Crime Investigation Monitoring and Public Security Information System for Sri Lanka Police

A dissertation submitted for the Degree of Master of Information Technology

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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.

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Abstract

Today, crime is being committed in more refined strategies and in a more structured form. To successfully manage such conditions, investigative organizations are likewise getting systematized in investigation strategies.

In Sri Lanka, every year there are many pending and accused unknown case. The police department want to increase the efficiency of the investigative process to solve this problem. Implementation of Information Technology into a Police department and connect both police and public by the use of technology is priority one to increase the efficiency of the investigative process.

This system connected the Police Headquarters, police stations, police officers, CID officers, and the public together. This system helps to get publics' participation in the investigative process and speed up the investigation speed by the notable percentage.

The system keeps logs of a case which includes case summary, people involved, disputes, past criminal history of those involved, complaints, complaints responses, police officer details and public users' details

This system handles the sensitive data. Hence the development process gave more priority to the data security. This system architecture providing a guarding against the most security threats.

This system has been developed using PHP with MYSQL. Laravel 5.5 LTE framework is used for the developing framework. Laravel provides a powerful query system and better security as well. Addition to these mayor technologies, this system used other effective technologies like Bootstrap, Datatables, MailGun Mailing system, Twilio SMS System also.

This system capable to generate various type of reports which are most important to the investigation process. The NIC number of the person is enough to know that person's whole criminal history.

This system was successfully verified and validated by the various types of testing including unit testing, integration testing, system testing, acceptance testing and usability testing. The testing results are used to the improvements of the system.

Acknowledgements

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List of Abbreviations

CIM&PSI System   -   Crime Investigation Monitoring and Public Security Information System

CID   -   Crime Investigation Division

ICT   -   Information Communication Technology

OIC   -   Officer in Charge

POS   -   Point of Sale

OOA   -   Object Oriented Analysis

PACT   -   People - Activity - Context - Technology

SDIG   -   Senior Deputy Inspector General

DIG   -   Deputy Inspector General

SSP   -   Senior Superintend of Police

SQL   -   Structured Query Language

CSRF   -   Cross Site Request Forgery

XSS   -   Cross Site Scripting

SSL   -   Secure Socket Layer

CPU   -   Central Processing Unit

RAM   -   Random Access Memory

RAD   -   Rapid Application Development

RUP   -   Rational Unified Processing

MVC   -   Model-View-Controller

UI   -   User Interface

LTS   -   Long Term Support

HTML   -   Hyper Text transfer Protocol

MIT   -   Massachusetts Institute of Technology

API   -   Application Programming Interface

STMP   -   Simple Mail Transfer Protocol

SMS   -   Short Message Service

AES   -   Advanced Encryption Standard

URL   -   Universe Resource Locator

MAC   -   Message Authentication Code

ORM   -   Object-relational mapping

PDO   -   PHP Data Objects

GPS   -   Global Positioning System

Chapter 1 : Introduction

Introduction

Crimes are being committed to greater subtle strategies and in a greater organized form nowadays. New forms of crime are continuously happening. To successfully address such situations, investigative agencies are also getting systematized in investigation strategies. Especially in Sri Lanka, Police department plays the main role in the investigation and public security process. Specially Crime Investigation Department (CID) is the major agency which handles the crime investigation. This system proposed for the CID to enhance their effectiveness and efficiency of the investigation process. And the public security information module of this system support to ensure the public security as well.

1.1 Motivation

In Sri Lanka, every year there are many pending and accused unknown cases. Based on the Crime Statistics – 2016, total filed cases in 2016 are 36937. Out of this, 17241 cases are in pending by investigation delay and 5625 cases are accused unknown [1]. As the percentage wise, 62% cases are in pending. It is a huge amount to compare with other countries like Singapore, Malaysia [2].

This following Table 1.1 shows the grave crime abstracts for the Years from 2005 to 2016. These details are gathered from the Sri Lanka Police Website [1].

Table 1.1 Grave crime abstracts (2005 - 2016) in Sri Lanka

		Details			
		Cases Recorded	**Accused Unknown**	**Investigation Pending**	**Total pending**
Year	**2005**	59391	19061	24263	35709
	2006	61196	18310	28650	38522
	2007	56454	15820	27009	36510
	2008	60870	16544	29800	39498
	2009	57340	14336	28448	38142
	2010	57560	16202	26049	34809
	2011	54367	14969	25193	34864
	2012	52836	13760	32720	37692
	2013	55349	12908	26461	37512
	2014	50962	11505	23034	34461
	2015	40188	8837	18168	27613
	2016	36937	5625	17242	26834
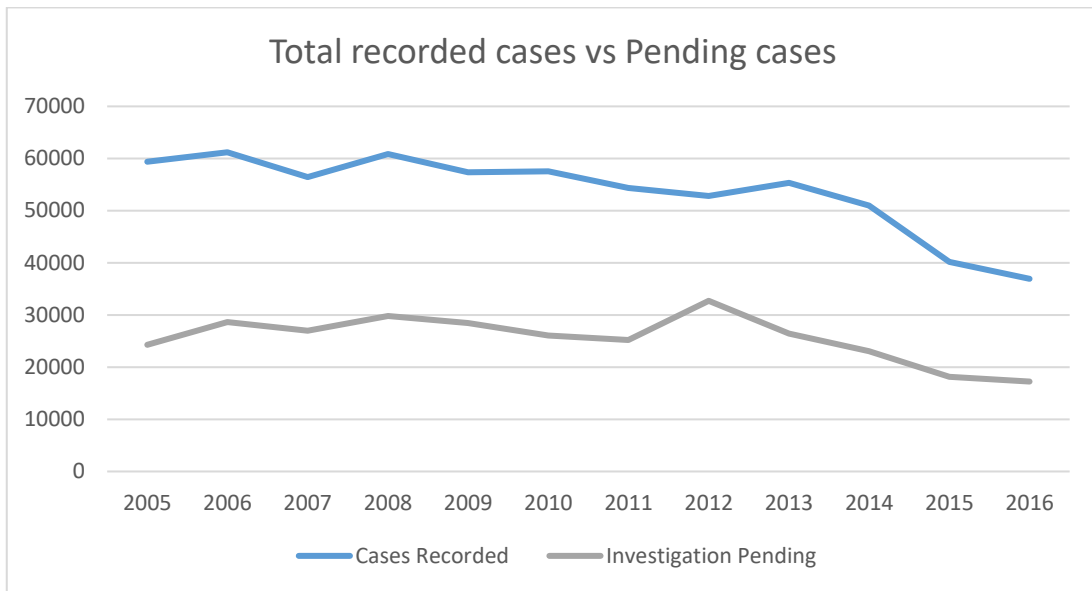
Figure 1.1 Total registered criminal cases vs pending criminal cases
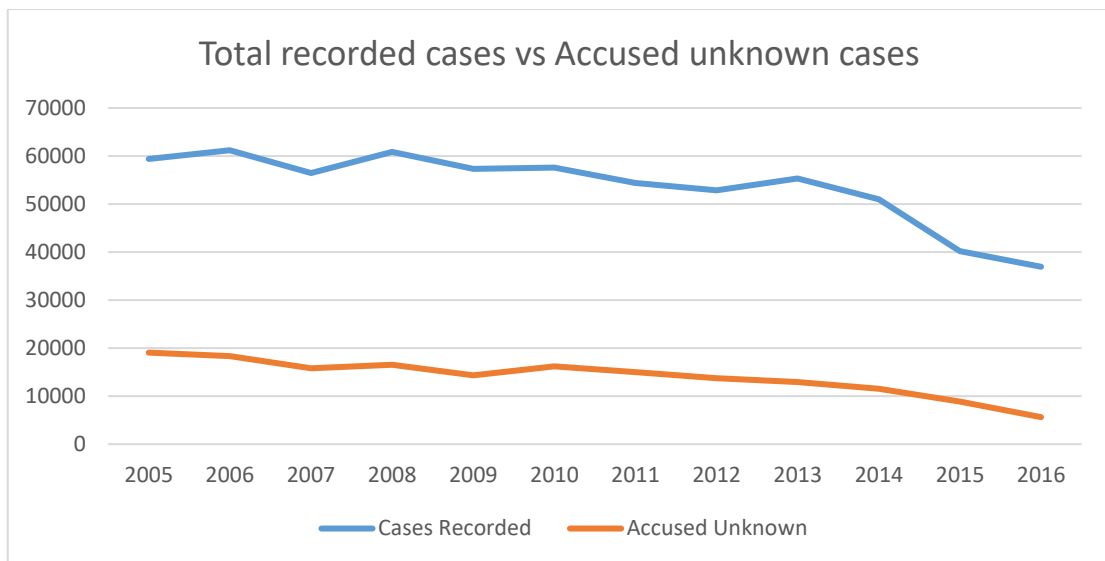
Figure 1.2 Total registered criminal cases vs accused unknown criminal cases

The Figure 1.1 and Figure 1.2 that created by the data from Table 1.1, there is no any major difference in ratio between total recorded cases and pending investigations and ratio between total recorded cases and accused unknown cases. Sri Lanka has witnessed a rapid increase in ICT Literacy, Computer Penetration and Internet Penetration. The following Figure 1.3 shows the rapid advancement in these areas. This Figure 1.3 was collected from the labor department website [3].
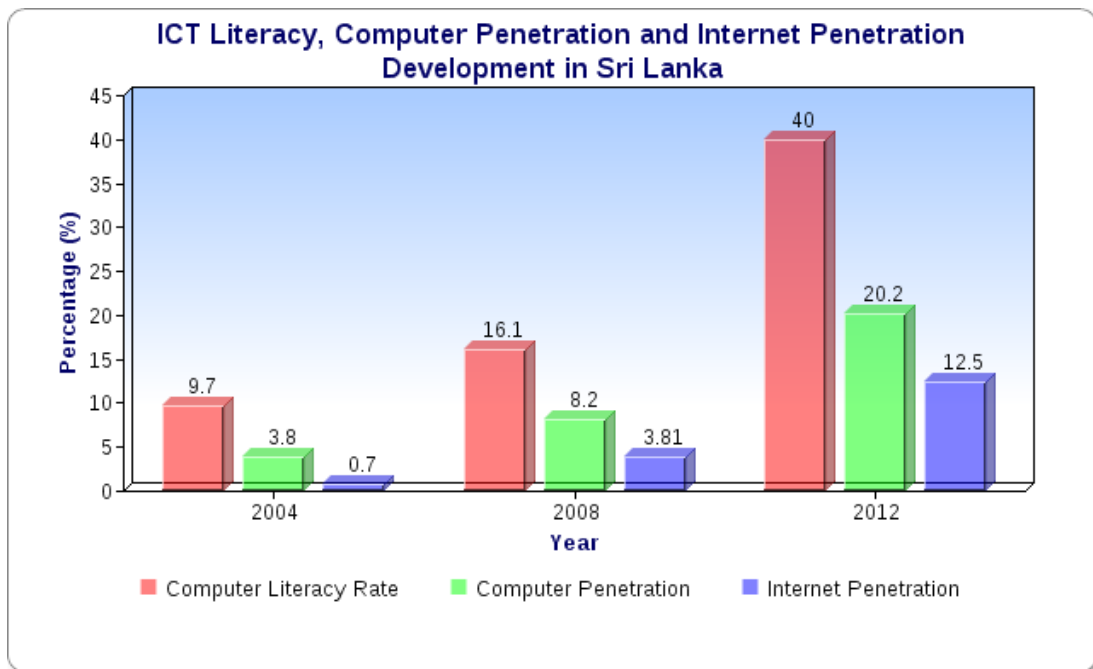
Figure 1.3 ICT literacy, computer penetration and internet penetration development

Hence, here obviously reveal that the technology growth of Sri Lanka is not impacting or poorly use the technology in the criminal investigation process and public security of Sri Lanka Police.

And another reason for this problem is lack of policemen. Public and police ratio in Sri Lanka is 424:100000 [4]. But in Singapore, it is 713:100000 [5]. Sri Lanka needs additional human resource power in the police department and wants to increase the efficiency of the investigative process.   To solve this problem, Sri Lanka government want to increase the human resource in Sri Lanka Police. It is a big procedure and generally impossible because the economic state of our country and commonly the public has less interest to join the police service.

This situation has motivated the criminals to continue their illegal activities and crimes. Therefore, States' law and order, public security are under threat. It is very important stuff which enriches the public security with information technology. Current manual processes in the police department, for the example complaints, security alerting is made unnecessary delays and these become mayor threads for public security. The implementation of Information Technology into a Police department and connect both police and public by the use of technology are essential.

1.2 Aims & Objectives of the System

This proposed Web-based Crime Investigation Monitoring and Public Security Information System aimed at getting involve the public into the investigation process. But also increase the efficiency of the investigation process and ensure the public security.

The system is proposed to assist police CID unit to boost up their investigation procedure and track the status of multiple cases at a time. In this system, public citizens itself helps the police to get the crime information rapidly and to proceed with the investigation. The system is designed to support to the investigation groups to work together on cases, coordinate and additionally speed up the process via the use of this system and ensure the general public protection with the aid of the general public security information system module. Additionally, this system makes the case transparent to the police department. consequently, corruption is impossible.

1.3 Scope

This system connected the Police Headquarters, police stations, police officers, CID officers, and the public together. This system helps to get publics' participation in the investigative process and speed up the investigation speed by a notable percentage.

The system keeps logs of a case which has case outline, people concerned, disputes, past criminal history of these concerned, things recovered on the scene, footages and other details that enter and transfer by the investigation officers. The system allows officials to update the status of investigation anytime anywhere. This system does not only help to track the history of the case but also provide support to track criminals' history.

The public user can view the wanted persons and missing person's information, photography and identity details which post by Police OIC in his interface and post a response if they know that persons. Same as this, Police OIC can get help request to the user to identify the unidentified objects which are collected as an evidence from crime area, for the example a watch, a piece of a cloth etc. When, if the user knows the details of the evidence, that user can easily give an information to police via provided data input portal in this system.

The public can easily make complaints without any delay with complaint trace facility and also they can get security related warnings and information which are post by police through this system on time.

The proposed system providing a support for high-level decision making by its information delivering techniques. Investigation and public security-related information are delivered to the police higher officials in well-structured graphical manner. Graphical representation of the information is easily understandable and support to efficient and effective decision making.

1.4 Structure of the Dissertation

Chapter 1: Introduction

The introductory chapter explains the motivation, aims, objectives and scope of the criminal investigation monitoring and public security information system. And this chapter compares the current trends of the crimes in Sri Lanka with the development of Information Technology.

Chapter 2: Background

The background chapter analyses the strengths and weakness of the system with identified stakeholders. And also review the features and technologies of existing similar systems.

Chapter 3: System Analysis

The Analysis chapter discusses the information gathering techniques that used to identify the requirements of the proposed system. And this chapter deeply explains the identified functional, non-functional requirements in various subsections.

Chapter 4: System Design

The system design chapter explains the software development methodology that used in this system designing and compares with other alternative solutions. And also it describes the structure and architecture of the proposed system.

Chapter 5: Implementation

The implementation chapter describes the implementation technologies that used in this proposed system. And It justifies the reasons for the selected Languages and framework, database technologies, user interface, security features and other technologies.

Chapter 6: User Evaluation and testing

The User Evaluation and testing chapter describe the testing objectives, strategy and testing plan. This chapter critically analyze the testing results.

Chapter 7: Conclusion and Future Work

The Conclusion and Future Work chapter summarizes the work, discusses its finding and point out the limitations of the current system. And also contains the recommendations on areas for improvements and future developments.

1.5 Summary

The introduction chapter explained the motivation, aims, objectives and scope of the proposed system and compares the current trends of the crimes in Sri Lanka with the development of Information Technology. next chapter is the background chapter that describes the background of the proposed system.

Chapter 2 : Background

Introduction

This chapter analyses the strengths and weakness of the system with identified stakeholders. And also review the features and technologies of existing similar systems.

2.1 Stakeholder Identification

Sri Lanka Police CID and the public are the Primary Stakeholders of the Crime Investigation Monitoring and Public Security Information System. Sri Lanka Law and Government policies also directly impact the system. As a stakeholder, the Police officer can simplify the investigation process and easily ensure the public security. Part of this, general public feel safe and anytime they can ask help from the police and they can also help the police for their investigation process. Sri Lankan Law directly impacts the system by human rights, national security acts, etc. And the government policies are also impacting the system as well.

2.2 Strengths

Rapidly Developing Tele Communication Technology of Sri Lanka is the major strength of this system. For this web-based system, telecommunication technology is the primary requirement. The telecommunication industry in Sri Lanka continued its growth momentum in 2016 largely supported by increased telephone and internet connections. The total number of mobile telephone connections available in the country increased by 7.6 percent to 26.2 million by end 2016 in comparison to the previous year. Figure 2.1 shows the telephone penetration from 2012 to 2016. This Figure 2.1 was collected from the Central Bank report [6]. With regard to internet services, total internet connections grew by 20.3 percent to 4,920,554 during the year, increasing the internet penetration to 23.2 by end 2016 [6].
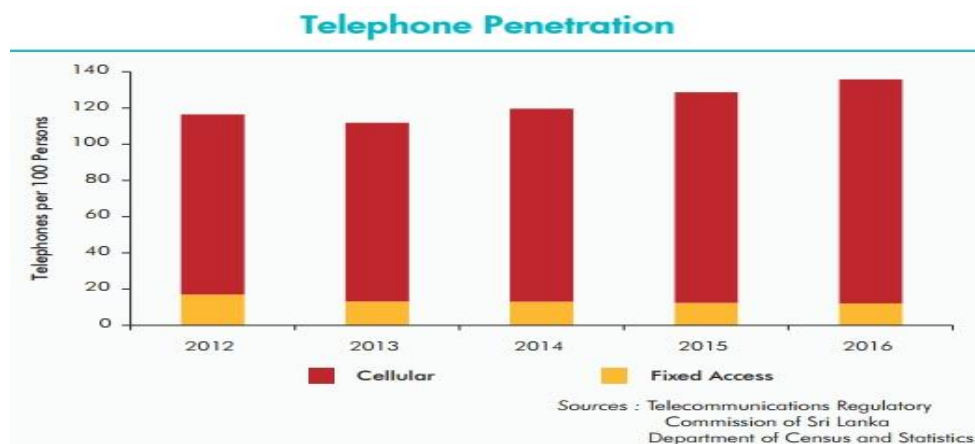
Figure 2.1 Telephone Penetration (2012 - 2016) in Sri Lanka

Rapidly Developing ICT Skills Among Sri Lankans also another strength. ICT skills like computing, using e-services, internet etc. are the requirement for this system from the user side. Active usage of ICT services in economic activities, such as e-banking, e-business, mobile banking, e-bus ticketing, and mobile point of sale (POS), has also increased in recent years [6]. This information is the proof for the developing ICT skills among Sri Lankans.

