the beginning of the research and the recommendations to implementing complains system based on Service Oriented Architecture (SOA) will be discussed. Furthermore, the limitations of the project will be discussed. At the end, further research on the area related to this study will be recommended.

6.1   Discussion and Conclusion

Sri Lankan citizens who are seeking for government services are not always served as they expected. Hence, they need to make complaints for the respective service providers or departments. Therefore, there is a need of having a convenient way to make these complaints and obtain a solution.

When there are many service providing centres or departments, when a customer needs to make a complaint he or she needs to visit that respective service centre or make a telephone call or make it through an email or centre's web portal.

Currently, customers need to visit different service centres to make complaints where they need to know beforehand what the related department is. It is very tedious and cumbersome for customers to visit different centres and make these complaints since there is no standard process to submit their complaints. If there is only one common portal to make any complaint and get the solution, it is an easier way for their tight schedule. If there is one back-end service which takes care of the department routing, any desktop or mobile client can plug into that layer and it is easier from development perspective as well.

After investigating some governmental websites and statistical analysis of the data, researcher found out that there are some complaint handling systems for specific departments where user should know the exact department before complaining. Researcher explored that the variety of complaints types in governments' sector is the most critical barrier for implementing a complaint system based on Service Oriented Architecture (SOA).
The investigations were carried out through internet resources. Research continued phase by phase which consists of analysis, conceptual design and implementation design. In the implementation design phase, a SOA based complaint system model became generated. In this model, first it can submit a complaint and receive status as pending with complaint reference

number. Then there is the complaint routing part and the handling part, ultimately it is the status changing part. In complaint handling web portal, when a complaint is being added by a client, all types and sub types of complaints are being listed through a dropdown and child dropdown integrated into two main complaint types which complainant should select in its complaint.

All the objectives mentioned in above section 1.4 have been achieved, tested and prototyped as described below. First objective was to study and analyse the current processes in government departments. It selected two departments and continued the analysis. First, it found the common and specific details related to issue resolution. They are the same as inputs required from user related to the issue. Then it identified common and specific inputs needed from users related to the issue and it included complaint type, complaint sub type, subject, date, location and description where the description should specifically be stated and descriptive. Finally, a prototype was implemented successfully as the solution illustrating two government departments in Sri Lanka and further any number of departments can be added to the system. It is only a little configuration change in BPEL layer.

Second objective was to design a solution that could be used to capture issues related to different departments. It came up with a solution which users can interact with and submit their complaints without worrying about what the issue related department is. In the complaint submission form, it is very easy to identify the relevant department since all the possible issue scenarios are listed down in a dropdown as sub categories.

Third objective was that this system should have the ability to capture department specific issue management criteria from users. Developed web portal is able to capture common details as well as department specific details related to the issue. These details include complaint type, complaint sub type, subject, date, location and description where the description should specifically be stated and descriptive.

Fourth objective is that this solution should be able to interact with different governmental departments to route and manage the overall issue resolution process. The developed prototype has the said ability based on the complaint type which user selects. BPEL layer with BPEL engine is responsible for routing to the different departments based on an algorithm. This design has the simplicity and flexibility where any number of departments can be added with a little configuration.

This system is modularized and the components have been integrated so that the maintenance is high. Low coupling and high cohesion have also been achieved.

6.2 Outcomes of the Research

6.2.1 Investigate the Benefits of Comprehensive Complaint System in e-Government

In this research, the researcher discovered the fact that the government departments will become more reliable in the minds of citizens by using a comprehensive complaint management system implemented through the SOA architecture. Since many observations can be found through the complaints in department personnel and services, governments find these observations as plus points to improve themselves. Further, the comprehensive complaints system can facilitate the process of handling complaints, can encourage citizens to complain about the government's shortcomings and problems. It is less confusing to refer to a single website rather than interacting with many websites of governmental organizations to make complaints. This may be the most prominent advantage of the SOA-based complaint system compared to the traditional system.

When using SOA, it was analysed that all the core logic can be gathered in a layer called SOA layer. Therefore, it does not need to consider about the back-end and the complexity when it connects client devices to this layer. Any type of client device (mobile client, desktop, etc.) can be connected to the SOA layer and it is only a matter of invoking this SOA service from the end of the client device. The SOA layer will take care of all the complexity by talking to several department services based on the routing algorithm.

This is a great achievement compared to the cost of development, the cost of maintenance and ease of use which are the current burning problems in e-complaint management systems.

6.2.2 To Propose an e-Complaint Model based on SOA

With the consideration of the needs of citizens, a new model of complaint system based on SOA was promoted. In this model, the complaint process is facilitated since all citizens wishing to complain about any government employee or service need only refer to a single website, so it can be a general service on a SOA based government website.

This is a rich design compared to the complaint handling systems already available. Even though complaint management systems are currently being implemented, there are a variety of cumbersome problems that clients must face and maintain. Clients have no proper place to complain where there is a high coupling of services in departments.

6.3   Limitations of the Project

In data capturing level and research level, according to the web resources, it is said that some departments avoid getting permission for accessing their complaint system archive since they want to   keep   plaintiffs' information secured. In some cases, contents of complaints were classified as confidential hence access to a huge number of this type of complaints became impossible.

6.4   Future Work

However, in this research, researcher tried to prototype complaint system for two departments. But this should be extended for all other Sri Lankan government departments and their complaint categories as well. From the customer end, more options for the web portal should be added including signing up, search facility for complaint history, complaint updating and complaint deletion. Based on user requirements and suggestions, some more functionalities can be added.

Due to culture that has the most influence in complaints emerging, it has such influence in type of complaints. Involving culture in complaint categories may complicate implementing the complaint system based on SOA especially when the country consists of different cultures. In addition, cultures are changing in period of time thus complaint categories should be reformed temporarily to be more efficient and compatible with employees' working culture.

References

[1] Yi, Yooujae, "A Critical Review of Consumer Satisfaction," in *In Review of Markiting Valerie A, Zeithaml, ed. Chicago, American Marketing Association*, Chicago, 1990.

[2] Cho,Fejemstad and Hilyz, "Causes and Outcomes of Online Customer Complaining," 2001. [Online].

[3] Julta, D., Craig, J., & Bodorik, P, "Enabling and Measuring Electronic Customer Relationship Management Readiness," in *Proceedings of the 34th Hawaii International Conference on System Sciences*, Hawaii, 2001.