The main strategies of Ministry of Telecommunication and Digital Infrastructure, Sri Lanka are to improve the digital infrastructure of Sri Lanka for facilitating the enhancement of digital ecosystems, utilize the ICT for improving the governance, improve the use of ICT applications in key sectors, improve citizens' engagement/participation in ICT enabled society and facilitation of ICT industry development [7]. These strategies are providing great support for this system.

2.3 Weakness

There is a chance to misuse the system by some users both police and public. For the example, fake complaints by users. In manual complaint process, there is a less probability to provide fake information. But in this online process, confidentiality is in lower level. And there is a change to some higher officials in police department misuse the crime investigation information, evidence or delete the files. And human 'mistakes' also impact the effectiveness of this system.

2.4 Review of Similar Systems

This section reviews the existing systems that are similar to CIM&PSI System.

2.4.1 Sri Lanka Police Website

Currently, in Sri Lanka, there is no any this type of system. In the police website (police.lk), the user can only make a complaint. But there is no any facility to trace their complaints. Without tracing facility, online complaints are pointless.

Figure 2.2 Online complaint registration form in Sri Lanka Police website

Above Figure 2.2 shows the complaint form that exists in the Sri Lanka Police website [8]. This complain form is not suitable for emergency situations because of its complexness. In the emergency situation, this long form filling is not an important thing. The efficiency of the complaint process depends on time take to make the complaint. And another problem is, there is no user registration facility. The Sri Lanka police highly depend on media to publish the wanted person or missing person details.

2.4.2 Indian Tamilnadu Police Website

The Indian Tamilnadu Police provides an online complaint portal on their website with tracing facility. But the tracing of the complaint depends on the complaint reference number. Without the reference number, tracing is not possible. It is not a good practice. And user interface of the website also developed in a disturbing manner and difficult to identify the tasks and elements. Mobile friendliness also missing and complaints form are in complex format. Figure 2.3 that captured from the Tamilnadu police website shows the complexness of that system [9].

Figure 2.3 Online complaint registration form in Indian Tamilnadu Police website

2.4.3 The Interpol Website

In Interpol also provide an online complaint facility like above mentioned Sri Lanka and Tamil Nadu police web portal and additionally they provide the Wanted Person and Missing Person Information. But they do not provide security alerting facility or user registering facility. Displaying the wanted Person and missing Person details are not mobile friendly. It is very difficult to view on mobile devices. Figure 2.4 shows the wanted Person and missing Person details that display on the Interpol website [10].

Figure 2.4 Wanted persons details page in Interpol website

2.5 Summary

This chapter analyzed the strengths and weakness of the system. Rapidly developing telecommunication technology in Sri Lanka, rapidly developing ICT skills among Sri Lankans and Great support from Sri Lanka government are identified as strengths and possibilities of the misusing of the system is identified as a weakness. And this chapter compares the features and the technologies of the existing similar system. System analyzing is the next chapter that going to analyze the proposed system.

Chapter 3 : Analysis

Introduction

This chapter discusses the information gathering techniques that used to identify the requirements of the proposed system. And this chapter deeply explains the identified functional, non-functional requirements in various subsections. The analysis part of this system starts with information gathering that using the methods of interviewing, secondary research and PACT analysis. Analyzed results were clearly showing by use case diagram and use case narratives at the end of this chapter.

3.1 Object Oriented Analysis (OOA)

This completed system used Object Oriented Analysis (OOA) method to analyze the system. Object-Oriented Analysis focuses on data rather than the procedures as in Structured Analysis. It permits effective management of software system complexness by the virtue of modularity. It will be upgraded from little to massive systems at a bigger ease than in systems following structured analysis.

3.2 Information Gathering Techniques that used in CIM&PSI System Analysis

These following techniques are used to gather the requirements of the system

3.2.1 Interviewing

CIM&PSI collected information from higher officials of the police department and also the field officers by both unstructured and structured Interviews. Unstructured Interviews help to acquire basic information about the CIM&PSI system. And the structured Interviews help to understand the deep view of the system.

The reasons for selecting interviewing method for this system is for the work nature of the policemen, they have not enough time to communicate by writing or complete any questionnaires. This system contains complex subjects. Hence there is not a possible efficient way to get detailed information rather than interviewing. This method helps to easily validated and cross-check the information immediately.

3.2.2 Secondary Research

It is a method which uses the any previously gathered information from any internal or external source.

Sri Lankan Police system is well structured and pre-defined one. Therefore, it is possible to acquire most of the initial information from trust sources. The proposed system used Police department official website and the other government organization websites as trashed sources to gather the information.

3.2.3 PACT Analysis

The essential part of the design approach is to place people first. That's mean "People-Centered" design. For this People-Centered designing, at the start need to analyze the system with regard to people and the way they are going to use.

Designers ought to concern the people who will use the system, activities that people need to undertake, contexts in which those activities take place and the technologies which are exploitation the system in before the designing a part of the system.

Refer Appendix A for the complete PACT analysis

3.3 Gathered General Information About Crime Investigation Division – Sri Lanka Police

Sri Lanka police are the organization for ensuring Law enforcement, Security in national range. More than 85000 employees are working in this organization. The Sri Lankan Police is headed by the Inspector General of Police, who has, in theory, autonomy to commanding the service from the Police Headquarters in Colombo, and support by the Police Field Force Headquarters [11].

The police area is divided into five primary geographic commands, named as ranges under the command of a Senior Deputy Inspector General of Police (SDIG). The ranges were subdivided into Provinces, Divisions and police stations. Each police province headed by a Deputy Inspector General of Police (DIG), police division headed by a Senior Superintendent of Police (SSP) and the police station headed by an Officer in Charge (OIC) [11].

One of the major agency of this Police department is Crime Investigation Division (CID). This system fully supports the CID and also has public security information module. The main role of the CID is investigating all the serious crimes including murders, rape and organized crime. The CID has the power to arrest a person from anywhere in Sri Lanka without getting approval from any Range DIG. The main actor of the CIM&PSI system is station OIC. OIC has most of the powers. Higher officials who above the OIC range, they are doing a supervisory role in this system. Station OIC and the officers who are work under the OIC have used this system for their day to day investigation process. And the same time, this system support for the higher officials to supervising and decision-making.

3.4 Functional Requirements

3.4.1 General Requirements

- Non-Registered users shall be able to register into the system
- Registered and account activated users shall be able to login into the system
- Registered and account activated users shall be able to reset password
- Registered and account activated users shall be able to edit their profiles

3.4.2 Functional Requirements Related to Criminal Cases

- OIC shall be able to register new case that under his police station
- OIC shall be able to Close the case that registered under his police station
- The administrator shall be able to re-open the case
- The administrator shall be able to transfer the case between police stations
- OIC shall be able to add evident to the case that registered under his police station
- Below OIC officer shall be able to add evident to the case that assigned with him
- OIC shall be able to add new crime related individual into the system
- OIC shall be able to add or remove crime related individuals into the case that registered under his police station
- OIC shall be able to assign the crime types for a case that registered under his police station
- OIC shall be able to assign the police officers to the case that registered under his police station
- OIC shall be able to enter the court related details into the case that registered under his police station
- OIC shall be able to enable the crime related individuals' information to the public view

- OIC shall be able to enable the evident information to the public view
- Registered and account activated public users shall be able to view and response the publicly enabled CRI details
- Registered and account activated public users shall be able to view and respond to the publicly enabled case evident details

3.4.3 Functional Requirements Related to Users
- OIC shall be able to activate the public users' accounts which are registered under his police area
- OIC shall be able to activate the below OIC officers' accounts which come under his police station
- Admin shall be able to activate the SGIG, DIG, SSP and OICs' user accounts.
- Admin shall be able to transfer all police officers
- All level of police officers shall be able to view the crime related individuals' details

3.4.4 Public Security Related Requirements
- Registered and account activated public users shall be able to register a complaint
- Registered and account activated public users shall be able to trace the complaint status
- OIC shall be able to respond to the complaint that occurred in his police area
- OIC shall be able to create and publish the security-related emergency notes and news
- Registered and account activated public users shall be able to view the security-related emergency notes and news.

3.4.5 Report Generation Related Requirements
- The administrator shall be able to generate the various type of reports including registered police officers, registered public users, registered cases, pending cases, registered complaints, pending complaints and case related individuals details.
- SDIG, DIG, SSP and OIC shall be able to generate various types of reports by the details that come under their areas.

3.5 Non -Functional Requirements

3.5.1 Maintainability

- The system should be able to easily adopt future changes without doing major changes in existing components.

3.5.2 Availability

- The system should be guaranteed with 99 percent uptime

3.5.3 Security

- The system shall be able to protect against unauthorized activities
- The system shall be able to protect against common web application security threats that including SQL injection, Cross-Site Request Forgery (CSRF) and Cross Site Scripting(XSS)
- The system shall not allow the users to access pages or contents by edit the URL
- Data inputs shall be validated properly
- The system shall automatically log out all users after a period of inactivity.
- Number of fail attempts shall be limited
- Connection from the web server to browser shall be protected with Secure Socket Layer (SSL)

3.5.4 Scalability

- The system should be handle increases in load without impact on the performance

3.5.5 Portability

- The system should be support for the all modern browsers and screen sizes

3.5.6 Efficiency

- System server should be able to manage the connections nearly fifty percent of Sri Lanka population at a time.

3.5.7 Supportability

- The system should provide helpful information for identifying and resolving when it fails to work correctly

3.5.8 Usability

- The user interface should be simplified and provide a clear sequence of screens
- Reading characters on the screen should be easy
- Organization of information should be clear
- Use of terms are should be proper
- Terminologies are should be related to tasks
- The position of notifications should be proper on screen
- The system should be informed about its progress
- The system should be easy to learn to use the system
- The system should be performing tasks straightforward

3.5.9 Hosting Server Requirement

The number of users of this system are really huge because that the CIM&PSI system was developed to serve the whole citizens of Sri Lanka. As a web-based system, CIM&PSI need to host with a powerful and secure server.

Minimum Requirements of Server

- 8 Core/ 16Thread CPU
- 16 GB of RAM
- Unmetered Bandwidth

In addition to this hardware requirements, Server should be facilitated with Load Balancer. Load Balancer distributes the incoming traffic across multiple availability zones. It increases the availability and fault tolerance of the application

3.6 Use Case Diagram of CIM&PSI System

A use case diagram is the simplest way to represent the interaction between the different type of users and system. It describes who are the users and what ways the user interacts with the system in a graphical representation. Figure 3.1 shows the Use case diagram of the CIM&PSI System.
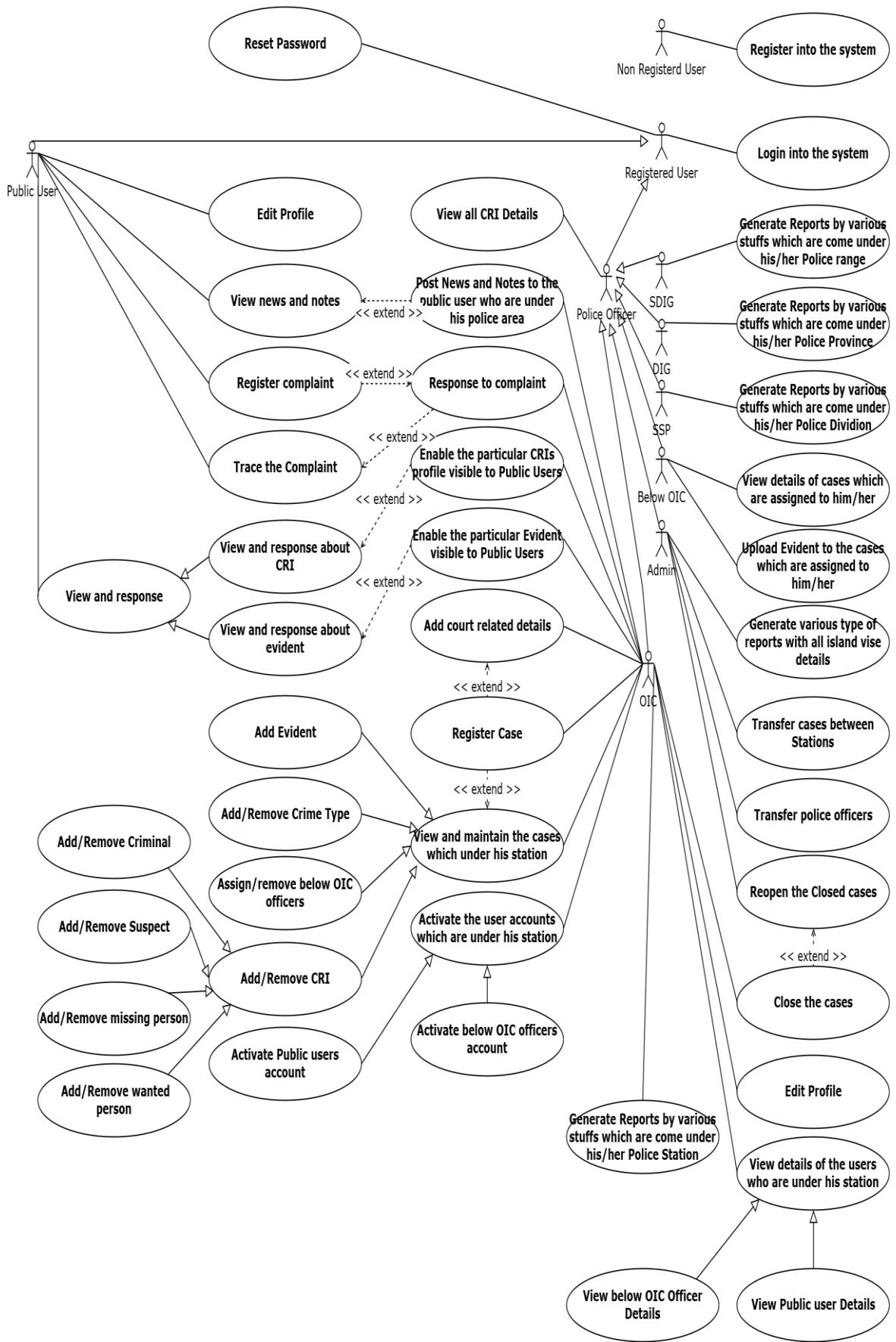
Figure 3.1 Use Case diagram of CIM&PSI System

Refer Appendix B for Use Case Narratives

3.7 Summary

CIM&PSI system used Object Oriented Analysis (OOA) methodology to analyze the system. System requirements are gathered from interviewing, secondary research and the PACT Analysis. requirements are categorized as functional requirements and non-functional requirements and visually represented the diagram by the Use case diagram. System designing is the next chapter that going to explain the designing part of the project

Chapter 4 : Design

Introduction

This chapter explains the software development methodology that used in this system designing and compares with other alternative solutions. And also it describes the structure and architecture of the proposed system.

4.1 Software Development Methodology

Software development methodologies play an important part in developing the software system. There are several methodologies that are utilized by the professional software system development firms these days. There are bound benefits and drawbacks related to each of them. the fundamental purpose of those methodologies is to provide sleek software system development consistent with the project requirements.

This completed CIM&PSI system developed under Rational Unified Process methodology. There are many development methodologies. Waterfall Model, Prototype Methodology, Rapid Application Development methodology (RAD) are some famous software development methodologies. For the nature of this CIM&PSI system, Rational Unified Process methodology is most suitable one.

Waterfall model is one of the traditional software methodologies. It is a linear sequential flow process model that means it is not possible to start a particular development phase rather than that the phase which is previous one to the current phase is completed. This development approach does not allow to go back to the previous phase and work on changes in requirements. The nature of the human, it is not possible to understand or delivering the accurate requirements in a very first step. Changes in requirements are very common and frequent one in software development. May it possible to rise a change requirement in very last movements also. The nature of this completed system is complex because of the functionalities. Therefore, it is not possible to define all requirements in initial movement. For this reason, waterfall model is not ideal for this CIM&PSI System [12].

The prototype is also one of the trending software development methodology which that allows the developer to develop a prototype of the real system and demonstrate the functionalities to the clients. In this methodology allow the clients to get the detailed understanding of the system and they can realize and deliver the actual requirements. And developer can make necessary modification before the development of actual software. But this methodology needs very much

of client involvement. It is not possible to get regular support and involvements from police officials because of their busy work nature. And the over modifications are causes negative impacts on the structure of the system like CIM&PSI and it easily affects the workflow of the entire development process [12].

Rapid Application Development (RAD) is also one of the leading software development methodologies. It allows the developer to provide quicker development. But the major drawback is that this methodology depends on the strong team performance and clearly identified system requirements [12].

CIM&PSI system follows the Rational Unified Process methodology for the system development. This modern methodology divides the development process into four phases which are inspection, elaboration, construction and transition. These four phases are each involves business modelling, analysis and design, implementation, testing, and deployment. This object-oriented and web-enabled development methodology helps developers for providing them guidelines and templates for all stage of the software development [12]. Following Figure 4.1 shows the RUP methodology as a graphical view.

Figure 4.1 Rational Unified Process Methodology

The idea for the project is stated in inspection phase and the project's architecture and required resources are further evaluated in elaboration phase. In the construction phase, the project is developed, completed and tested. The transition is the final phase. In this phase, the software is released to the client. And the final adjustments or updates are made based on end users' feedbacks [13].

The RUP is easy to tailored to fulfil almost any of the user requirements and working iteratively allows higher risks to be addressed in the early stage of the software development process.

The elaboration phase allows making sure that the proposed software architecture works. It projects technical risks during the development of the system skeleton in the elaboration phase. Through the iteration, it is easy to realize that the proposed architecture satisfies the requirements or not.

4.2 Software Architecture of the CIM&PSI System

CIM&PSI system is a Model-View-Controller (MVC) architected system. MVC support the faster development process, ability to provide multiple views and work on the modifications without affecting the entire system.

This software architecture divided into three interconnected components named model, view and controller. Figure 4.2 shows the architecture of MVC.
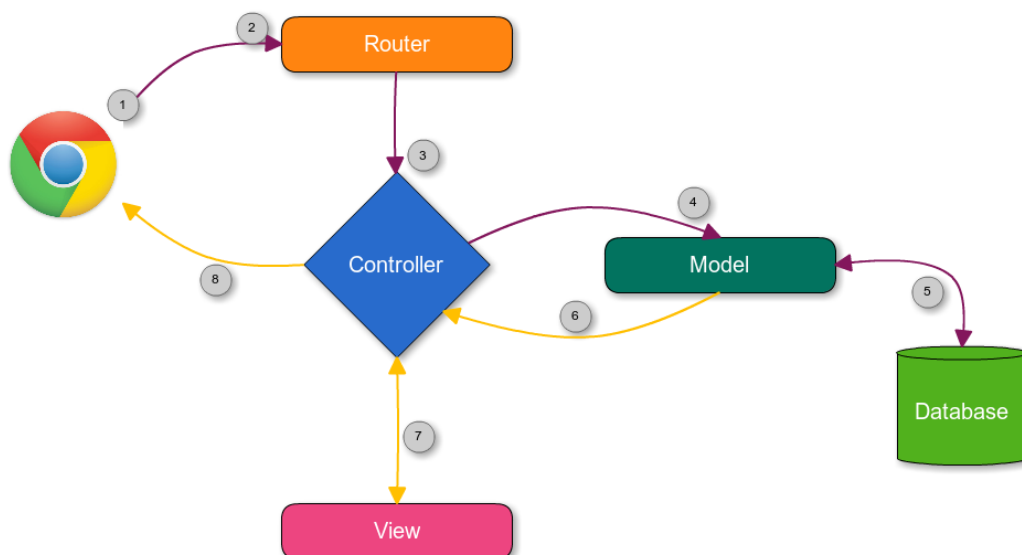
Figure 4.2 Model-View-Controller Software Architecture

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In this MVC method, Controller handles all requests from the application and instruct the model to prepare the content which required by the view. Then the controller receives the data from the model and brings it to the view for the final output [14].

4.3 Class Diagram of CIM&PSI System

The class diagram is the static structure type diagram and it describes the structure of the system. By this diagram, it is easiest to visualizing and documenting the different aspects of the software system and constructing code. Figure 4.4 shows the Class diagram of CIM&PSI System.
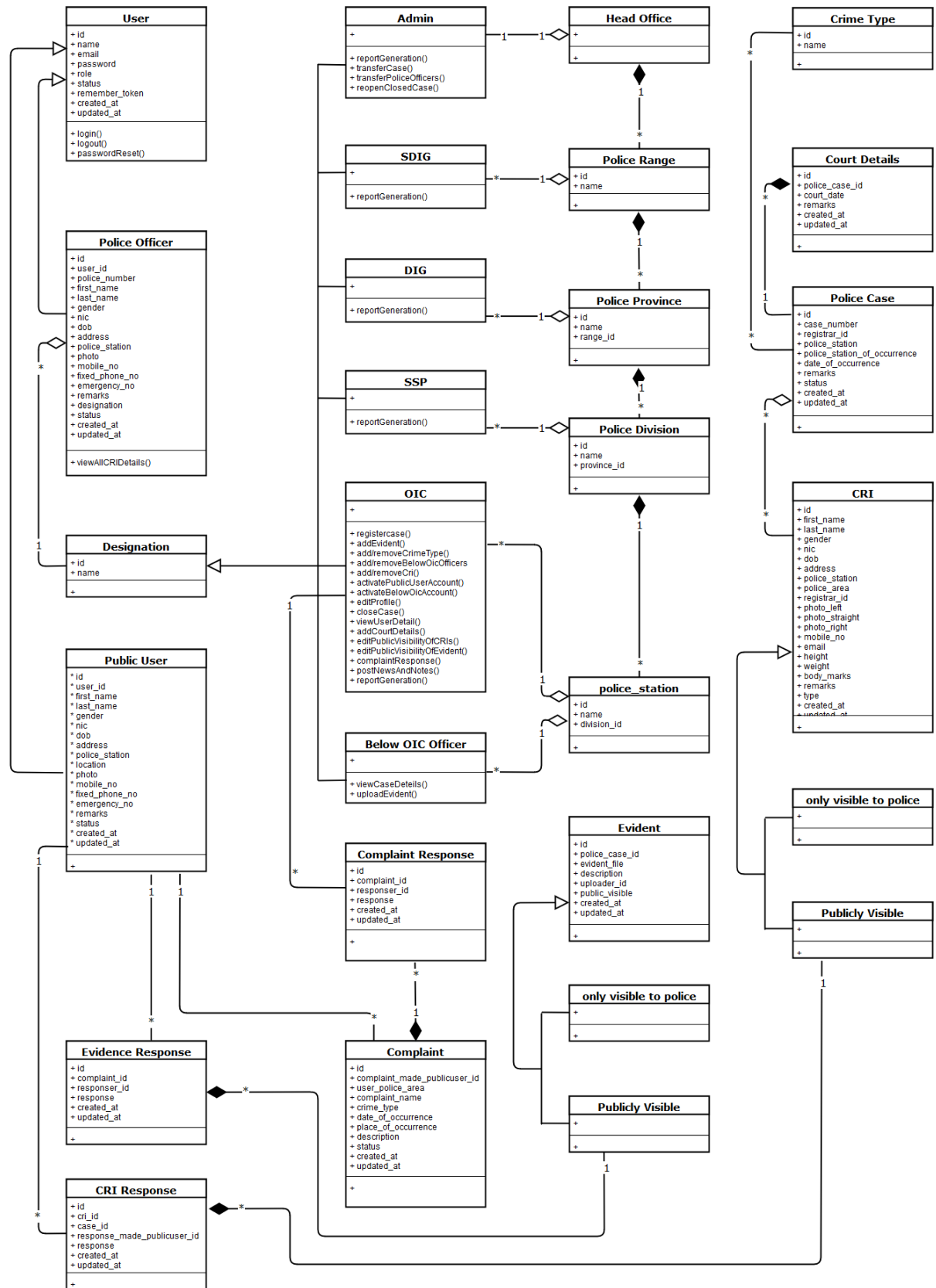
Figure 4.3 Class Diagram of CIM&PSI System

Refer Appendix C for Activity Diagrams

Refer Appendix D for Sequence Diagrams

4.4 User Interface Design

User interface designing should be simple and understandable. By the PACT Analysis of CIM&PSI system (Refer Appendix A) users of the completed system are physically, psychologically and socially differ from each other. By the people-centered designing methodology, system interface should be support for every user.

The interface should be kept in a simple manner and want to avoid the unnecessary elements. It is better to use very common UI elements in interface designing. its provide more comfort to the users and allow them to hit the targets quickly.

System alerts and notifications are should use suitable colors and positions. for the example success messages should be green and warning messages are orange like.

Police officials are generally physically fit. But because of their job environment, their fingers may be little rough. This is occurring button click problems when the officers use this system on their touch mobile phones. Small Touch Targets Lead to Big Problems. So the buttons which are in the system must be little bigger. This solution is also suitable for public people who are with big or rough fingers and with long nails. Also, these big buttons are helping the elders who are suffering from handshaking and the vision problems.

For the strategical decision making, information is should be represented by graphical view and reports are should be easily customizable. The elder people may have some physical problems like vision, color blind etc. Big fonts, dark texts and light backgrounds are the solutions for the people who are suffering from vision problems. For the color blindness peoples, the system needs to be sure that colors that system users do not convey important information. And increase the contrast between similar colors, lighten light colors and darken the dark ones, Increase saturation of colors, use patterns, symbols and strokes are also providing a positive impact on color blind and vision problems.

Following Figure 4.4 and Figure 4.5 are the sample mockups for the system design. Figure 4.4 shows the planed administrator's home page and the Figure 4.5 shows the public user homepage.
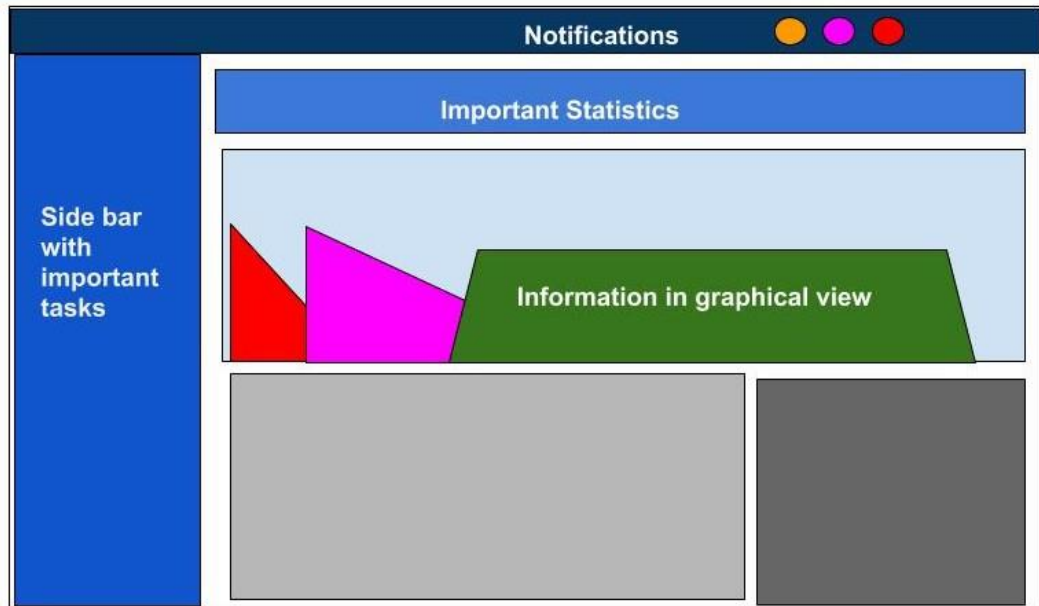
Figure 4.4 Administrator home page Mockup
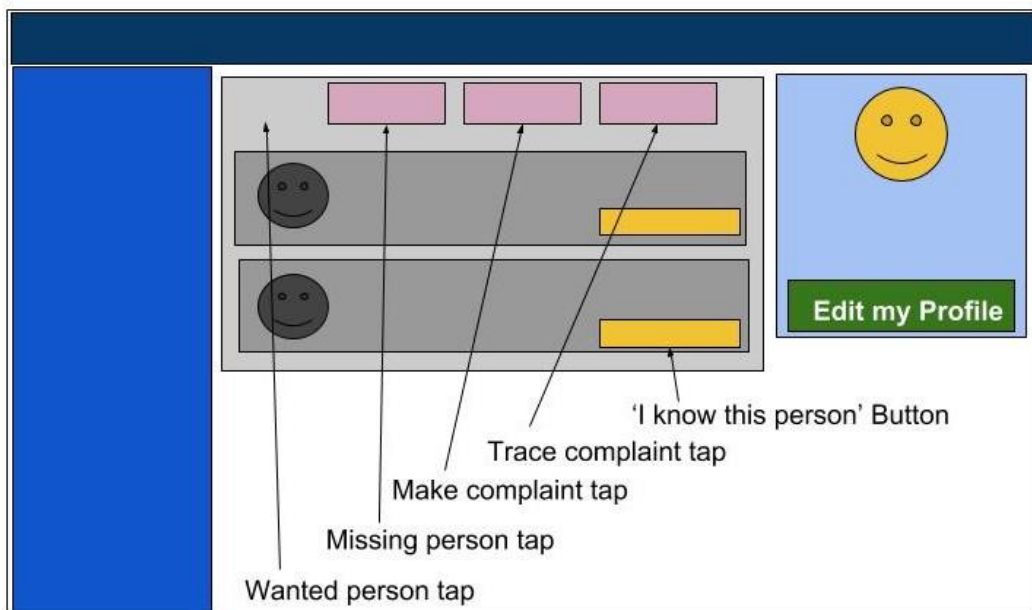
Figure 4.5 Public user home page Mockup

4.5 Summary

The completed system developed with the Rational Unified Process (RUP) Software Development Methodology and Model-View-Controller Architecture. RUP development methodology helps developers for providing them guidelines and templates for all stage of the software development and the Model-View-Controller (MVC) architecture support the faster development process, ability to provide multiple views and work on the modifications without affecting the entire system. Implementation is the next chapter that going to explain the implementation process of the completed system.

Chapter 5 : Implementation

Introduction

This chapter describes the implementation technologies that used in this proposed system. And It justifies the reasons for the selected Languages and framework, database technologies, user interface, security features and other technologies.

5.1 Web-Based System

CIM&PSI is a web-based system that allows the users connect to this centralized system from various locations throw web browser. Unlike traditional desktop applications, it is possible to access the web-based systems anywhere, anytime and any web-enabled devices. Web-Based systems just plug and play for the users and they do not need to worry about anything technical. Web-based is most suitable for the system like CIM&PSI system which for the users with different technical knowledge level and from different locations.

5.2 Languages and Frame Work – Laravel PHP Frame Work

A framework providing a structure to the code, allow the developer to write readable, maintainable code. Rapid development, more secure, easier maintenance, support to the stronger teamwork and the community support are the main advantages of using a framework for system development [15]. Laravel, Codeigniter, CakePHP, Symfony, Zend are some of the PHP frameworks which are using in PHP web application development. The completed system built with Laravel 5.5 MVC framework. Currently, Laravel is the most popular trending framework for the Google trend comparisons. Following Figure 5.1 shows the comparison between the PHP frameworks by Google Trends [16].
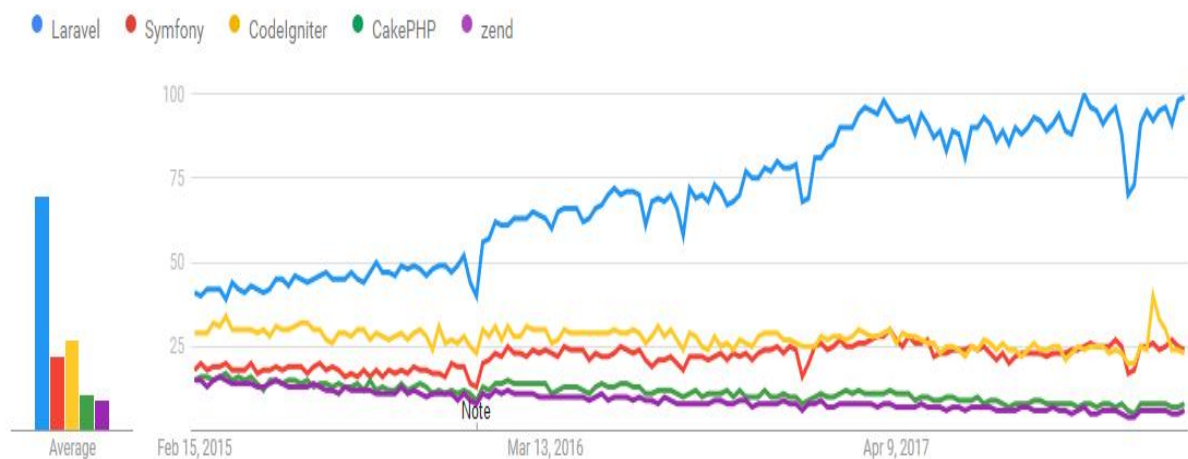
Figure 5.1 PHP Frameworks trend comparison (2015 - 2017) by Google Trends

Laravel provides a routing system that can be triggered in the application with better control. And it is an open source one. Laravel's Built-in Database Query Builder work smoothly on the database system and allow to run queries easier. The "Artisan" Command-Line Interface is the most powerful feature in Laravel which support to interact with the entire application using the command line. Laravel 5.5 is a long-term support (LTS) version and come with two years of bug fixes and three years of security updates [17].

5.3 Database

MySQL database is one of the Laravel recommended database and free to use and open source. It provides stable and reliable database solution and with advanced features and trusted by the world leading web applications like WordPress, Drupal, Joomla, Facebook and Twitter [18]. Data security, on-demand Scalability, high performance, complete workflow control and the flexibility of open source are the advantages of MySQL. Especially, MySQL gives an assurance of twenty-four hours- seven-days uptime [18].

5.4 User Interface

The user interface is that the area wherever interactions between humans and machines occur. The goal of UI design is to produce a UI that makes it straightforward, efficient, and pleasant (user-friendly) to control a machine within the approach that produces the specified result.

User Interface of the CIM&PSI designed in a simple manner with Twitter Bootstrap 3 integration. Bootstrap is a trendiest and effective lightweight frontend framework which come with CSS UI elements, layouts and JavaScript components using the jQuery. Responsiveness is the one of best bootstrap feature which allows the application to run on many devices including smartphones and tablets. Mobile friendliness is the priority feature for the system like CIM&PSI because of the emergency time usages.

Some of the UI components are extended from AdminLTE bootstrap 3 based admin dashboard template to this system for better usability. It is open source and available on GitHub with MIT License [19].