[4] Razali R., Abd Halim K. N., & Jusoff K., "Quality Improvement of Services in Unversiti Teknologi Mara Pahang from a Management Perspective," in *Management Science & Engineering Vol.5*, 2011, pp. 71-80.

[5] Jay DiMare & Richard S. Ma, "Service -oriented architecture Revolutionizing today's banking systems," White Paper, IBM conference, 2006.

[6] Najar, A. S., Al-Sukhni, H. A., & Aghakhani, N, "The Application of Service-Oriented Architecture in E-complaint System," in *Paper presented at (ICCSN '10) the Second International Conference on Communication Software and Networks*, 2010, 26-28 Feb.

[7] Fornell C., & Westbrook A. Robert, "The Vicious Circle of Consumer Complaints," *journal of Marketing,* vol. Summer, pp. 68-78, 1984.

[8] H. Zhang, "Delay-Insensitive Networks," University of Waterloo, Waterloo, Ontario, Canada, 1997.

[9] C. o. B. B. Bureau, "Effective Customer Relationships and complaint Handling," Business Advisory Service Publication, Virginia , USA, 1998.

[10] Ezra and Krendel, "A Case Study of Citizen Complaints as Social Indicators," in *IEEE Transactions on Systems Science and Cybernetics*, Philadelphia, IEEE, 1970, pp. sec-6.

[11] Jorstad, Ivar, Schahram Dustdar, and Do Van Thanh, "A Service Oriented Architecture Framework for Collaborative Services," IEEE, Linkoping, Sweden, 2005.

[12] Mcgovern, James, Oliver Sims, Ashish Jain, and Mark Little, "Enterprise Service Oriented Architectures," Springer, 2006.

[13] "Service-oriented architecture (SOA) definition," [Online]. Available: www.service-architecture.com/web-services/articles/serviceoriented_architecture_soa_definition.html. [Accessed 28 July 2008].

[14] West, Darrell M, "Improving Technology Utilization in Electronic Government around the World," in *Governanace studies at brookings*, Japan, Yuriko Nakao, 2008.

[15] MacIntosh, A, E robson, E smith, and A Whyte, "Electronic democracy and young people," Social Science Computer Review, 2003.

[16] Seifert, J and R.E. Peterson, "The Promise of All Thing E? Expectations and Challenges of Emergent Electronic Government. Perspectives on Global Development and Technology," 2002.

[17] "eGovernment platform based on a Service-Oriented Architecture," in *BEA Systems, Inc*, 2005, p. 5.

[18] "Dictionary, Business. Complaint," [Online]. Available: <http://www.businessdictionary.com/definition/complaint.html>. [Accessed 29 April 2009].

[19] "Complaint Handling Guidelined For Trades," Ministry of Fair Trading, Western Austrailiya, 2000.

[20] Cho, Yooncheong, Roxanne Hiltz, and Jerry Ferjemstad, "An Analysis of Online Customer Complaints," in *Proceedings of the 35th Hawaii International Conference on System Sciences*, Hawaii, 2002.

[21] Tse and Wilton, "Model of Concumer Satisfaction Formulation," *Journal of Marketing Research,* 1988.

[22] "Using Complaints for Quality Assurance Decisions," 1997.

[23] "Customer's Firs-complaint Management Checklists," Office of Consumer Affairs, Canada, 1998.

[24] "Technical and Research Programs," 1988.

[25] L. Guijarro, "Interoperability frameworks and enterprise architectures in egovernment initiatives in Europe and the United States," *Elsevier Jouranl of Government Information Quarterly,* vol. 24, pp. 89-101, 2007.

[26] "Electronic Government," International City/County Management Association (ICMA)., 2002.

[27] Lemuria, Carter and Belanger, "Citizen Adoption of Electronic Government Initiatives," in *37th Annual Hawaii International Conference on System Sciences*, France, 2004.

[28] D. Wijesekara, "Service oriented architecture (SOA)," wso2, [Online]. Available: https://wso2.com/library/webinars/2015/09/service-oriented-architecture/.

Appendices

Appendix A (Database Scripts)

<u>MySQL DB scripts in government departments</u>

- Immigration department

CREATE DATABASE `immigrationdeptdb` /*!40100 DEFAULT CHARACTER SET latin1 */;
SELECT * FROM immigrationdeptdb.complain;

CREATE TABLE `citizen` (
 `citizenid` varchar(15) NOT NULL,
 `citizenfname` varchar(45) DEFAULT NULL,
 `citizenlname` varchar(45) DEFAULT NULL,
 PRIMARY KEY (`citizenid`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1 COMMENT='This table contains needed information of citizens in country.';

CREATE TABLE `complain` (
 `complainid` varchar(15) NOT NULL,
 `subject` varchar(45) DEFAULT NULL,
 `incidentDateTime` varchar(45) DEFAULT NULL,
 `location` varchar(45) DEFAULT NULL,
 `description` varchar(150) DEFAULT NULL,
 `citizenid` varchar(45) NOT NULL,
 `status` varchar(45) NOT NULL,
 PRIMARY KEY (`complainid`),
 KEY `fk1_idx` (`citizenid`),
 CONSTRAINT `fk1` FOREIGN KEY (`citizenid`) REFERENCES `citizen` (`citizenid`)
ON DELETE CASCADE ON UPDATE CASCADE
) ENGINE=InnoDB DEFAULT CHARSET=latin1 COMMENT='This table holds each complain detail submitted by citizen.';

- Health department

CREATE DATABASE `healthdeptdb` /*!40100 DEFAULT CHARACTER SET latin1 */;

CREATE TABLE `citizen` (
 `citizenid` varchar(15) NOT NULL,
 `citizenfname` varchar(45) DEFAULT NULL,
 `citizenlname` varchar(45) DEFAULT NULL,
 PRIMARY KEY (`citizenid`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1 COMMENT='This table contains needed information of citizens in country.';

CREATE TABLE `complain` (
 `complainid` varchar(15) NOT NULL,
 `subject` varchar(45) DEFAULT NULL,
 `incidentDateTime` varchar(45) DEFAULT NULL,
 `location` varchar(45) DEFAULT NULL,
 `description` varchar(150) DEFAULT NULL,
 `citizenid` varchar(45) NOT NULL,
 `status` varchar(45) NOT NULL,
 PRIMARY KEY (`complainid`),
 KEY `fk1_idx` (`citizenid`),
 CONSTRAINT `fk1` FOREIGN KEY (`citizenid`) REFERENCES `citizen` (`citizenid`)
ON DELETE CASCADE ON UPDATE CASCADE
) ENGINE=InnoDB DEFAULT CHARSET=latin1 COMMENT='This table holds each complain detail submitted by citizen.';

Appendix B (Investigations in Other Countries)

- In New York City, for example, the Mayor's Action Centuries a round-the-clock operation which processes 200 000 phone calls and 5000 letters per year from complaining citizens [10].