CIM&PSI System support the admin and the higher officials to make a strategical decision by providing a graphical data representation. Figure 5.2 shows the admin panel of the CIM&PSI System.
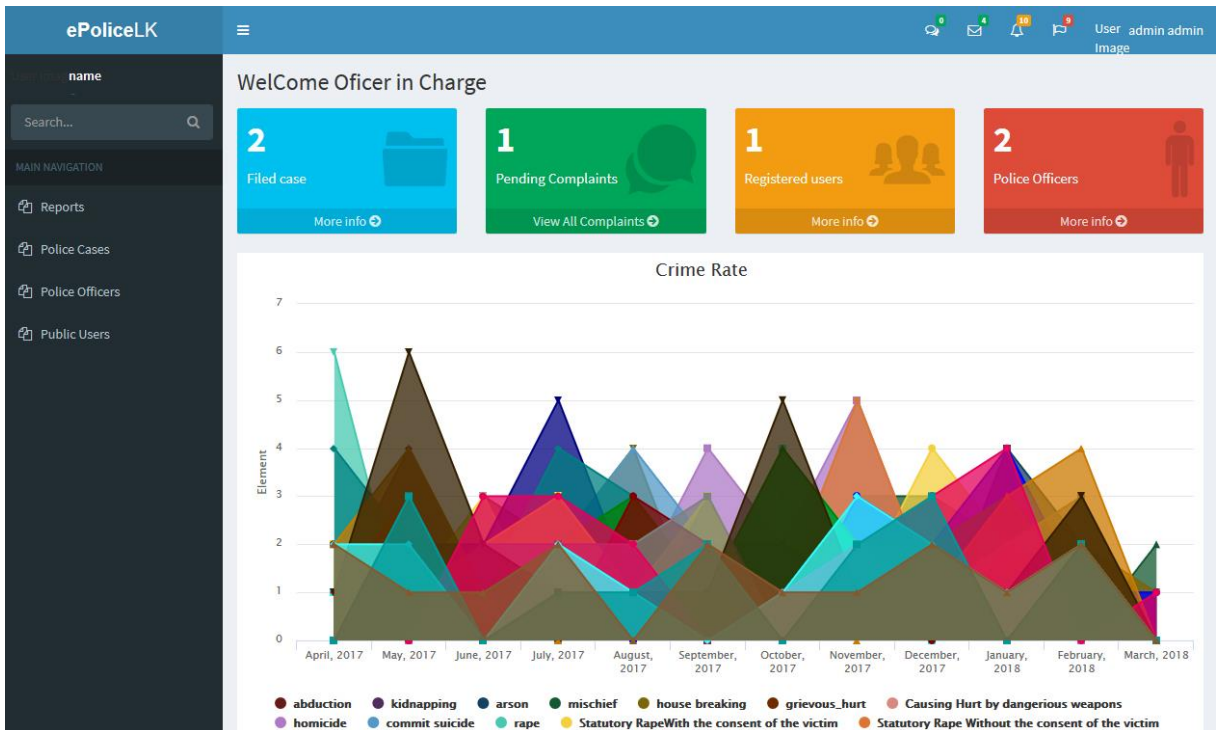
Figure 5.2 Administrator Home page view of CIM&PSI System

Highcharts JavaScript Charts libraries are adapted to provide a graphical view as charts for data.
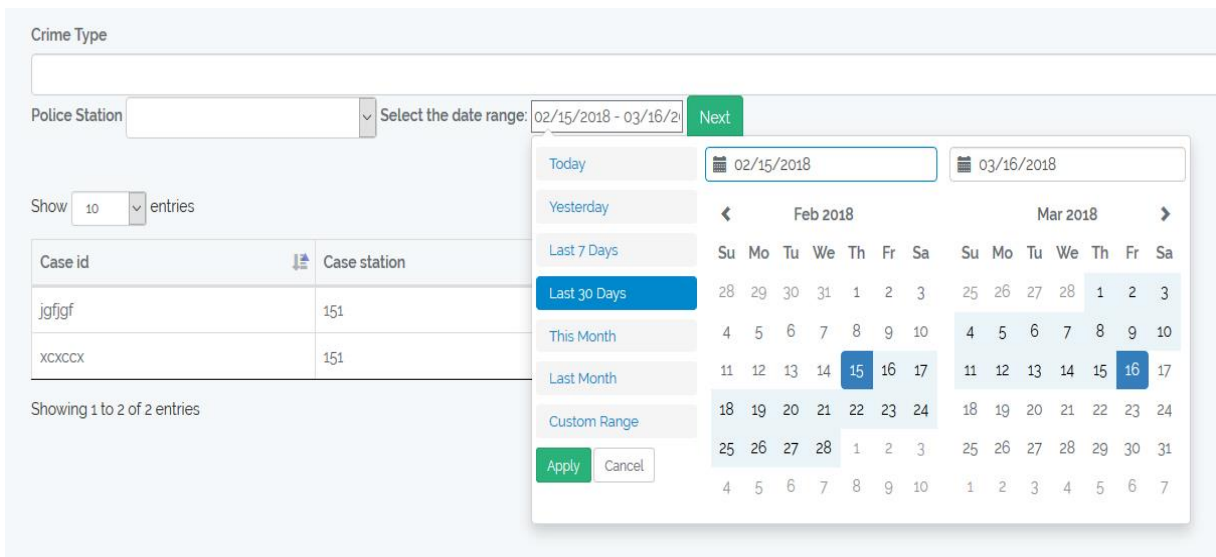
Figure 5.3 Crime case related report generation sample view of CIM&PSI System

Figure 5.3 is one of the sample report pages. It allows the user to customize the result by different aspects. The date picker is user-friendly to select a date range in simplest manner. Reports are easy to customize.

Figure 5.4 Single criminal case view of CIM&PSI System

The above Figure 5.4 shows the single case view dashboard with the control panel. OIC can easily update the investigation details throw this left side control panel. This interface also allows tracking the investigation process by its data.

5.5 Other Technologies that used to the Implementation

5.5.1 DataTables - The jQuery JavaScript Library

CIM&PSI system enhanced with the free open source Datatable.net jQuery JavaScript library to provide an advanced interaction controls for the HTML Tables. DataTables come with MIT license that means free to use and possible to modifying and redistributing the code. Pagination, instant search, multi-column ordering and mobile friendly are the notable advanced features in dataTables. Figure 5.5 shows the list of public users that generated by Data Tables technology.

Figure 5.5 Sample table that integrated with datatables technology in CIM&PSI System

Client-Side Processing and Server-side processing are the two methods which the dataTables allows for processing data to ordering, searching. In the client-side processing mode, dataTables allows to loaded up-front the full dataset and processing are done in the browser. This mode is suitable for small sized datasets. In this completed system, some activities, for the example, activating the public users by OIC, access the pending complaints are dealing with a small set of data. For this type of activities, client-side processing is most suitable and this mode also providing a speed processing. In another hand, there is a server-side processing mode which suitable for large datasets. In this mode of dataTables, an Ajax request is made for every redraw with only the data required for each display returned. The data is processing on the server. This server-side processing handle data rows smoothly even 20 million of rows. This mode is used in CIM&PSI system to process large datasets. For the example, view all registered users, view all cases are dealing with large datasets [20].

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5.5.2 Mailgun Email API

Mailgun is one of the leading email automation services which that offers cloud-based email service. It is owned by Rackspace Cloud service and allows the user to send fifty thousand of email every month free of charge. Mailgun is capable of integration with the application, sending email throw STMP. Mailgun also providing an email tracing facility throw the specified control panel. The CIM&PSI System need to send a lot of emails as notifications, emergency news and other kinds of messages across between millions of users. It is not the possible and effective way to send emails to throw local server. But Mailgun providing enough resources for this ultimate task [21].

5.5.3 Twilio Short Message Service

CIM&PSI system used Email and desktop notification systems to allow the users connect with an application. These two methods are little far with providing fulltime connectivity scenario because of it is not practically possible to expect the users use these services all time. The solution is SMS notification. SMS services are easily accessible even with feature phones also. It is the best communication way to increase the users' engagement with the system.
One of the main scopes of this completed system is to ensure the public security on time. SMS is the smartest way to inform and alert the users in emergency periods.

This completed system used Twilio SMS service to providing SMS notifications. Twilio is one of the leading and stable SMS service providers in worldwide and come with reasonable pricing.

This SMS service allows the developer to deal with trail SMS in developing and testing phase by providing numbers of free SMS. And also provide twenty-four hours' customer support [22].

5.5.4 Google Maps

Google map is taking the major role in current day to day activities. Advanced and accurate information that provide by google map makes it smart. Locations are one of the keys to security services. CIM&PSI used google map to share location related details between users and system. For the example, in complaint registration form, there is a form element named "Police Area of Occurrence" to find the OIC email and phone number by the system. In this field, a user needs to enter the police area of occurrence to submit. A problem arises here, what happens if that user does not know the police area of occurrence. Provided solution for this issue is Google

Map. In the complaint form, there is a customized Google map to find the police area of crime occurrence.

Figure 5.6 Customized Google Map by Sri Lanka Police Areas

The user can easily search the place and find out the police area of that place. This Figure 5.6 shows the customized map by the "My Map" feature of Google maps.

5.6 Security Features

The data which are handled by this CIM&PSI system is very sensitive. Not only the public security, also the state security is depending on this data. Nowadays, security of the web applications is in very critical condition. Correct the vulnerabilities of the system and keep the application securely is an essential part.

CIM&PSI system is proofed by these following security features to prevent the attacks against the system security.

5.6.1 Authentication System

CIM&PSI System used the Laravel's own powerful authentication system. "Providers" and "Guards" facilitate the solid authentication. The guards are using to handle the way to user authentication and the providers are using to retrieve the users from the database. Mainly the maximum numbers of failed login attempt are limited to five. This limitation provides proof against the brute force attack. Laravel Authentication system also handling forgot password issues, reset password in a secure manner [15].

5.6.2 MD5 Hashing Function

Users passwords are saved in the database as its Hash values. Hash values are the one-way property and cannot reversible. CIM&PSI system using MD5 Hashing algorithm and passwords are converted as the 128-bit digest. By this Hash function, user accounts are save even the database was compromised [15].

5.6.3 Advanced Encryption Standard (AES) 256 Encryption with the Digital Signature

CIM&PSI use AES 256 encryption algorithm to encrypt the sensitive values. For the example, in the single case file viewing scenario, the case number which in the URL is in the encrypted format. This technique prevents the user to view other case files by changing the case id in the URL. And these encrypted values are digitally signed by message authentication code (MAC) algorithm. Hence it is not possible to change the value after encrypted [15].

5.6.4 Authorization throw Middleware

CIM&PSI System authorized the users by middlewares. These middlewares use to check and allow the user to a particular action by their role powers. Middleware authorizes the actions before the user requests are reached to the controllers or the routes. By the architecture of the CIM&PSI system, all the user requests are pass throw routes. Routs are the key to transfer the requests to the suitable controller for further actions. Middlewares are placed in route directory and control the requests by user authorization. This technique prevents the unauthorized actions inside the system [15].

5.6.5 Protection against SQL Injection

CIM&PSI system using the Eloquent ORM. it uses the PDO parameter binding to prevent the SQL Injection. This PDO parameter binding method, data which pass from users are not utilized in SQL queries. Therefore, it is not possible to compromise the query by the third person.

5.6.6 Prevent Cross-Site Request Forgery (CSRF)

The completed system uses the CSRF Token to prevent the forged requests. CIM&PSI system attached a CSRF token together with every request. And compare the token value with particular user's session. The request was rejected when the token value is mismatched.

5.6.7 Protect against Cross Site Scripting (XSS)

Laravel's inbuilt function automatically escape the inputs while saving it on the database. And also escape while displaying the data.

5.7 Summary

This web-based system used Laravel PHP framework for development. Laravel provides rapid development, more secure, easier maintenance and support to the stronger teamwork. Addition to Laravel, there are many modern technologies were implemented which are bootstrap, MySQL, Charts, DataTables, Mailgun API, TWILIO SMS, Google Maps and various security features. User evaluation and testing is the next chapter that going to explains the verification and validation of the system.

Chapter 6 : User Evaluation and Testing

Introduction

This chapter describe the testing objectives, strategy and testing plan. And also this chapter critically analyze the testing results.

Quality is the most valuable thing of any product. The software product is different from others by its complexity, invisibility and the limited opportunity to detect defects. By this unique characteristic, the software product requires special attention on its quality. By the IEEE definition, software quality is "The degree to which a system, component or process meets specified requirements". Software quality assurance is the key to ensure the software quality.

6.1 Testing Objective

The main part of the software quality assurance is the software testing. Main objectives of the software testing are to verify and validate the software. Verification ensures that built the software right and the validation ensure that built the right software.

6.2 Testing Strategy

The incremental testing strategy was applied in the testing process of CIM&PSI. Because this system is the large one and the big bang strategy is not suitable for this. The incremental strategy allows to test and debug during smaller iteration. By this incremental testing strategy, unit testing, integrating testing, system testing and the acceptance testing were performed.

6.3 Verification and Validation

The unit testing, integration testing and the system testing were performed by the developer of the CIM&PSI to verify the system and the acceptance testing was done by the variety of users including police officers and the public users to validate the system. The completed testing process used both black-box testing and white-box testing classification for unit testing and the integration testing and black-box testing classification for system testing and acceptance test.

6.3.1 Unit Testing

Individual modules of the CIM&PSI system were tested by the developer under this methodology. Identified issues are fixed and the testing process applied again to that fixed

modules. This testing methodology helped to capture the defects in the early phase and allows better refactoring of code.

6.3.2 Integration Testing

After the completion of the unit testing, an integration test was executed by the developer under the Big-Bang strategy to test the integrated units. Integration testing verified the functional and performance of software units that are integrated.

6.3.3 System Testing

System testing performed under black-box testing technique. Prepared test cases were tested with completed CIM&PSI system by the developer. Functionalities of the completed system have tested an end to end perspective. Part of the system testing, load and stability test also performed. The system was loaded with heavy sample datasets and performance and stability were compared. Laravel's "Database Factory" method with faker function was used to load the sample data into the database.

6.3.4 Acceptance Testing

Specially selected group of users form both police and public were performed the testing to evaluate whether or not the system met the software requirements specifications.

6.3.5 Usability Testing

Part of the acceptance test, the usability of the system also tested by the targeted group of persons including both police and public with different educational level and age group. They are allowed to use the CIM&PSI system individually and collected their opinions by the questionnaire which contained the questions under categories of overall reaction, interface, terminology, system information, learnability and system capability. And also those users were allowed to mention the negative, positive aspects of the system.

Security test also performed in addition to these above four testing methods. Part of the security test, CIM&PSI system's capability against SQL injection, Cross-Site Request Forgery and Cross Site Scripting were checked with sample inputs.

6.3.6 Test Automation

The automated test was performed to check some functionalities which are required to run multiple times. Functions of user login, case updating were automated by Selenium IDE. Selenium used to record and run test cases. Figure 6.1 shows the screenshot of test case recording by Selenium IDE.
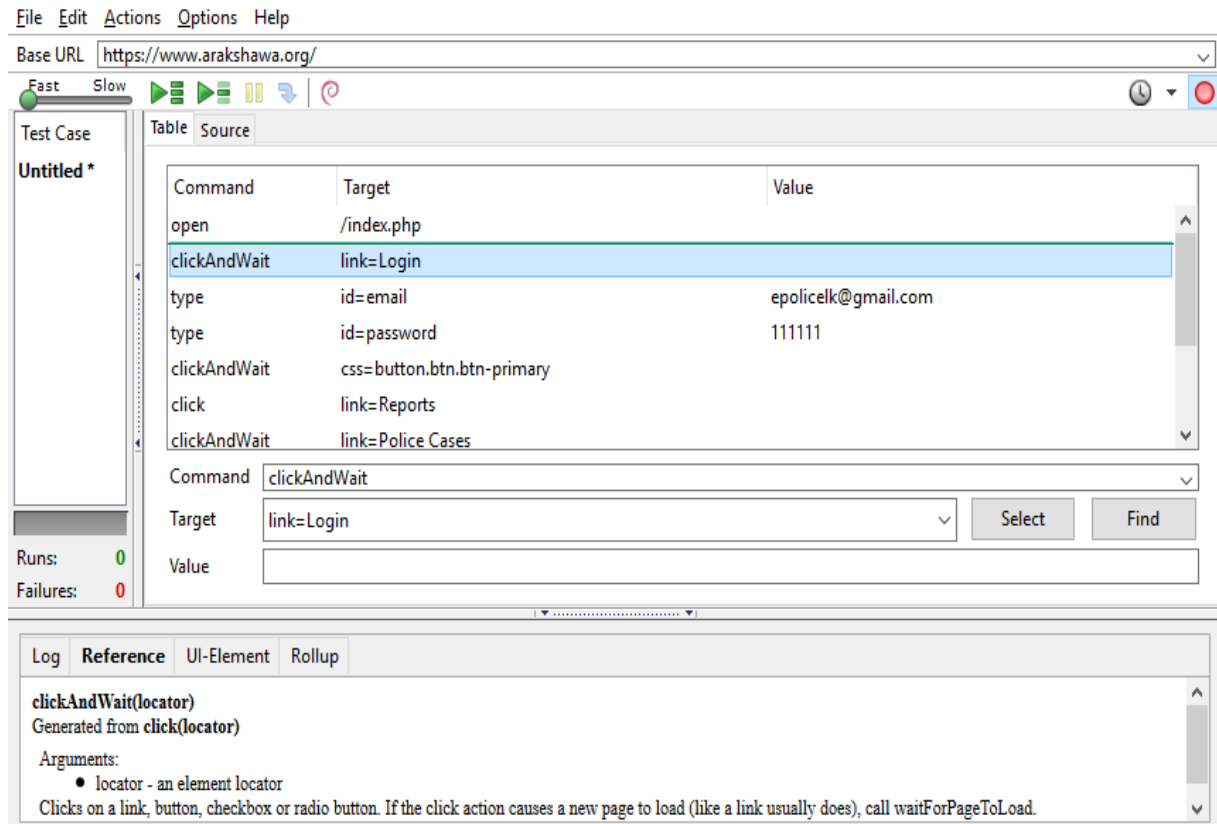
Figure 6.1 Screenshot of Selenium IDE test case recording

Refer Appendix E for complete test plan and test cases

Refer Appendix E for Usability Test Questionnaire Sample

6.4 Result Analysis of Usability Test Questionnaire

Following analysis completed by the data which got from sixty filled Questionnaires. For the easy understanding, data were graphically converted as the pie chart.

Note: Positive of the answer is increasing with the increase of the color's darkness.

6.4.1 Section: Overall Reaction

From question number 1 to 5									
Answer	Negative	1	2	3	4	5	6	Positive	NA
Count (Percentage)		0	0	0.6	6.7	86	6.7		0
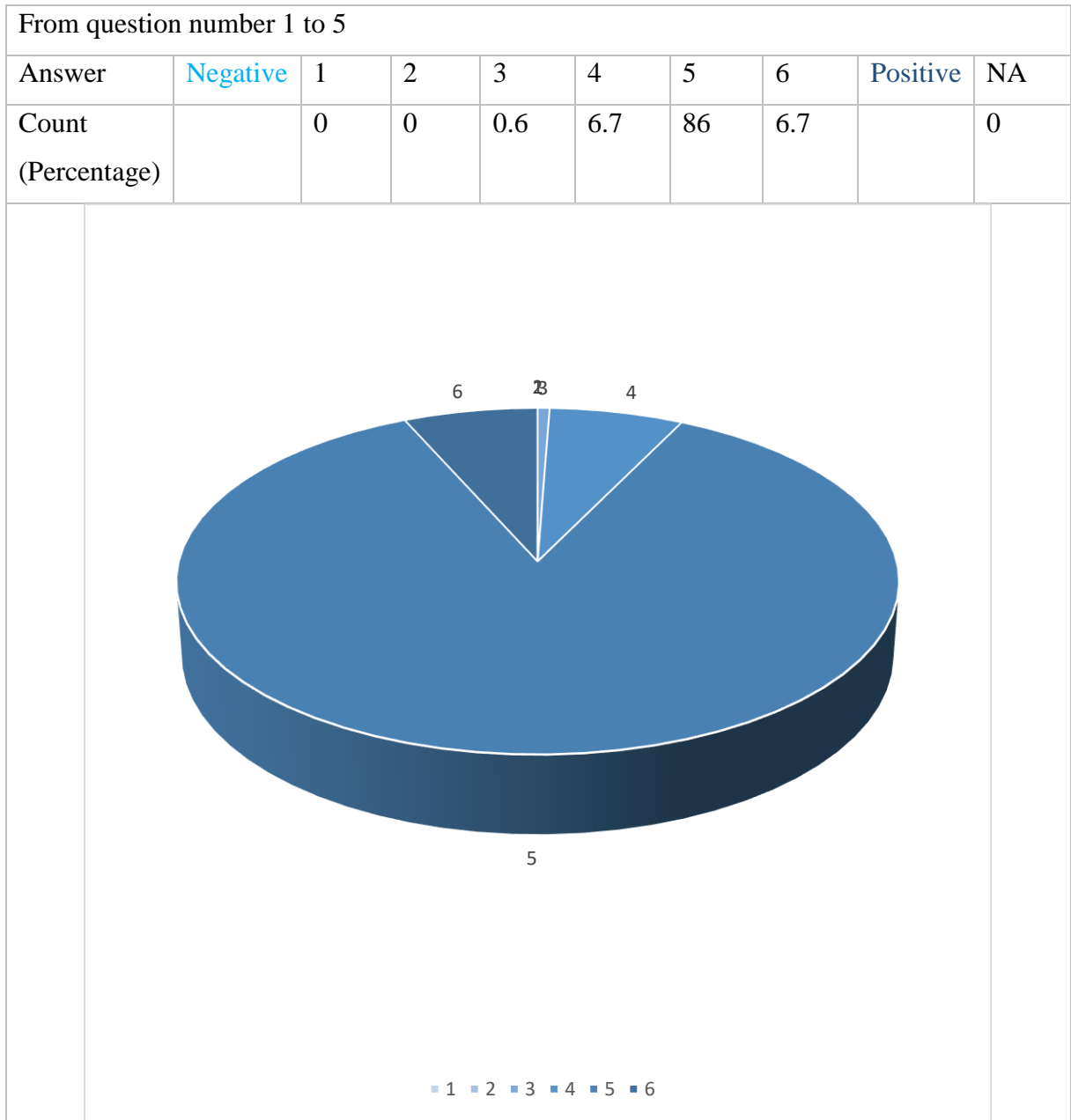
Figure 6.2 Usability test results of overall reaction about CIM&PSI System

The above Figure 6.1 displaying the overall reaction to the software. Users were allowed to express their opinion by the titles of easiness, satisfying, stimulating and flexible. It clearly shows the CIM&PSI system satisfied the users in a good manner.

6.4.2 Section: User Interface

From question number 6 to 9									
Answer	Negative	1	2	3	4	5	6	Positive	NA
Count (Percentage)		0	0.4	1.25	4.6	88.3	5.42		0
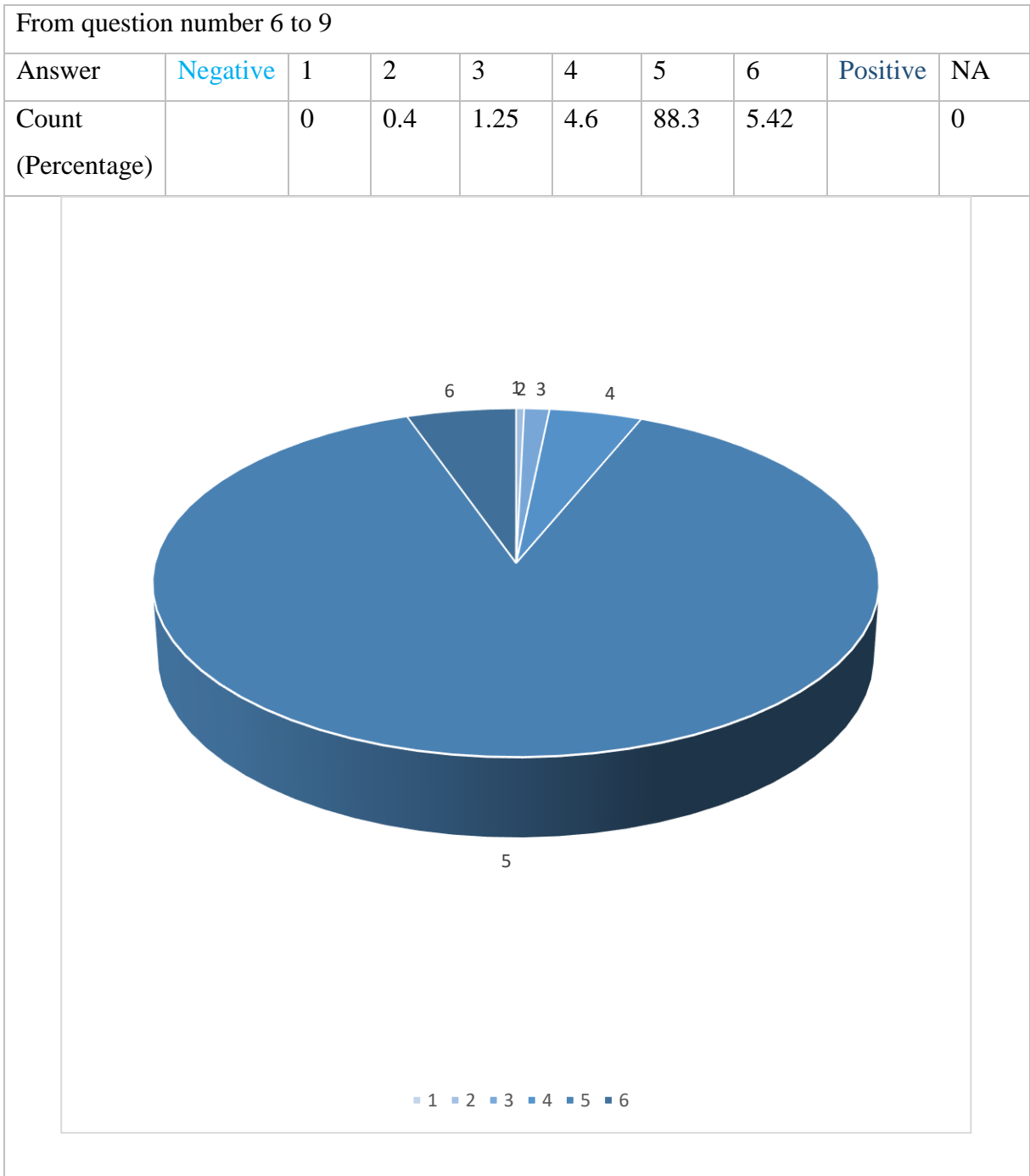
Figure 6.3 Usability test results of User Interface of CIM&PSI System

user-friendliness of the graphical user interface was checked with four question that, Is the reading characters on the screen are easy, system highlighting and simplifies the task, the system organizes the information as correct manner and system maintain the sequence of screens. Summarization answers that show in Figure 6.2 of those questions are shows that the system interface providing a proper friendliness.

6.4.3 Section: Terminology and System Information

From question number 10 to 15									
Answer	Negative	1	2	3	4	5	6	Positive	NA
Count (Percentage)		1.39	2.2	5	10.56	68.33	12.5		0
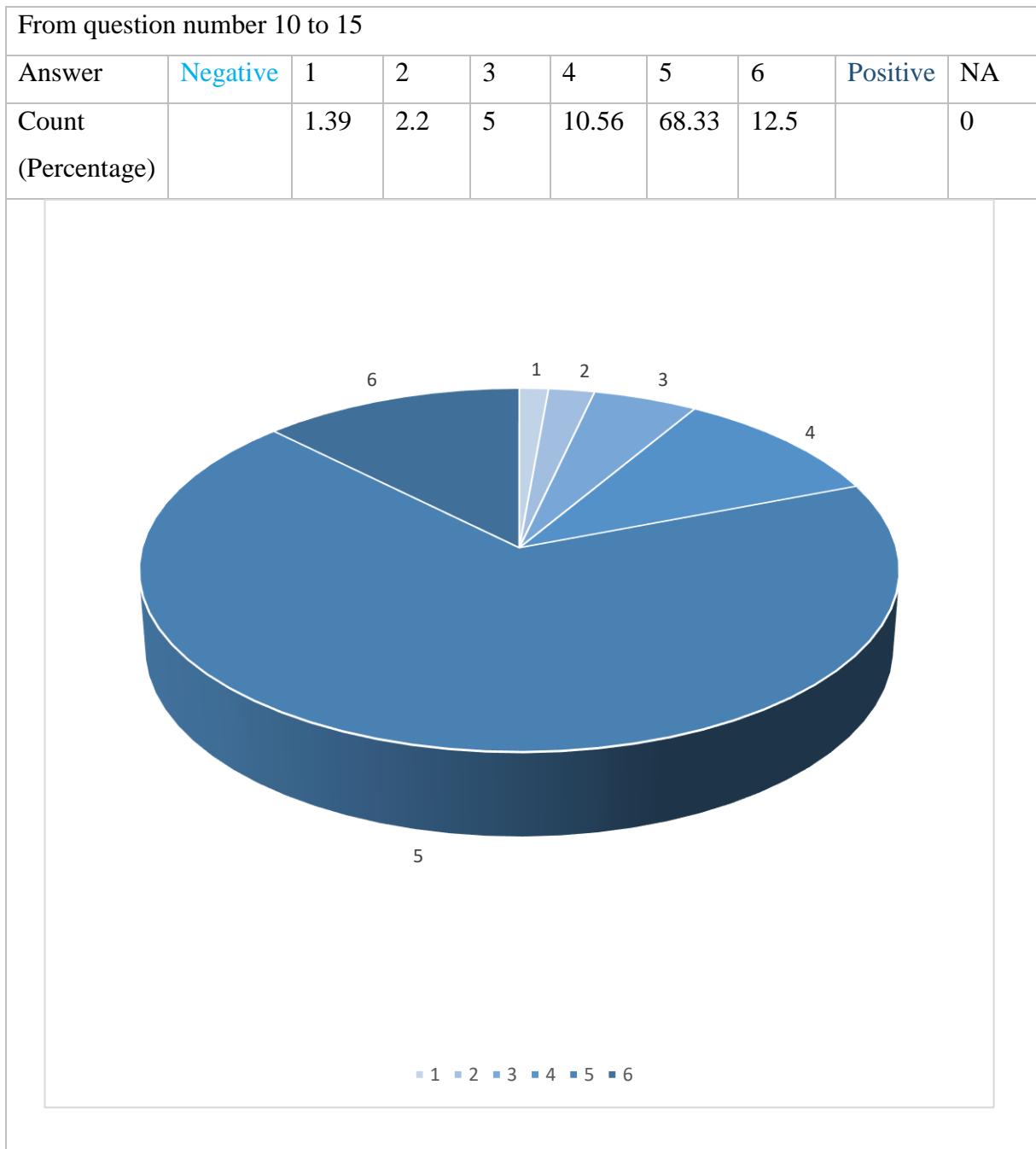
Figure 6.4 Usability testing results of terminology and system information

The above Figure 6.3 shows the analysis of terminology and system information of the CIM&PSI System. Terminology and system information was tested by the categories of questions that use of terms, terminology related to the task, position of messages on the screen, prompt for input, information of system progress, error messages. In that above chart, part of the negative is little increased with compare to the previous sections. Hence a deep analysis needs on that issue.

Following figure 6.4 display the analysis of sup part of the Terminology and system information.

Q10. Use of terms throw-out system	Q11. Terminology related to task
Q12. Position of message on screen	Q13. Prompts for input
Q14. System informs about its progress	Q15. Error Messages
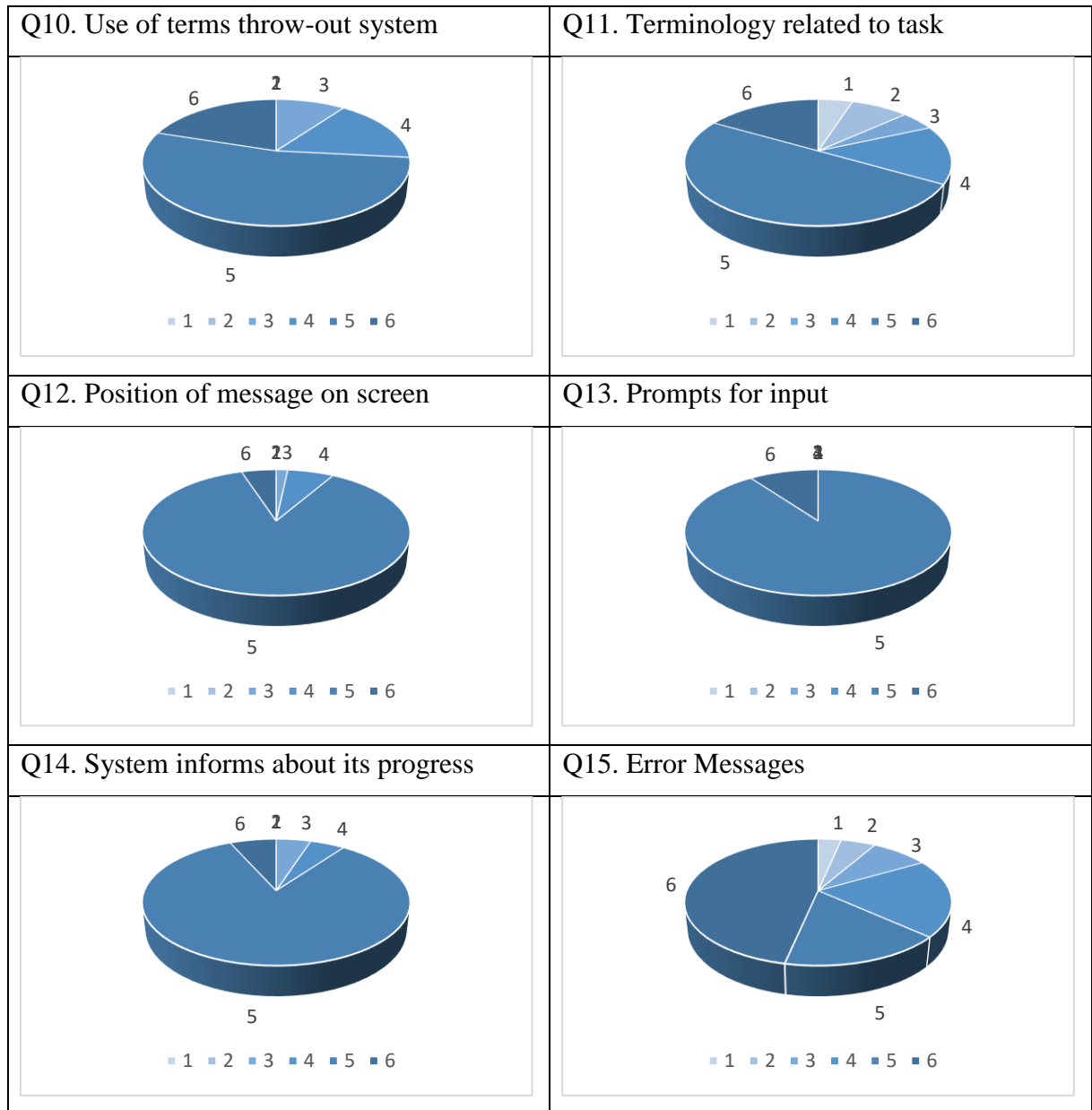
Figure 6.5 Detailed Usability testing results of terminology and system information

The position of the message on a screen prompts for input and the system informs about its progress are looking better. But the subsections that use of terms throw-out system, terminology related to task and error Messages reflect some negative effects.

This result clearly says that the problem is language. Terminologies, error messages are in English on CIM&PSI system and some of the users get trouble to understand that. The solution is trilingual integration. It is possible to implement trilingual in this system by Laravel's "Locale" facility. next version of the system must consider about this stuff.

6.4.4 Section: Learnability

From question number 10 to 15									
Answer	Negative	1	2	3	4	5	6	Positive	NA
Count (Percentage)		0	0	0.42	4.6	87.5	7.5		0
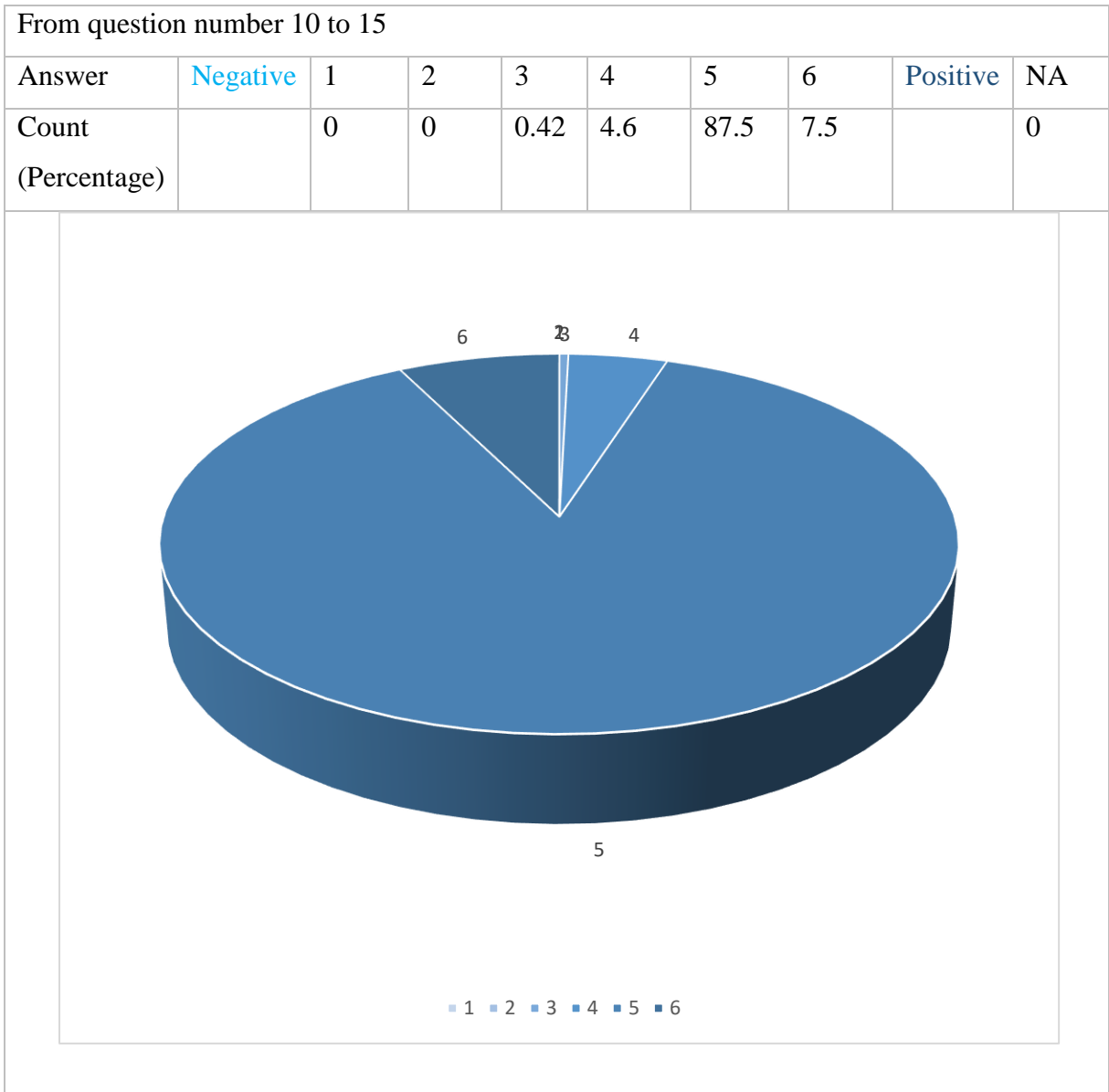
Figure 6.6 Usability results about learnability of CIM&PSI System

Learnability is the important part of usability concept. The system should allow the user to learn them self. Learnability was evaluated by the system's capability of allowing to exploring the new features by trial and error, straightforward task performing, help messages. By this above Figure 6.5, learnability of the CIM&PSI System is acceptable.