- http://www.basques.euskadi.net/t32-7413/en/ (Basque government website based on SOA) Refer to BEA system report [18]; today Basque government website is based on SOA. Although many services are being offering on this website, no complaint services have been established there to make a complaint against governments' staff or departments.

- http://www.irlgov.ie/departments/ (Irish government website) Website does have some futures to submit complain but they are not based on SOA since there is no distinguish between departments complaints' forms.

- http://www.direct.gov.uk/en/index.htm (UK government website based on SOA) However this website has some forms to submit complains; most of them just show the process of complaints and do not get online complaints. Also, there is no specific complaint system for complaints from the government staffs.

- http://www.usa.gov/ (USA government website base) this website has some features to complain, citizens can complain of officers, organization but this service does not look like SOA based system. There are several types of complaints; complainer needs to find specific department and the specific page they for making your complaint. Although the main government website is based on SOA.

- http://www.tehran.ir/Default.aspx?tabid=3206andlanguage=fa-IR (Tehran municipality website: in Persian language) in researcher view this website has the best feedback pages through the other governmental departments in Iran. In this website municipality tries to get feedback from citizens about, urban services and traffics. The feedbacks are in forms of multiple choice questions. The main subject matter on this website is the same as others, but there is still no page for e-complain from municipality staff. Also, Tehran municipality tried to offer e-complain through

its website, though their focus of capturing complaints was through telephone communication.

- http://www.mrt.ir/New/static/UcE.asp (Iran ministry of road and transportation)
  In this website, they have tried to show citizens how to make complaints via, phones, email or letter but there is no service for citizens to submit their complaints forms online.

Appendix C (WSDL Files Used)

BPEL SOA WSDL

    1. <u>WSDL of complaint submitting and routing</u>

```xml
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<definitions xmlns="http://schemas.xmlsoap.org/wsdl/"
        xmlns:plnk="http://docs.oasis-open.org/wsbpel/2.0/plnktype"
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
        xmlns:tns="http://complain.handler.org" xmlns:vprop="http://docs.oasis-
open.org/wsbpel/2.0/varprop"
        xmlns:wsdl="http://imm.service.project.msc.ucsc.com"
xmlns:wsdl1="http://health.service.project.msc.ucsc.com"
        name="ComplainHandlerBpel" targetNamespace="http://complain.handler.org">

        <!--
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
                TYPE DEFINITION - List of types participating in this BPEL process The
BPEL
                Designer will generate default request and response types but you can define
                or import any XML Schema type and use them as part of the message types.

        ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~ -->
        <plnk:partnerLinkType name="ImmServicePLType">
                <plnk:role name="ImmRole" portType="wsdl:ImmComplainServiceImpl" />
        </plnk:partnerLinkType>
        <plnk:partnerLinkType name="HealthServicePLType">
                <plnk:role name="HealthRole"
portType="wsdl1:HealthComplainServiceImpl" />
        </plnk:partnerLinkType>
        <import location="ImmComplainServiceImpl.wsdl"
namespace="http://imm.service.project.msc.ucsc.com" />
        <import location="HealthComplainServiceImpl.wsdl"
namespace="http://health.service.project.msc.ucsc.com" />
        <types>
                <schema xmlns="http://www.w3.org/2001/XMLSchema"
                        attributeFormDefault="unqualified" elementFormDefault="qualified"
                        targetNamespace="http://complain.handler.org">

                        <element name="ComplainHandlerBpelRequest">
                                <complexType>
                                        <sequence>
                                                <element name="type" type="string" />
                                                <element name="subject"
type="string"></element>

                                                <element name="date"
type="string"></element>

                                                <element name="location"
type="string"></element>
```

```xml
                                        <element name="description"
type="string"></element>
                            </sequence>
                        </complexType>
                    </element>

                    <element name="ComplainHandlerBpelResponse">
                        <complexType>
                            <sequence>
                                <element name="result" type="string" />
                            </sequence>
                        </complexType>
                    </element>
            </schema>
        </types>


        <!--
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
            MESSAGE TYPE DEFINITION - Definition of the message types used as
part of
            the port type defintions
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
-->
        <message name="ComplainHandlerBpelRequestMessage">
            <part element="tns:ComplainHandlerBpelRequest" name="payload" />
        </message>
        <message name="ComplainHandlerBpelResponseMessage">
            <part element="tns:ComplainHandlerBpelResponse" name="payload" />
        </message>

        <!--
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
            PORT TYPE DEFINITION - A port type groups a set of operations into a
logical
            service unit.
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
-->

        <!-- portType implemented by the ComplainHandlerBpel BPEL process -->
        <portType name="ComplainHandlerBpel">
            <operation name="process">
                <input message="tns:ComplainHandlerBpelRequestMessage" />
                <output message="tns:ComplainHandlerBpelResponseMessage" />
            </operation>
        </portType>
        <!--
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
            PARTNER LINK TYPE DEFINITION
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
-->
        <plnk:partnerLinkType name="ComplainHandlerBpel">
```

```
                    <plnk:role name="ComplainHandlerBpelProvider"
portType="tns:ComplainHandlerBpel" />
        </plnk:partnerLinkType>


        <!--
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
            BINDING DEFINITION - Defines the message format and protocol details
for
            a web service.
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
-->
        <binding name="ComplainHandlerBpelBinding" type="tns:ComplainHandlerBpel">
            <soap:binding style="document"
                    transport="http://schemas.xmlsoap.org/soap/http" />
            <operation name="process">
                    <soap:operation soapAction="http://complain.handler.org/process" />
                    <input>
                            <soap:body use="literal" />
                    </input>
                    <output>
                            <soap:body use="literal" />
                    </output>
            </operation>
        </binding>


        <!--
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
            SERVICE DEFINITION - A service groups a set of ports into a service unit.

            ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~ -->
        <service name="ComplainHandlerBpel">
            <port binding="tns:ComplainHandlerBpelBinding"
name="ComplainHandlerBpelPort">
                    <soap:address location="http://localhost:8080/ComplainHandlerBpel"
/>
            </port>
        </service>
</definitions>
```

2. WSDL of receiving complaint history

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<definitions xmlns="http://schemas.xmlsoap.org/wsdl/"
        xmlns:plnk="http://docs.oasis-open.org/wsbpel/2.0/plnktype"
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
        xmlns:tns="http://complaint.getter.com" xmlns:vprop="http://docs.oasis-
open.org/wsbpel/2.0/varprop"
```

```xml
      xmlns:wsdl="http://imm.service.project.msc.ucsc.com"
xmlns:wsdl1="http://health.service.project.msc.ucsc.com"
      name="ComplaintGetterBpel" targetNamespace="http://complaint.getter.com">

      <!--
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
            TYPE DEFINITION - List of types participating in this BPEL process The
BPEL
            Designer will generate default request and response types but you can define
            or import any XML Schema type and use them as part of the message types.

      ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~ -->
      <plnk:partnerLinkType name="ImmPLType">
            <plnk:role name="ImmRole" portType="wsdl:ImmComplainServiceImpl" />
      </plnk:partnerLinkType>
      <plnk:partnerLinkType name="HealthPLType">
            <plnk:role name="HealthRole"
portType="wsdl1:HealthComplainServiceImpl" />
      </plnk:partnerLinkType>
      <import location="ImmComplainServiceImpl.wsdl"
namespace="http://imm.service.project.msc.ucsc.com" />
      <import location="HealthComplainServiceImpl.wsdl"
namespace="http://health.service.project.msc.ucsc.com" />
      <types>
            <schema xmlns="http://www.w3.org/2001/XMLSchema"
                  attributeFormDefault="unqualified" elementFormDefault="qualified"
                  targetNamespace="http://complaint.getter.com">

                  <element name="ComplaintGetterBpelRequest">
                        <complexType>
                              <sequence>
                                    <element name="input" type="string" />
                              </sequence>
                        </complexType>
                  </element>

                  <element name="ComplaintGetterBpelResponse">
                        <complexType>
                              <sequence>
                                    <element name="result" type="string" />
                              </sequence>
                        </complexType>
                  </element>
            </schema>
      </types>

      <!--
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
            MESSAGE TYPE DEFINITION - Definition of the message types used as
part of
```
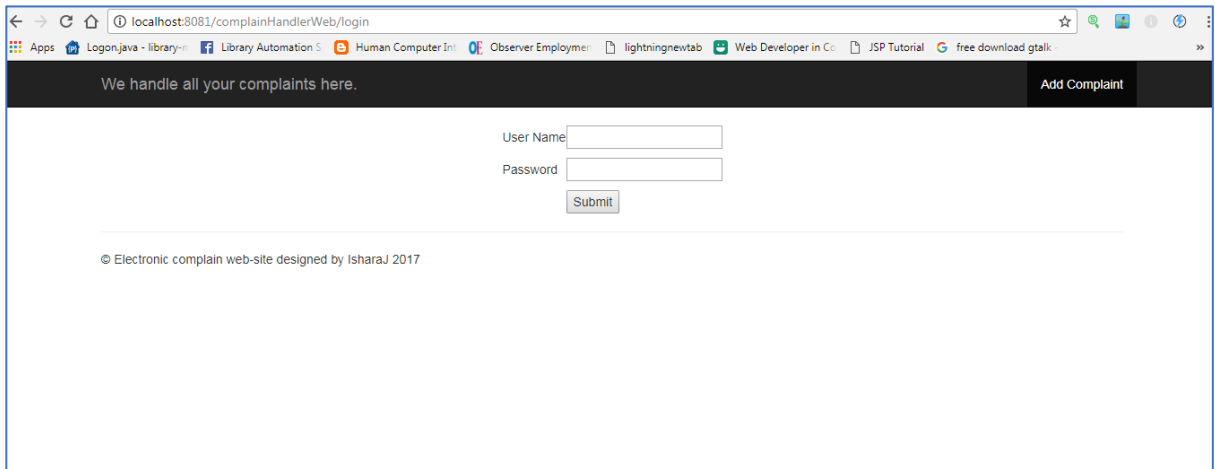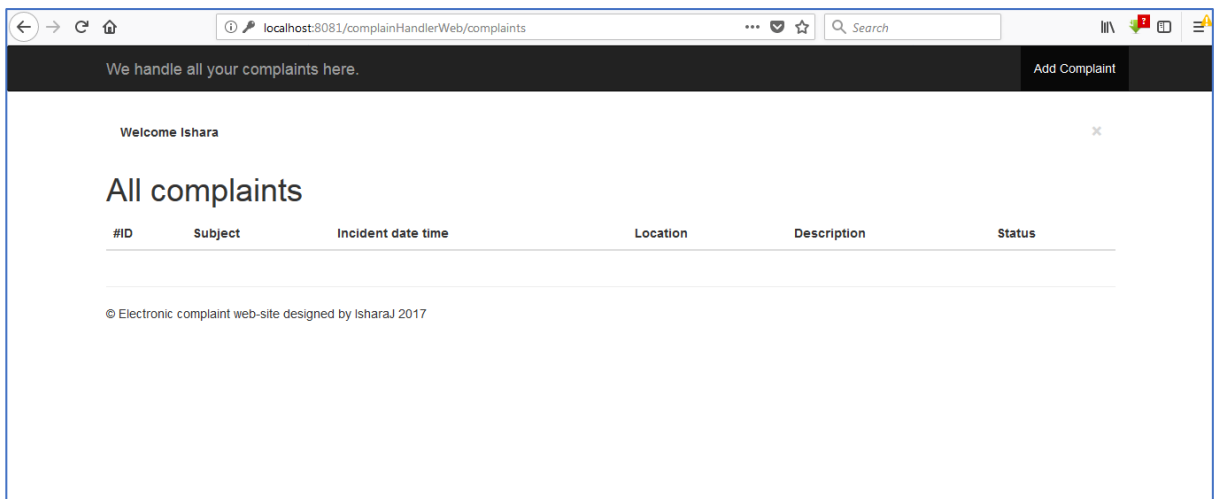
the port type defintions
~~~~~~
-->
```
<message name="ComplaintGetterBpelRequestMessage">
        <part element="tns:ComplaintGetterBpelRequest" name="payload" />
</message>
<message name="ComplaintGetterBpelResponseMessage">
        <part element="tns:ComplaintGetterBpelResponse" name="payload" />
</message>

<!--
```
~~~~~~
        PORT TYPE DEFINITION - A port type groups a set of operations into a
logical
        service unit.
~~~~~~
-->
```
<!-- portType implemented by the ComplaintGetterBpel BPEL process -->
<portType name="ComplaintGetterBpel">
        <operation name="process">
                <input message="tns:ComplaintGetterBpelRequestMessage" />
                <output message="tns:ComplaintGetterBpelResponseMessage" />
        </operation>
</portType>
<!--
```
~~~~~~
        PARTNER LINK TYPE DEFINITION
~~~~~~
-->
```
<plnk:partnerLinkType name="ComplaintGetterBpel">
        <plnk:role name="ComplaintGetterBpelProvider"
portType="tns:ComplaintGetterBpel" />
</plnk:partnerLinkType>


<!--
```
~~~~~~
        BINDING DEFINITION - Defines the message format and protocol details
for
        a web service.
~~~~~~
-->
```
<binding name="ComplaintGetterBpelBinding" type="tns:ComplaintGetterBpel">
        <soap:binding style="document"
                transport="http://schemas.xmlsoap.org/soap/http" />
        <operation name="process">
                <soap:operation soapAction="http://complaint.getter.com/process" />
                <input>
                        <soap:body use="literal" />
                </input>
                <output>
                        <soap:body use="literal" />
```