6.4.5 Section: System Capabilities

From question number 10 to 15									
Answer	Negative	1	2	3	4	5	6	Positive	NA
Count (Percentage)		0	0	0.4	5.9	86.7	7		0
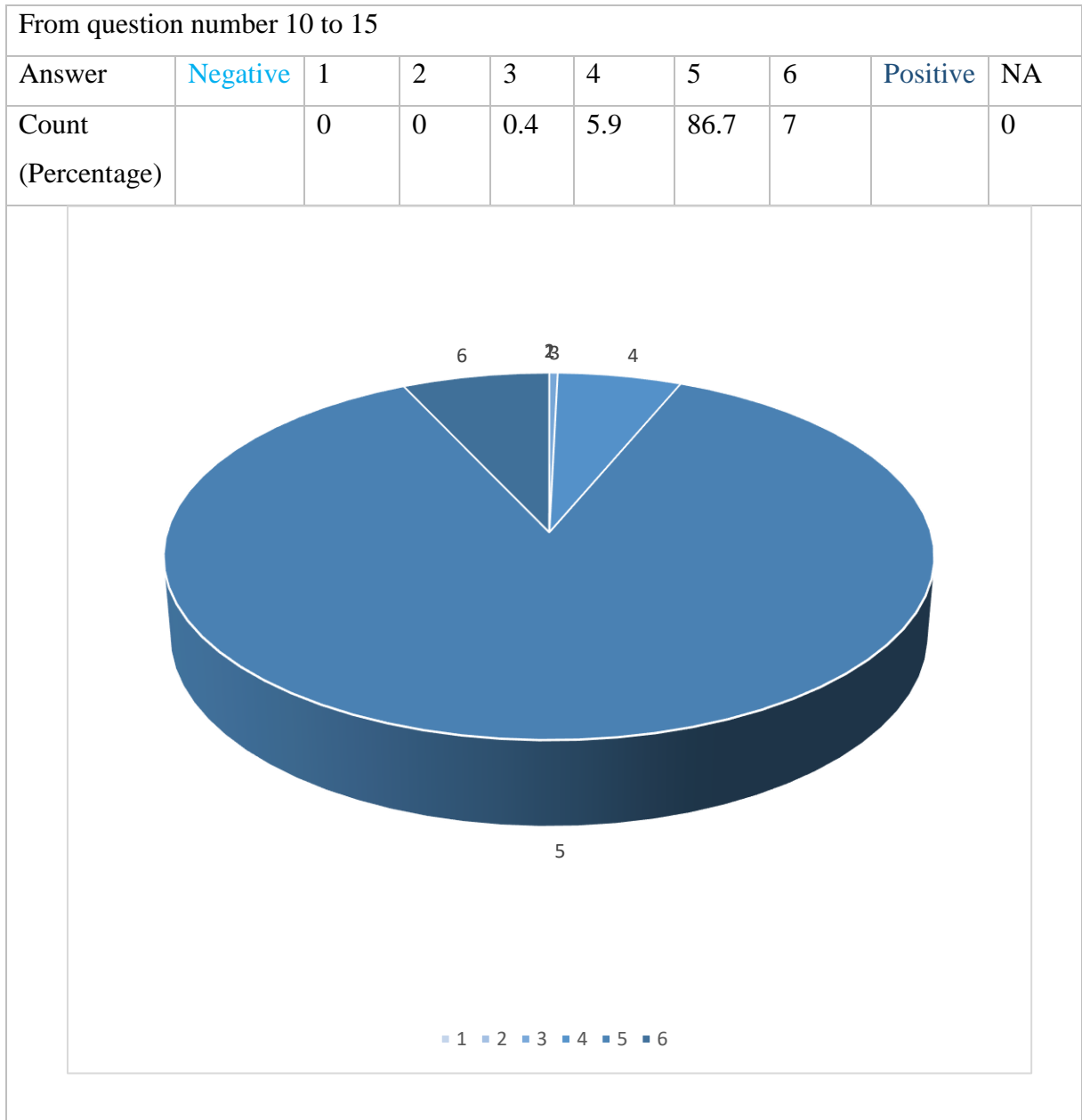
Figure 6.7 Usability results about system capabilities of CIM&PSI System

System capabilities which that speed, reliability, correcting the mistakes and all user-level support were evaluated. Result shows, that the system capabilities are perfect by the figure 6.6.

6.5 Summary

Completed system verified and validated by the various types of the tastings and the test results are critically analyzed. Testing process used incremental testing strategy. By the summary of the test result analyses, Trilingual implementation is recommended.

Chapter 7 : Conclusion and Future Work

Introduction

This chapter summarizes the work, discusses its finding and point out the limitations of the current system. And also contains the recommendations on areas for improvements and future developments.

7.1 Achievement of Objectives

The Crime Investigation Monitoring and Public Security Information system was developed to increase the productivity of crime investigation process in crime investigation division of Sri Lanka police and ensure the public security. Completed system was successfully verified with functionalities and validate with user requirements by testing.

In this system, public citizens itself helps the police to get the crime information rapidly and to proceed with the investigation. The system is designed to support to the investigation groups to work together on cases, coordinate and additionally speed up the process via the use of this system and ensure the general public protection with the aid of the general public security information system module. Additionally, this system makes the case transparent to the police department. consequently, corruption is impossible.

7.2 Major Findings and Lessons Learnt

Requirement gathering is the difficult part of this project, because of the complexness of work nature. By the dedicated support from the both higher and field level police officers, it became possible to understood the police system completely.

The development part of the system put a priority on information security. Because this Completed system going to handle much sensitive data and information. The current state of the web application security issues was analyzed deeply and solutions were provided with the latest cryptography advancements. In the security testing process, the system was checked with the current common vulnerabilities of web applications. the previous knowledge of the information and network security subject was successfully implemented in this project and its help together with the further knowledge in this field.

The problem arose in the designing part of the system that, how to ensure the originality of users. The solution was found by the discussion with the supervisor of this project. We decided and put the user activation module to confirm the user identification.

This system is going to use by all of the citizens of Sri Lanka. Therefore, we decided to put the users first by user-centered designing methodology. User interfaces, instructions, outputs were carefully designed to provide a better usability. By the usability testing results, its confirmed the user-friendliness of this system.

7.3 Limitations of completed system

There are some limitations on this system that the scenario of user account activation, general public need to present physically to the nearest police station. It is one of the drawbacks of this system. This limitation will solve by the integration the person registration department information into the system in future.

And another limitation is that system developed only for the criminal investigation division of Sri Lanka Police.

7.4 Future Implementations

The completed system developed with a Laravel 5.5 which packaged with a guarantee of long-term support (LTS). Therefore, this system has an ability to long-term running with efficiently. CIM&PSI easily face the future challenges by the Laravel Technology. For an example, Laravel supports to the Representational state transfer (Restful). By this ability, it is easy to developing the API for this system and connecting with other applications.

7.4.1 Implementation of GPS Technology

By the implementation of the GPS technology into the system by GPS Tag, Police headquarters easily track the criminal and police officers as well. Police officers easily point out the crime scene locations and take an action soon has been possible.

7.4.2 Mobile Native Application for this System

Smartphones are commonly used gadgets nowadays. Hence it is possible that connect the users with a mobile app. The current version of the application supports the mobile view. But Some of the mobile features are only available in mobile native apps. For the example current system only using email and SMS technologies for notification purpose. But by the mobile native

application, it is possible to provide push notifications also. Google firebase cloud messaging service is one example which that provide push notification service for native mobile applications free of charge.

7.4.3 Implementation of Image Processing Module

The current system automates the criminal investigation related process. But some features are limited. An example, it is not possible to match the person photography with the database. By the Image processing technology, the system can match and identify the person automatically.

7.4.4 Trilingual Integration

By the usability testing result, medium language is one of the drawbacks of the system. Use of trilingual is essential for this system.

7.4.5 Interconnect with Department of Person Registration

Current system using the manual process to confirm the users' identification. After the interconnection, the system with Department of Persons registration's system, easily exchange the persons' information and confirm the identity.

7.5 Future Research Approach

It is possible to get large data set after a long time run of this system. Data scientists can use that big data for knowledge mining. For the example, the market basket analysis may predict the upcoming crime scene with even the location and time.

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Appendix A - PACT Analysis for Crime Investigation Monitoring and Public Security Information System (CIM&PSI System)

A.1 Introduction

The essential part of the design approach is to put people first. That's mean "People-Centred" design. For this People-Centred designing, initially want to analyse the system with respect to people and how they will use.

Designers need to concern the

o   people who will use the system,

o   activities that people want to undertake,

o   contexts in which those activities take place and the

o   technologies which are using the system

in before the designing part of the system.

System overview

This web-based Crime Investigation Monitoring and Public Security Information System connected the Police Head Quarters, police stations, police officers, CID officers, public relation officer and the public together. This system helps to get publics' participation in the investigative process and speed up the investigation speed by a notable percentage.

Proposed keeps logs of a criminal case that includes the summary of the case, involved individuals, criminal history of those involved individuals, Items recovered on the crime scene, footages and other details that enter and upload by the investigation officers. The system allows officials to update the status of investigation anytime anywhere.

The public user can view the wanted persons and missing persons' information with photography and identity details which post by admin or Police OIC in their interface. Same as this, admin or Police OIC can make help request to the user by area wise to identify the unidentified objects which are collected as an evidence from crime area (e.g. watch, the piece of a cloth etc.). When, if the user knows the details of the above-wanted person, missing person

or the evidence, that user can easily give an information to police via provided data input portal in this system.

The public can easily make complaints without any delay with complaint trace facility and also they can get security related warnings and information which are the post by police through this system on time.

A.2 People

Primary Stakeholders – Sri Lanka Police Officers, General Public

In both police officers and the public people case, there are numerous routes in which individuals vary from each other, from physical appearance to the qualities they have. Individuals have diverse identities and respond to things in various ways. Mainly people differ from one another in following ways.
o   Physical differences
o   Psychological differences
o   Social Differences

Physical Differences
Physical contrasts huge effect how accessible, how usable and how charming utilizing a technology will be for individuals in various contexts.

Police officials are generally physically fit. But because of their job environment, their fingers may be little rough. This is occurring button click problems when the officers use this system on their touch mobile phones. Small Touch Targets Lead to Big Problems. So the buttons which are in the system must be little bigger. This solution is also suitable for public people who are with big or rough fingers and with long nails. Also, these big buttons are helping the elders who are suffering from handshaking and the vision problems.

Sri Lanka's ageing population rapidly increasing. Statistics show that the population above the age of 60 years was 2.5 million in 2012 which is 12.5% of the total population whereas projection shows that Sri Lanka would have elderly population of about 3.6 million by 2021, which is 16.7% of the total population and by 2041, one-quarter of the population would be

elderly. These group of elder people may have some physical problems like vision, colour blind etc. Big fonts, dark texts and light backgrounds are the solutions for the people who are suffering from vision problems. For the colour blindness peoples, the system needs to be sure that colours that system users do not convey important information. And increase the contrast between similar colours, lighten light colours and darken the dark ones, Increase saturation of colours, use patterns, symbols and strokes are also providing a positive impact on colour blind and vision problems.

Psychological differences

Psychologically, people differ in a variety of ways. For example, individuals with great spatial capacity will think that it is considerably simpler to discover their way around and recall than those with poor capacity. This system is common for the all Sri Lankan citizens. Therefore, this system must support people with poor ability by providing good signage and clear directions. Police officers' work environment is risky and most of the time they are under stress. Hence this system should design for support under stress mood conditions.

For the better interface to handle human memory issues, user interfaces need to be consistent and the user interface should behave in consistent ways at all times for all screens and also terminology, icons and use of colour should be consistent.

Social Differences

Sinhala and Tamil are Sri Lanka's official language. This system interface is in English. May some people or police officers unable to understand something on the system. Therefor bilingual help instructions are needed in the system. This help instruction is also helping the people who do not have a good mental model.

Date format which uses in the system is also considerable. Sri Lanka follows (yyyy-mm-dd) for Sinhala and (d-m-yyyy) for Tamil. Hence system want to accept both these two formats.

A.3 Activities

The main goal of this system is to connect the Police Head Quarters, police stations, police officers, CID officers, public relation officer and the public together and get publics' participation into the investigative process. And this system keeps logs of a case and allows

officials to update the status of investigation anytime anywhere. And also the public can easily make complaints without any delay with complaint trace facility and also they can get security related warnings and information which are the post by police through this system on time.

Police officers are want to use this system regular and frequent. Therefore the tasks should be easy to do. Quick access mode is preferable. But in the case of general public, they are infrequently using this system. Therefore, the part of the system for the general public should be easy to learn or remember.

This system allows the police officers to work together with other officers. Hence this system should be support for communication and coordination functionalities.

A.4 Context

Three useful types of context are distinguishable:

o   the organizational context

o   the social context

o   Physical environments

The organizational context

Sri Lanka police is the organization that handle the very confidential and secret information. Therefore, this system should be ensuring the security. Police system is centralized one. So the web-based is the suitable one for this.

The social context

Public security information part of this system is for public use. Users will access the system in different places such as the home, workplace, educational institutions or on travel. therefore, it is vital that the site is accessible for those visitors that use different resolutions, operating systems, colour depths platforms and browsers. Please read the baseline specification for further information.

Physical environments

Police officers conduct their investigation process at any time both day or night. And also anywhere. System interface should be mobile friendly and support any light conditions. The light background is preferable. Public people may use this system in an emergency situation. In

that situation, they are in embarrass and tension. So this system must be supported instant access and with the big button like interface things.

A.5 Technology

Input

The police officer can update case details and also upload the investigation related contents like images, videos, audio into the system. The system should support multi files upload at a time. Some crime evident may depend on timing. Hence system should support instant access to input data. Most of the users both police and public access this system by mobile devices. Therefore, input fields are should be in the fluid grid.

Output

Mobile friendly display output is an important one. Less graphical objects are Preferred. And this system must be cross-browser and platform support. Because the system cannot force the user to particular product or technology.

Communications

This system is fully web-based. Therefore, internet connection is important. And this system must run on the low-speed internet. Because people who are from every part of Sri Lanka going to use this system.

Appendix B – Use Case Narratives

Use case Name	User login
Use case ID	01
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	Admin, SDIG, DIG, SSP, OIC, Below OIC Officers, Public User
Description	Authenticate the user
Pre-conditions	Internet connection should be available
Main Scenario	1. visit the application 2. click the 'login' button 3. The system asking for the user name and password 4. user provides the username and password and click 'login' button 5. system does authentication 6. system checks the account activation status 7. system redirect the user to the suitable homepage by his/her role
Alternative scenario	4(a) user input data is not in a correct format 4(a) 1. System shows "input not valid" error message 4(a) 2. System allows the user to re-enter details 4(b) user forgot the password 4(b) 1. User click the 'forgot your password' link 4(b) 2. System asks email address 4(b) 3. User enter the email and click 'send password reset link' button 4(b) 4. System sends a password reset link to the user email address 4(b) 5. User follow the link and reset the password 5(a) authentication fails 5(a) 1. System shows 'These credentials do not match our records' error message 5(a) 2. System allows to re-enter details. Maximum re-attempts were limited to 6

	6(a) account not activate yet
	6(a) 1. system redirect the user to the account activation instruction page

Use case Name	User Registration
Use case ID	02
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	SDIG, DIG, SSP, OIC, Below OIC Officers, Public User
Description	Register the user into the system
Pre-conditions	Internet connection should be available
Main Scenario	1. visit home page
	2. system asks name, email, type, password, confirm password
	3. user enter the details and submit "register" button
	4. system redirect the user to the second registration form by the type that user select (police/ public) and asks further details
	5. user enter the details and press "next" button
	6. system reditect the user to the "account activation instruction page"
Alternative scenario	3(a) user input data is not in a correct format
	3(a) 1. System shows "input not valid" error message
	3(a) 2. System allows the user to re-enter details
	3(b) password and confirm password not matched
	3(b) 1. System shows 'The password confirmation does not match.' Error message
	3(b) 2. System allows the user to re-enter passwords
	5(a) user input data is not in a correct format
	5(a) 1. System shows "input not valid" error message
	5(a) 2. System allows the user to re-enter details

Use case Name	Public User account activation
Use case ID	03
Version	1.0

Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	OIC
Description	Activate the public users account
Pre-conditions	Internet connection should be available User logged in as OIC
Main Scenario	1. OIC search the user that want to activate 2. system shows the user 3. OIC click "view" button on the user's row 4. system redirects the OIC to single user view page 5. OIC check the details and click "Activate" button 6. system activate the user account
Alternative scenario	2(a) user not found 2(a) 1. system shows "user not found" message

Use case Name	Below OIC officers account activation
Use case ID	04
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	OIC
Description	Activate the Below OIC officers account
Pre-conditions	Internet connection should be available User logged in as OIC
Main Scenario	1. OIC search the below OIC officer that want to activate 2. system shows the below OIC officer 3. OIC click "view" button on the below OIC officer's row 4. system redirects the OIC to single below OIC officer view page 5. OIC check the details and click "Activate" button 6. system activate the below OIC officer account

Alternative scenario	2(a) below OIC officer not found 2(a) 1. system shows "below OIC officer not found" message

Use case Name	SDIG, DIG, SSP, OIC account activation
Use case ID	05
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	Admin
Description	Activate the SDIG, DIG, SSP, OICs account
Pre-conditions	Internet connection should be available User logged in as Admin
Main Scenario	1. Admin search the officer that want to activate 2. system shows the officer 3. Admin click "view" button on the officer's row 4. system redirects the OIC to single officer view page 5. Admin check the details and click "Activate" button 6. system activate the officer account
Alternative scenario	2(a) officer not found 2(a) 1. system shows "officer not found" message

Use case Name	Register a complaint by public user
Use case ID	06
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	Public User
Description	Register a complaint by public user
Pre-conditions	Internet connection should be available User logged in as public user

	User in his/her home page
Main Scenario	1. user click the 'make complaint' button
	2 system shows the complaint form
	3. user enter the details and click 'submit my complaint' button
	4. system saved the complaint and shows the 'success'message
Alternative scenario	3(a) user input data is not in a correct format
	3(a) 1. System shows "input not valid" error message
	3(a) 2. System allows the user to re-enter details

Use case Name	Response to the complaint
Use case ID	07
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	OIC
Description	Response to the complaint by OIC
Pre-conditions	Internet connection should be available
	User logged in as OIC
	OIC in his/her home page
Main Scenario	1. OIC click the view button in the complaint row
	2. system redirect the page to complaint single view
	3. OIC type the response and click 'post' button
	4. system post the respons and shows the 'success' message
Alternative scenario	nill

Use case Name	Post emergency note/ news
Use case ID	08
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017

Priority	High
Actors	OIC
Description	Post emergency note/ news
Pre-conditions	Internet connection should be available
	User logged in as OIC
	OIC in his/her home page
Main Scenario	1. OIC type the note/ news and enter 'post' button
	2. system posted the note/news and shows 'success' message
Alternative scenario	nill

Use case Name	Case transfer
Use case ID	09
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	Admin
Description	Transfer the case between police stations
Pre-conditions	Internet connection should be available
	User logged in as Admin
	Admin in his/her home page
Main Scenario	1. admin enter the 'case transfer' button
	2. system redirect the page to transfer corner
	3. admin search the case that want to transfer
	4. admin select the police station that the case want to transfer and click transfer the case button
	5. system double confirm the option and transfer the case
Alternative scenario	3(a) case not found
	3(a) 1. System shows the message 'case not found'

Use case Name	New case registration
Use case ID	10

Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	OIC
Description	Register new crime case
Pre-conditions	Internet connection should be available
	User logged in as OIC
	OIC in his/her home page
Main Scenario	1. OIC click the 'add new case' button
	2. system redirect to case registration form
	3. OIC fill the details and click submit button
	4. system redirect the OIC to the home page with 'case registered successfully' message
Alternative scenario	2(a) case number already exit
	2(a) 1. System shows "case number already exit" error message
	2(a) 2. System allows the user to reenter the details.

Use case Name	Add crime type
Use case ID	11
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	OIC
Description	Add crime type into the case
	User logged in as OIC
	OIC in his/her home page
Pre-conditions	Internet connection should be available
Main Scenario	1. OIC search the case
	2. system shows the result
	3. OIC click the view button
	4. system redirect the OIC to the single case view page
	5. OIC click 'add crime type' button

	6. system shows a pop-up that contain crime types
	7. OIC click the crime type that want to assign to the case
	8. system close the popup and shows 'crime type successfully added' message
Alternative scenario	2(a) case not exit
	2(a) 1. System shows 'case not exit' error message

Use case Name	Add crime related individual
Use case ID	12
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	OIC
Description	Add CRI into the case
Pre-conditions	Internet connection should be available
	User logged in as OIC
	OIC in his/her home page
Main Scenario	1. OIC search the case
	2. system shows the result
	3. OIC click the view button
	4. system redirect the OIC to the single case view page
	5. OIC click 'add criminal/ add suspect/ add missing person/ add wanted person' button
	6. system shows a pop-up that contains list of crime related individuals
	7. OIC search the CRI that want to assign to the case
	8. system shows the search result
	9. OIC click 'add' button
	10. system close the popup and shows 'CRI successfully added' message
Alternative scenario	2(a) case not exit
	2(a) 1. System shows 'case not exit' error message
	8(a) CRI not found

	8(a) 1. Systems shows 'CRI not found' message

Use case Name	Add evident
Use case ID	13
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	OIC
Description	Add evident into the case
Pre-conditions	Internet connection should be available
	User logged in as OIC
	OIC in his/her home page
Main Scenario	1. OIC search the case
	2. system shows the result
	3. OIC click the view button
	4. system redirect the OIC to the single case view page
	5. OIC click 'add evident' button
	6. system shows a pop-up that contains file upload field
	7. OIC click the 'browse' button
	8. system shows the file directory of the logged in device
	9. OIC select the file that want to upload
	10. OIC type the remarks and click 'upload' button
	11. popup closed and system shows 'evident added successfully' message
Alternative scenario	2(a) case not exit
	2(a) 1. System shows 'case not exit' error message

Use case Name	Assign police officer to the case
Use case ID	14
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High

Actors	OIC
Description	Assign police officer into the case
Pre-conditions	Internet connection should be available
	User logged in as OIC
	OIC in his/her home page
Main Scenario	1. OIC search the case
	2. system shows the result
	3. OIC click the view button
	4. system redirect the OIC to the single case view page
	5. OIC click 'assign police officer' button
	6. system shows a pop-up that contains list of police officers that work under the logged in OIC
	7. OIC search the police officer
	8. system shows the search result
	9. OIC click 'add' button
	10. system close the popup and shows 'police officer assigned successfully' message
Alternative scenario	2(a) case not exit
	2(a) 1. System shows 'case not exit' error message
	8(a) police officer not found
	8(a) 1. Systems shows 'police officer not found' message

Use case Name	Add court details into the case
Use case ID	15
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	OIC
Description	Add court activity related details into the case
Pre-conditions	Internet connection should be available
	User logged in as OIC
	OIC in his/her home page
Main Scenario	1. OIC search the case

	2. system shows the result
	3. OIC click the view button
	4. system redirect the OIC to the single case view page
	5. OIC click 'add court details' button
	6. system shows a pop-up that contains court details entering form
	7. OIC enter the details and click the submit button
	8. system close the popup and shows 'court details added successfully' message
Alternative scenario	2(a) case not exit
	2(a) 1. System shows 'case not exit' error message

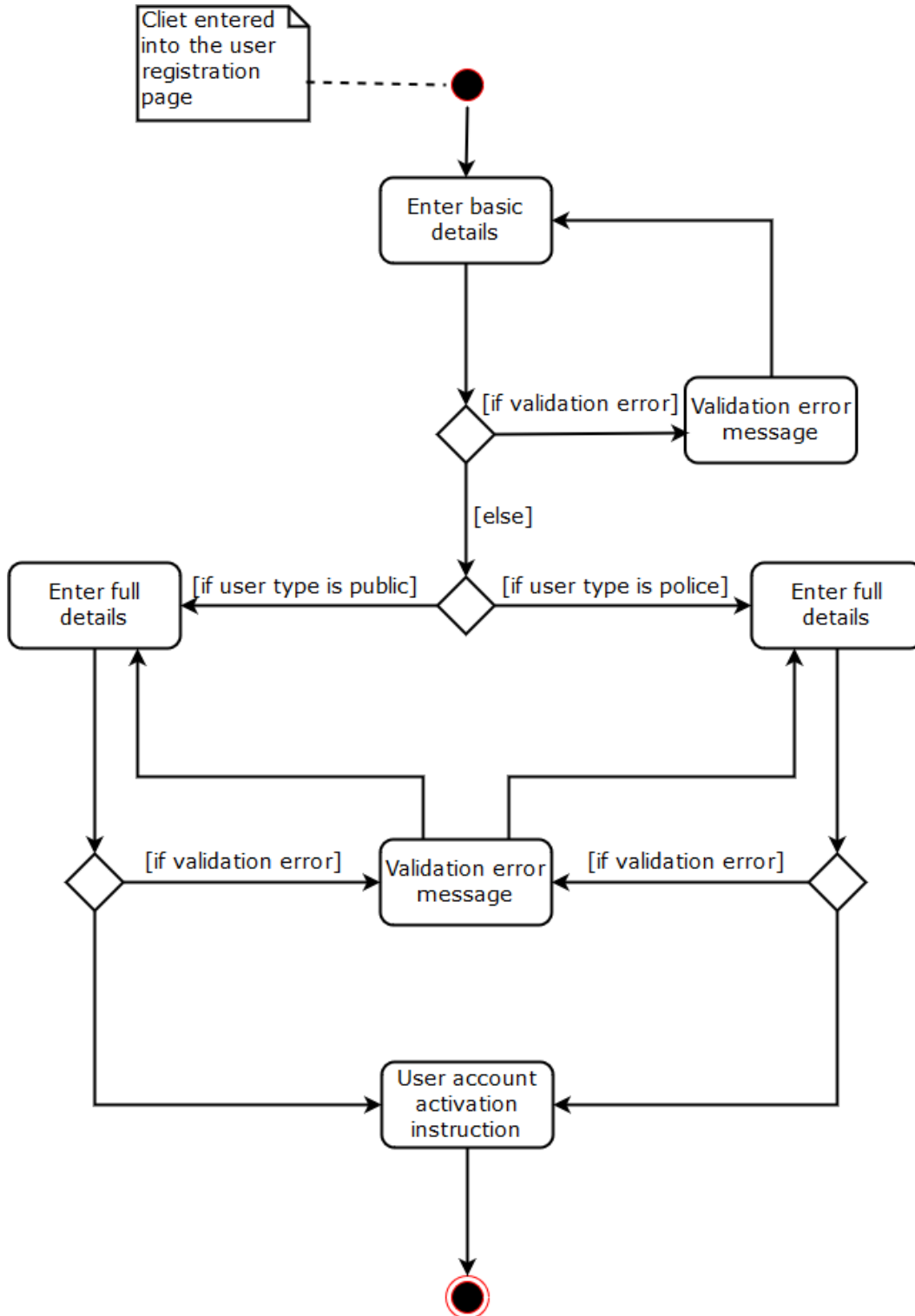|	
Use case Name	Close the case
Use case ID	16
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	OIC
Description	Close the case
Pre-conditions	Internet connection should be available
	User logged in as OIC
	OIC in his/her home page
Main Scenario	1. OIC search the case
	2. system shows the result
	3. OIC click the view button
	4. system redirect the OIC to the single case view page
	5. OIC click 'close the case' button
	6. system redirect the page to OIC home page with 'case closed successfully' message
Alternative scenario	2(a) case not exit
	2(a) 1. System shows 'case not exit' error message

Use case Name	Re-open the case

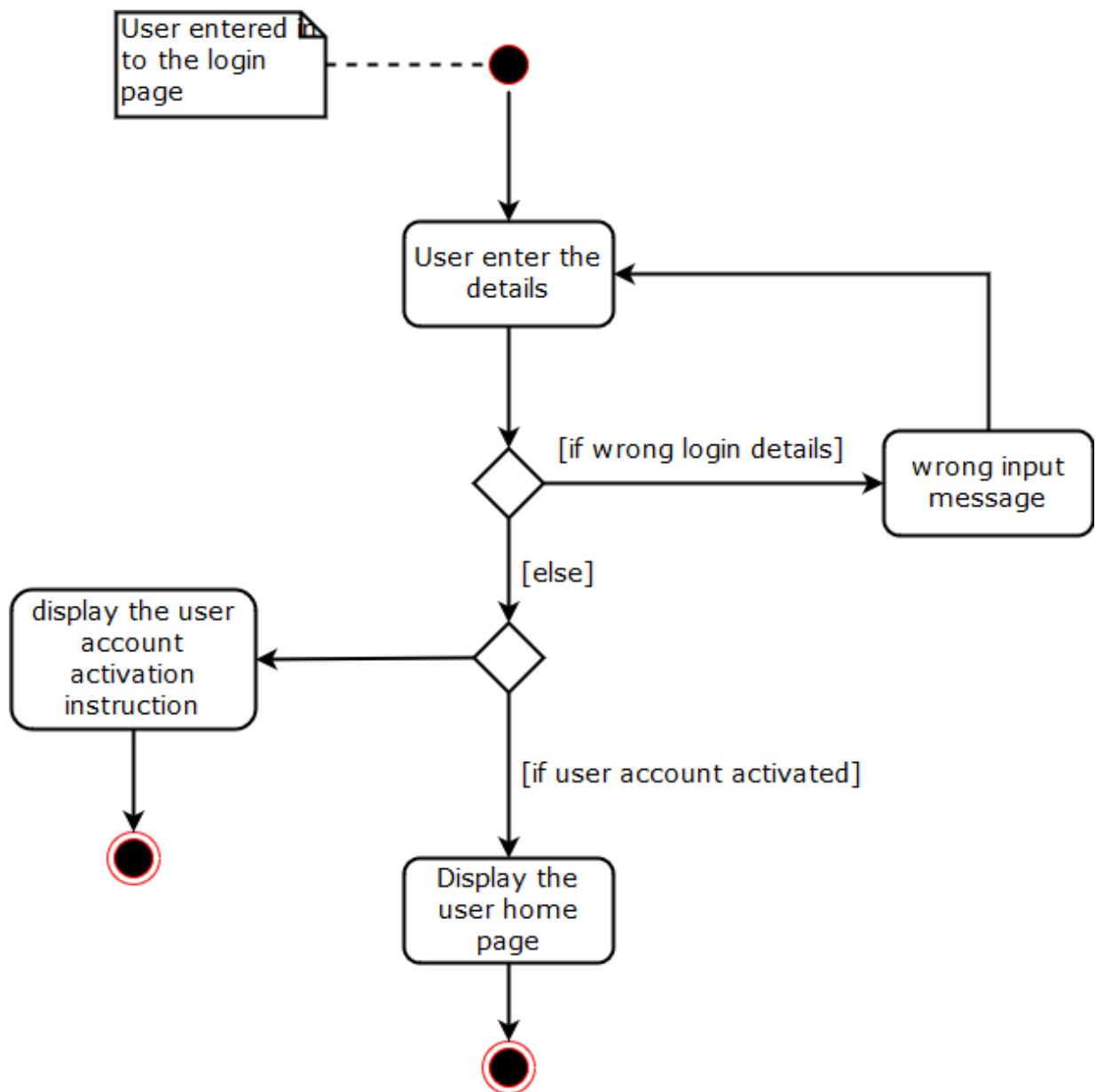| Use case ID	17
Version	1.0
Author	Y.D.Shanth
Date Created	01.10.2017
Priority	High
Actors	Admin
Description	Re-open the closed case
Pre-conditions	Internet connection should be available User logged in as Admin Admin in his/her home page
Main Scenario	1. admin click the 'case re-open' button 2. system redirect the page to that contain closed cases 3. admin search the case 4. system shows the result 5. admin click the 'reactivate the case' button 6. system shows 'reactivation successfully message'
Alternative scenario	3(a) case not found 3(a) 1. System shows 'case not found' message

Annex C - Activity diagrams of CIM&PSI System

Activity diagrams are uses to model the activities of the system. These diagrams represent the dynamics of the system.
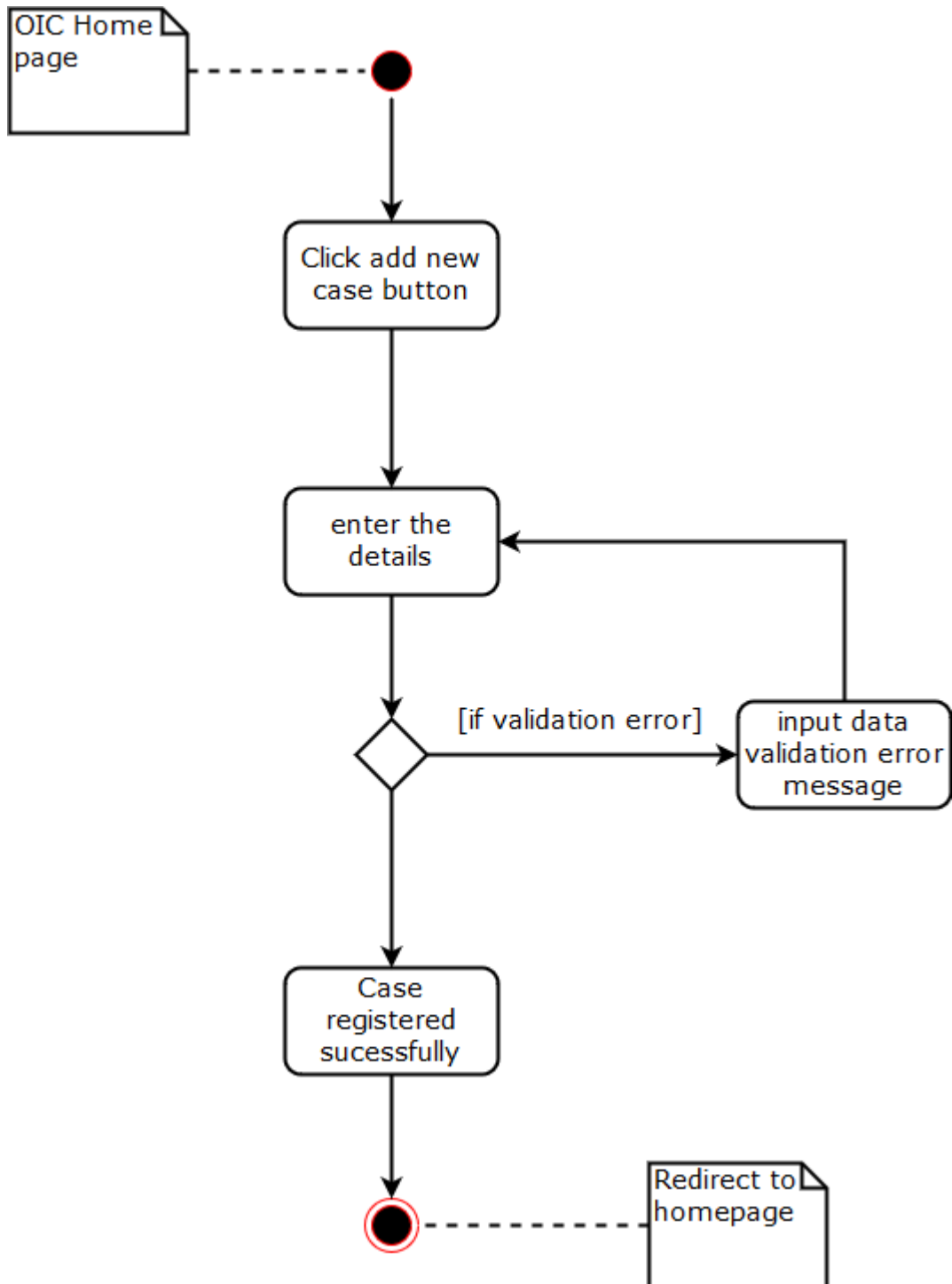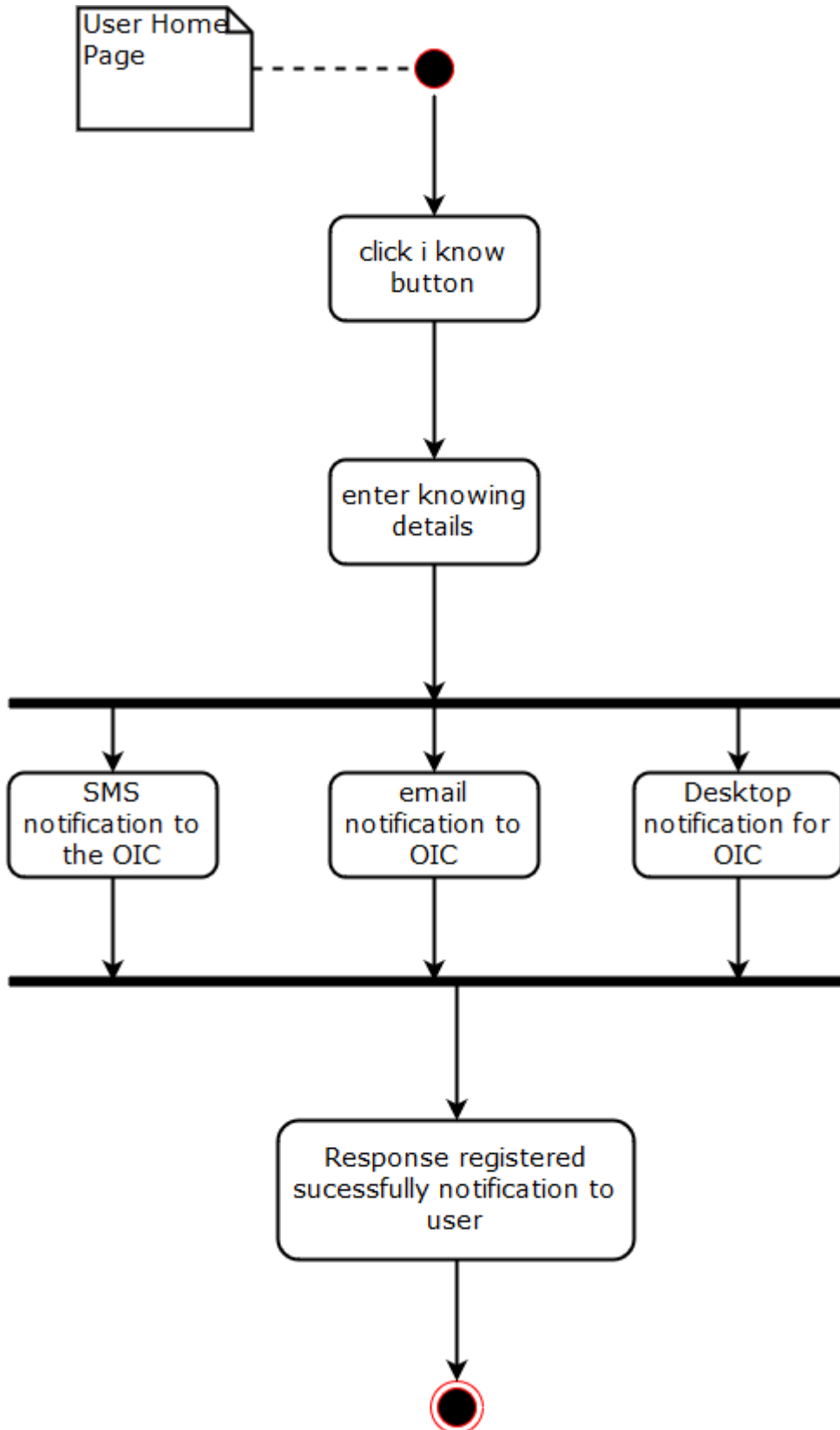
C.1 Activity diagram of user registration