85

```
                    </output>
               </operation>
        </binding>

        <!--
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
               SERVICE DEFINITION - A service groups a set of ports into a service unit.
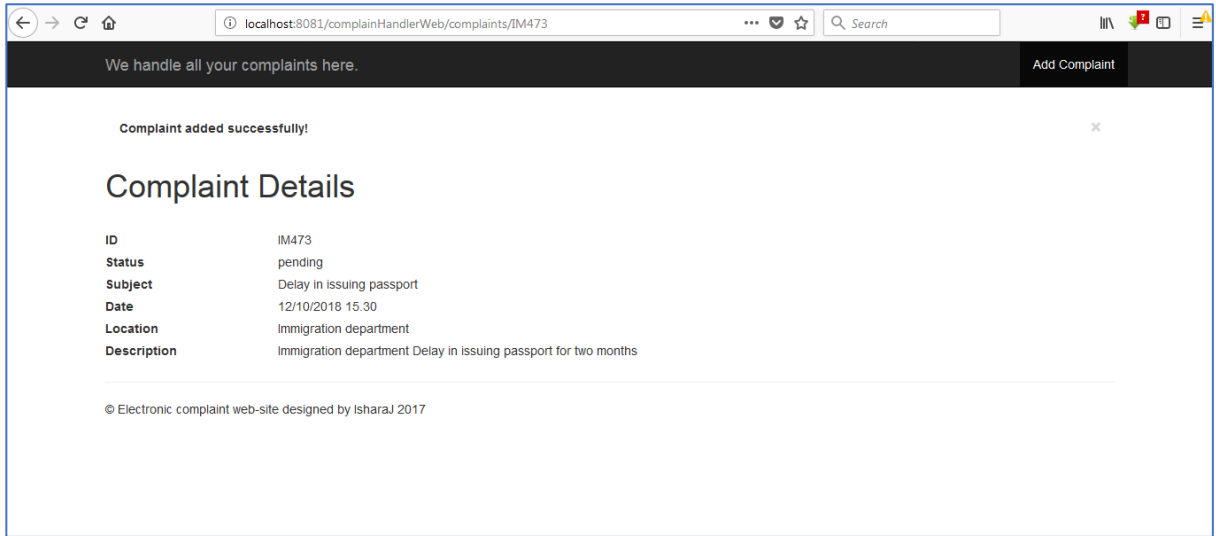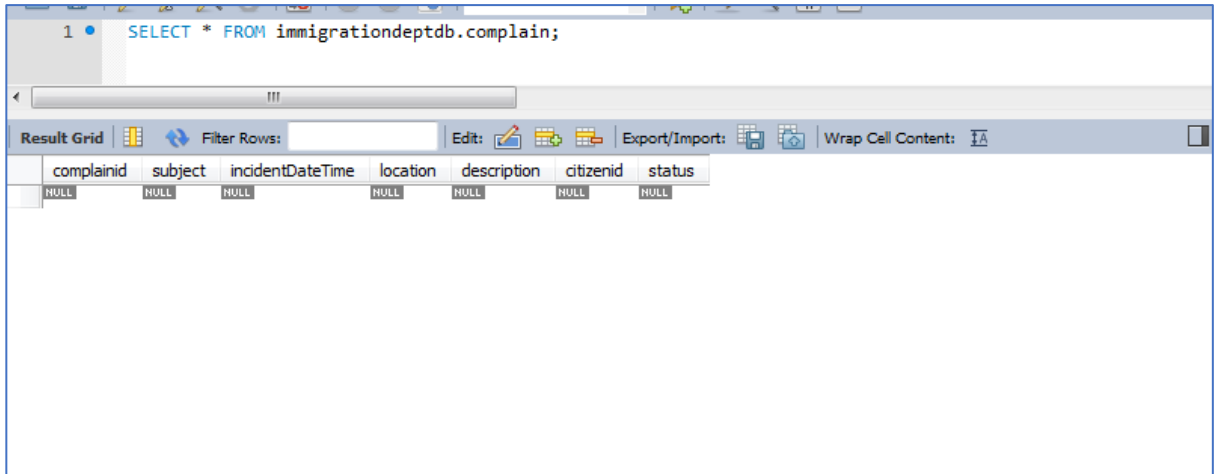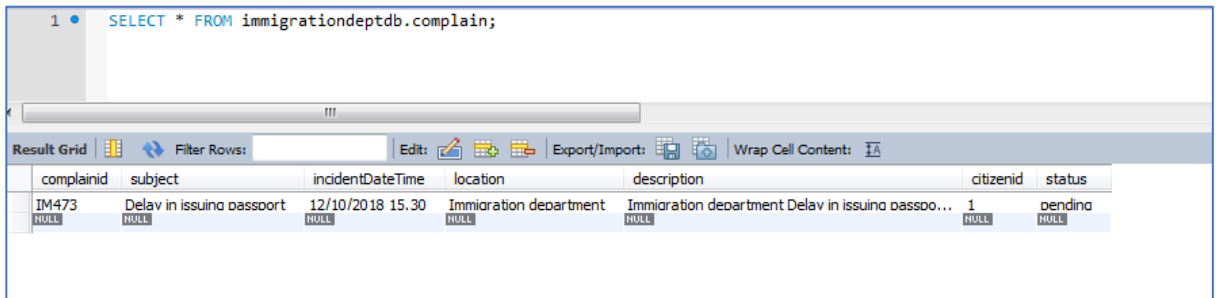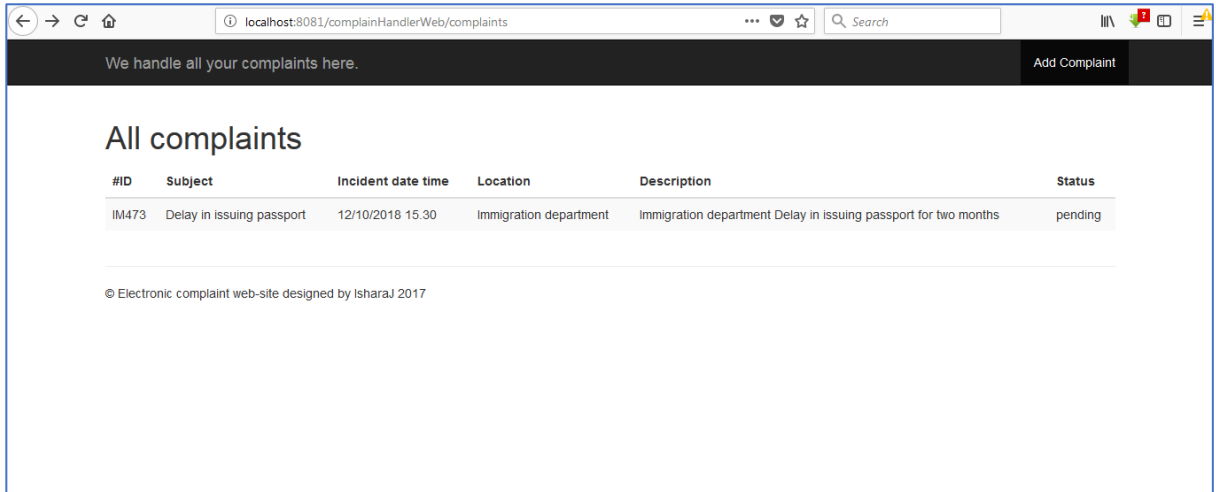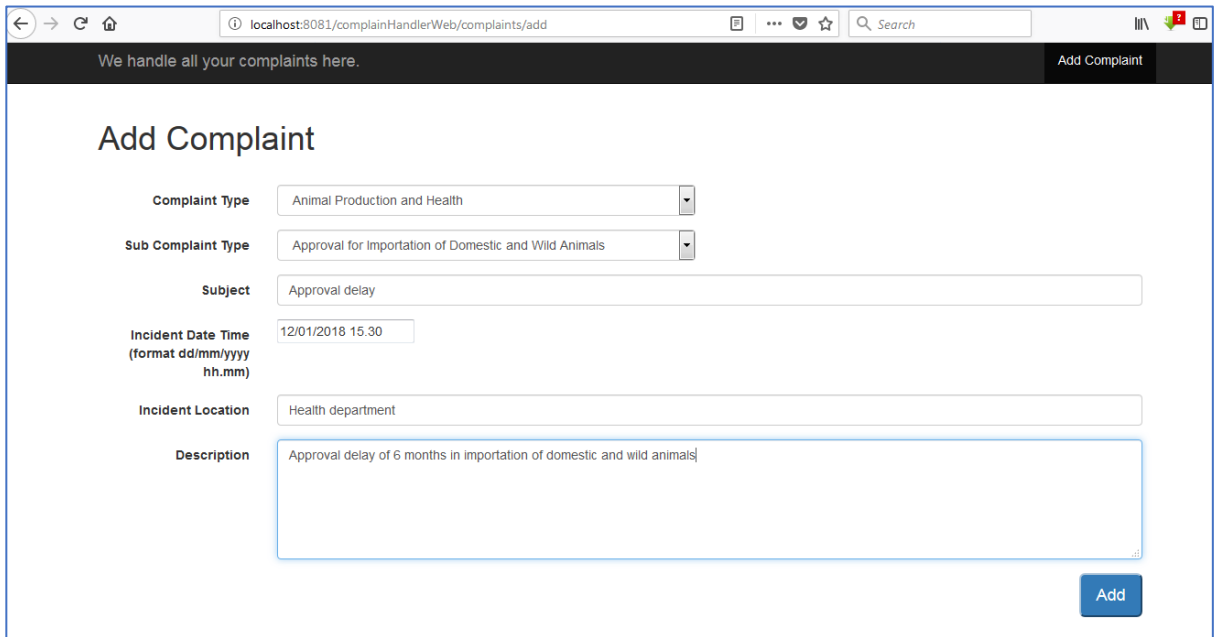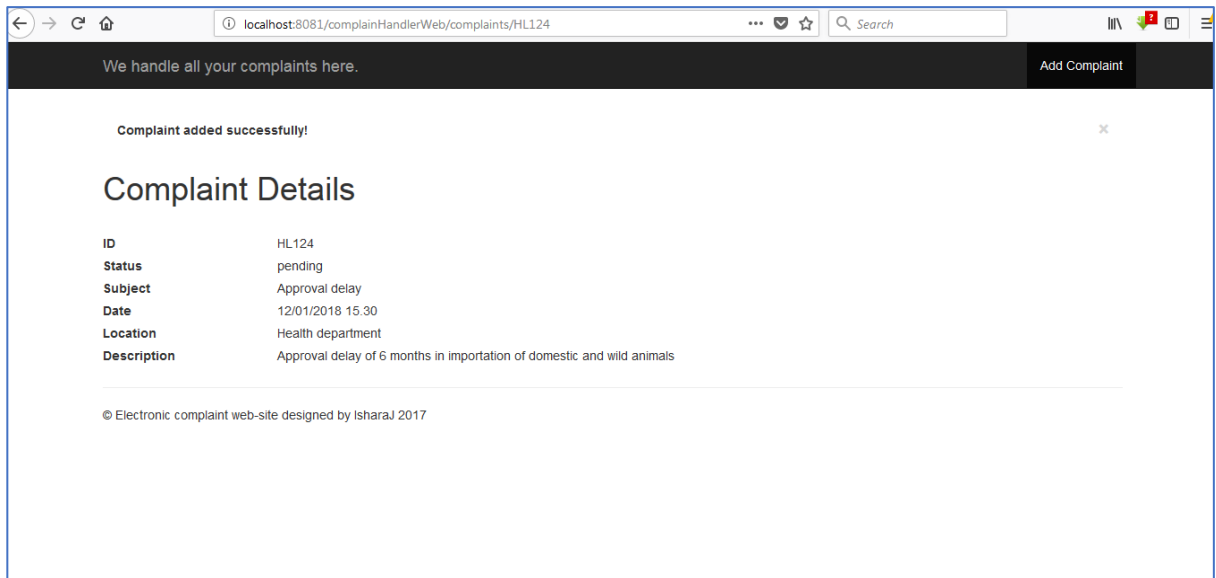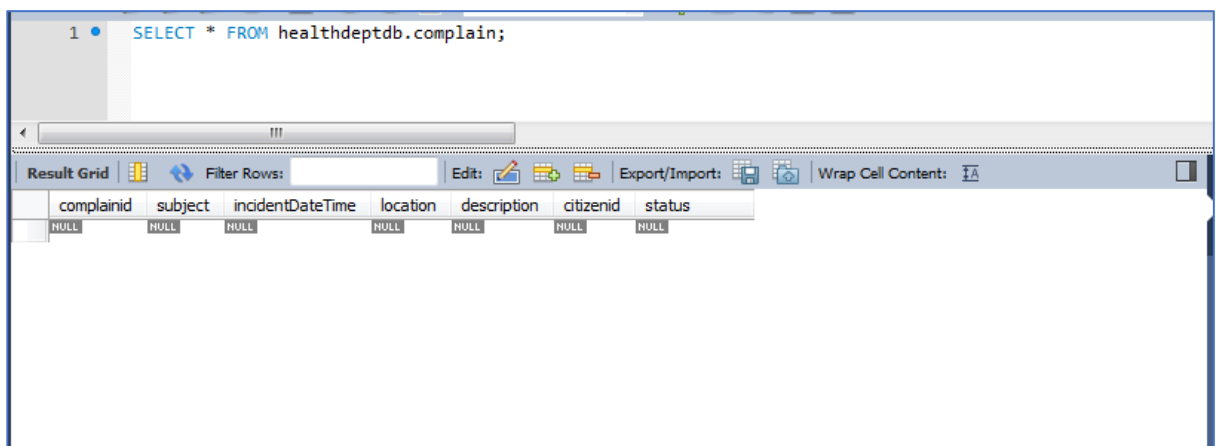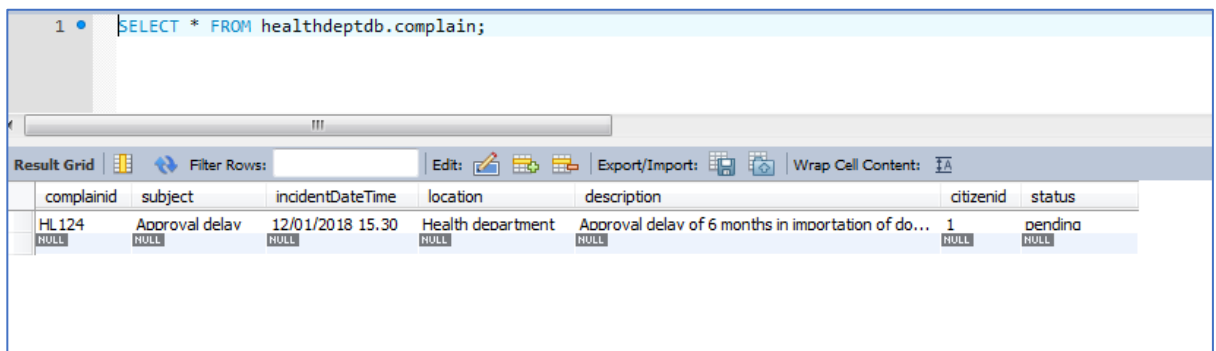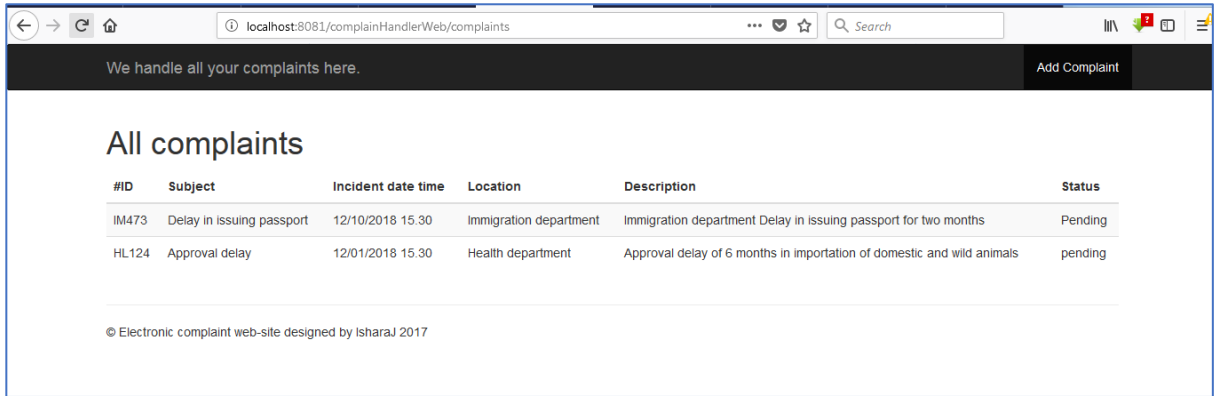
        ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
~~~~~~ -->
        <service name="ComplaintGetterBpel">
               <port binding="tns:ComplaintGetterBpelBinding"
name="ComplaintGetterBpelPort">
                      <soap:address location="http://localhost:8080/ComplaintGetterBpel"
/>
               </port>
        </service>
</definitions>
```

Appendix D (End to end Test Scenario of Complaint Handling)

1. Citizen logs in to the system

Since this is a new citizen who has not made any complaints yet, history view is empty.

2. Click on Add Complaint button

3. Selects complaint type (parent type) based on which complaint sub type list is displayed. Citizen fills details and click Add.

4. Citizen will see the success message, complaint id, status and other details.

5. Complaint gets saved in selected department's database. Here it is immigration department.

Before saving the complaint into DB.

After saving the complaint

6.Citizen visits home page and see the submitted complaint in history view.

7. Citizen again needs to submit another complaint which is related to animal health.
He picks up issue from drop down, fills details and clicks on Add

8. Citizen sees the submission results.

9. Second complaint gets saved in relevant department DB which is Health department.
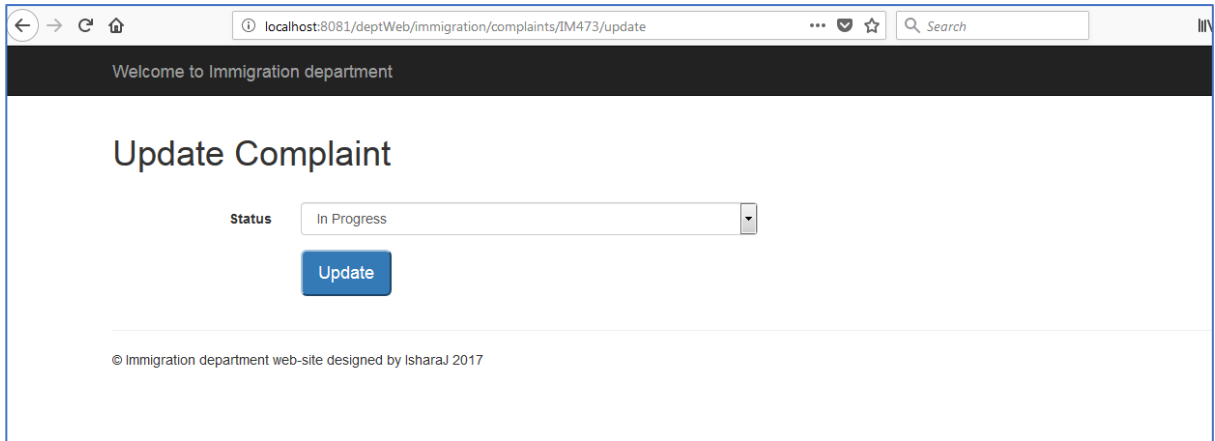
Before saving the complaint.

After saving complaint.

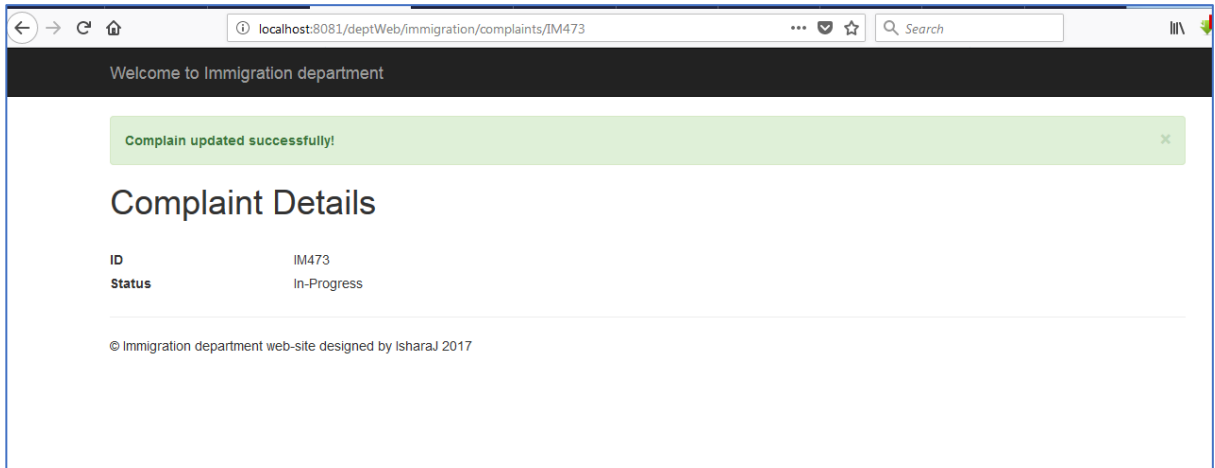10.Citizen sees complaint history with second complaint also

11. Staff member logs into the department web portal and view complaints
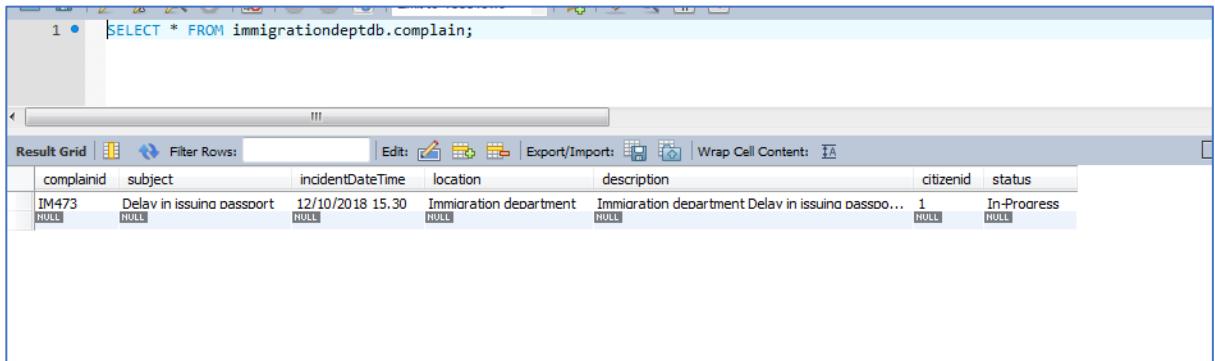

12. Staff member clicks on update and go to edit complaint status to in-progress.

Staff member sees the updates result.

New status gets updated in department DB

13. Updates status is reflected to citizen in history view