## C.2 Activity diagram of user login

A.3 Activity diagram of case registration by OIC

OIC Home page

Click add new case button

enter the details

[if validation error]

input data validation error message
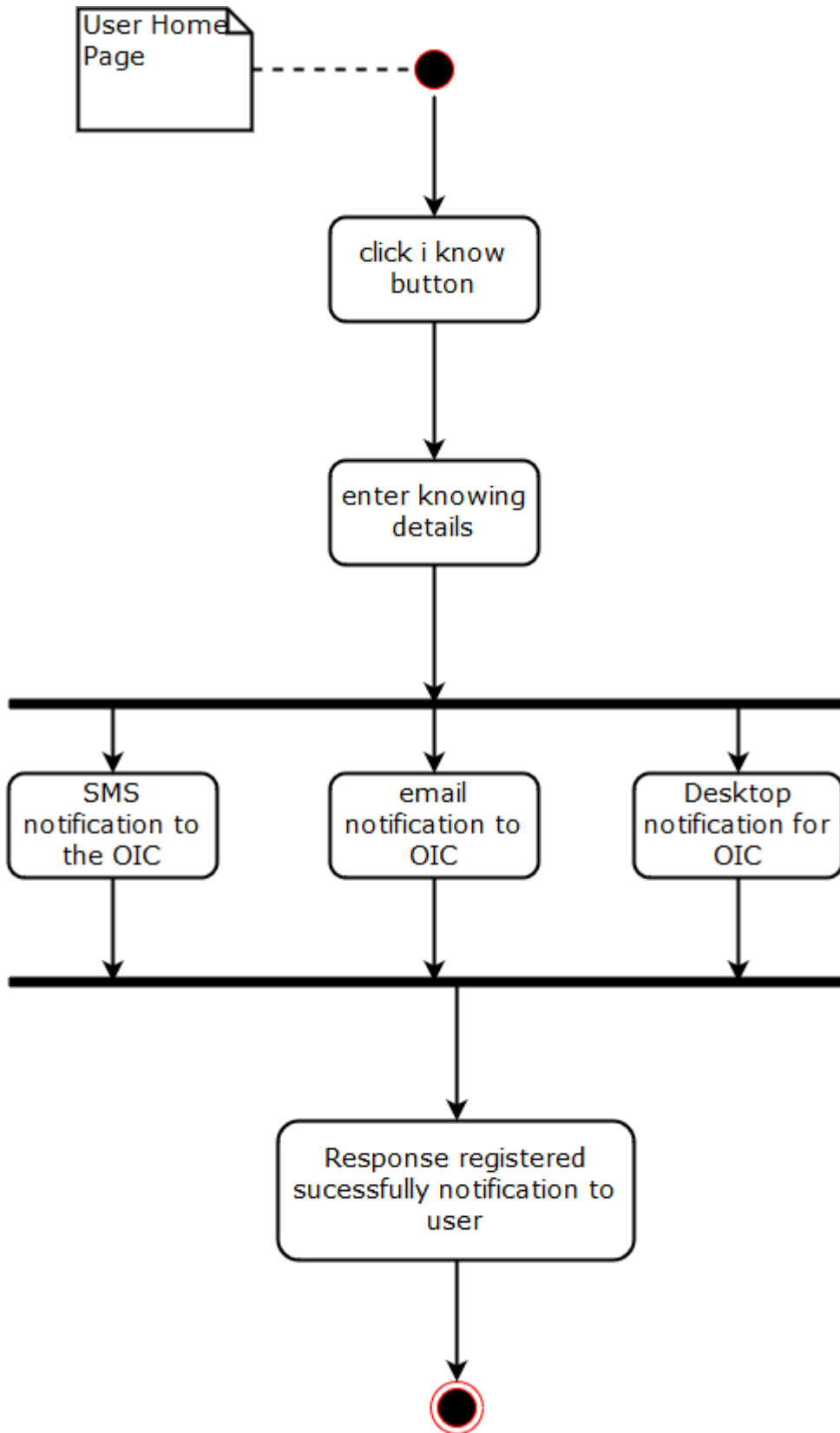
Case registered sucessfully

Redirect to homepage

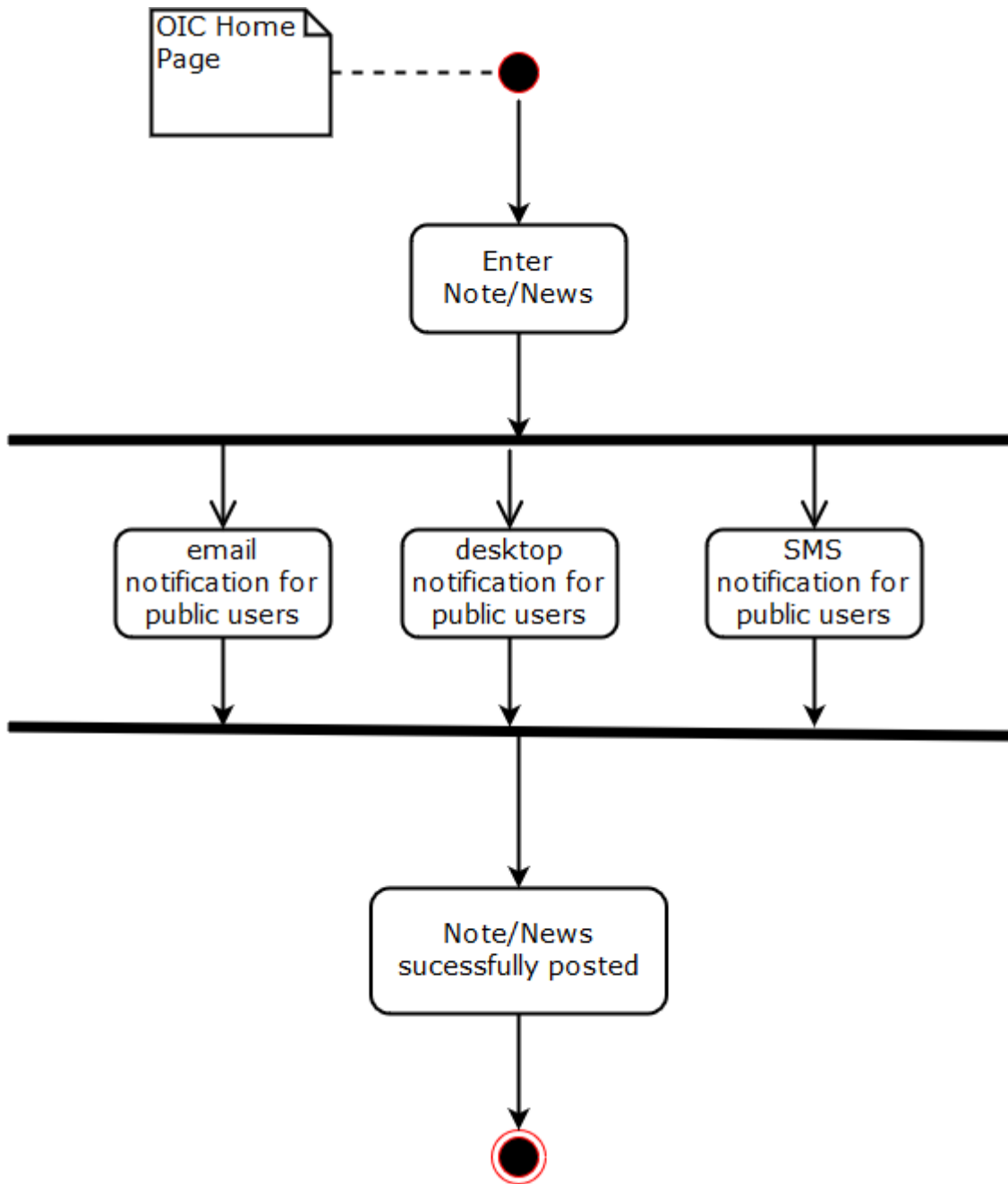**A.4 Activity diagram of response by Public user about crime related individual**

A.5 Activity diagram of new complaint registration by public user
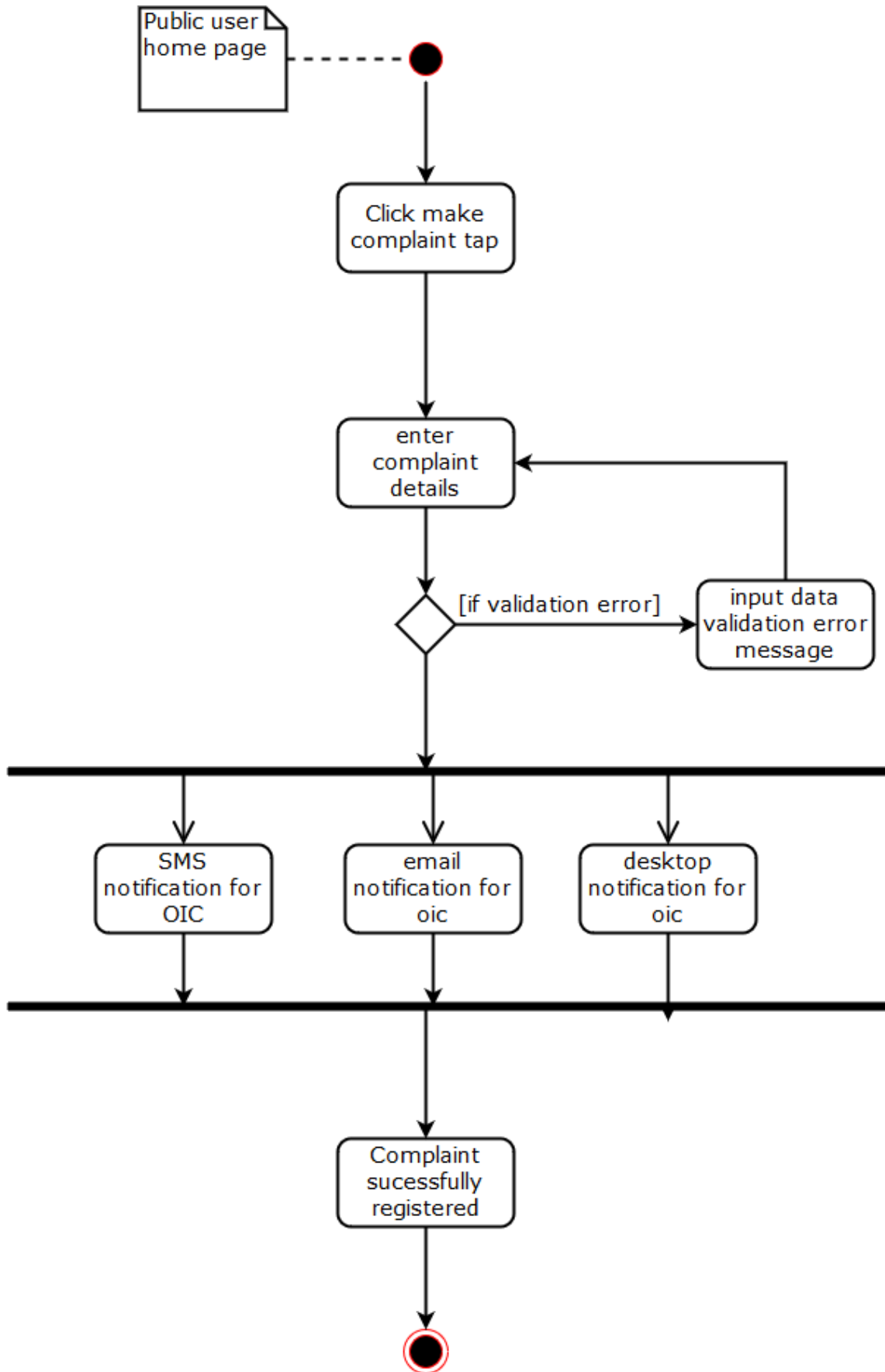
A.6 Activity diagram of response to the complaint by OIC

A.7 Activity diagram of posting emergency note/ news by OIC

Annex D - Sequence Diagrams of CIM&PSI System

Following sequence diagrams are shows object interactions arranged in time sequence.

D.1 Sequence diagram of user registration scenario
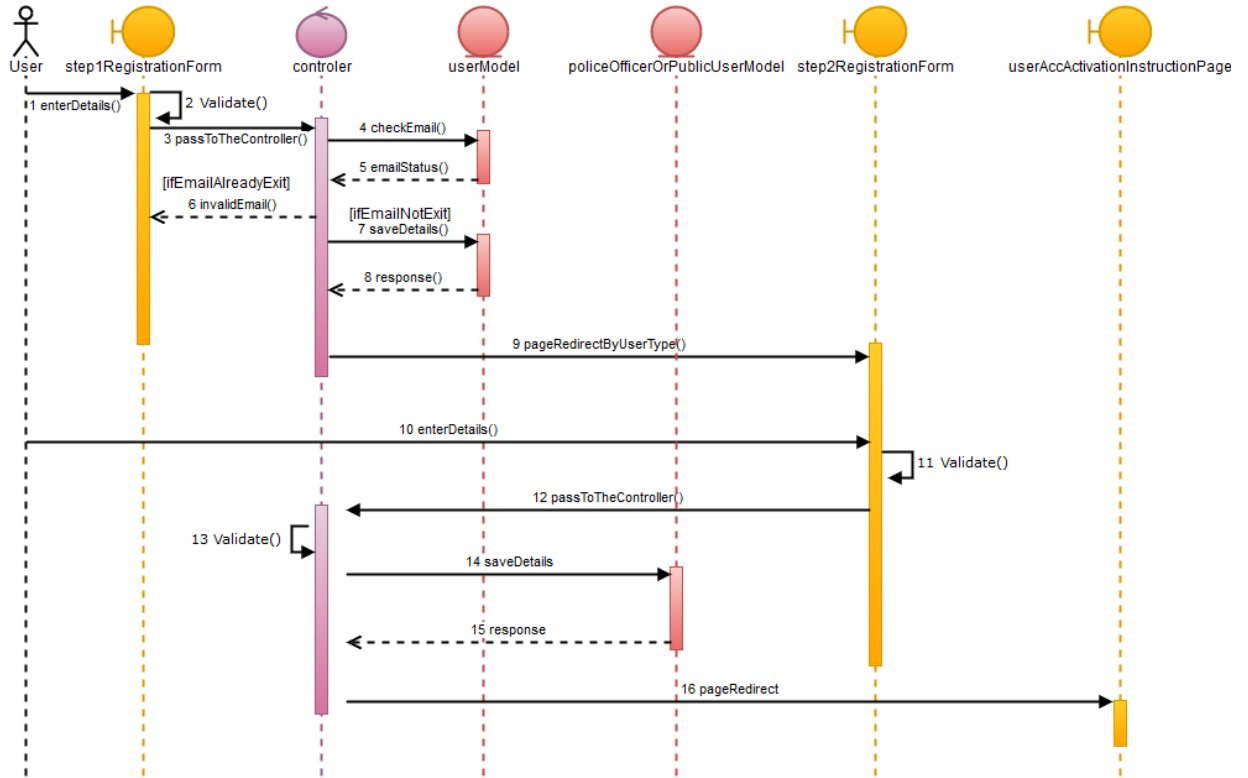
D.2 Sequence diagram of user login scenario
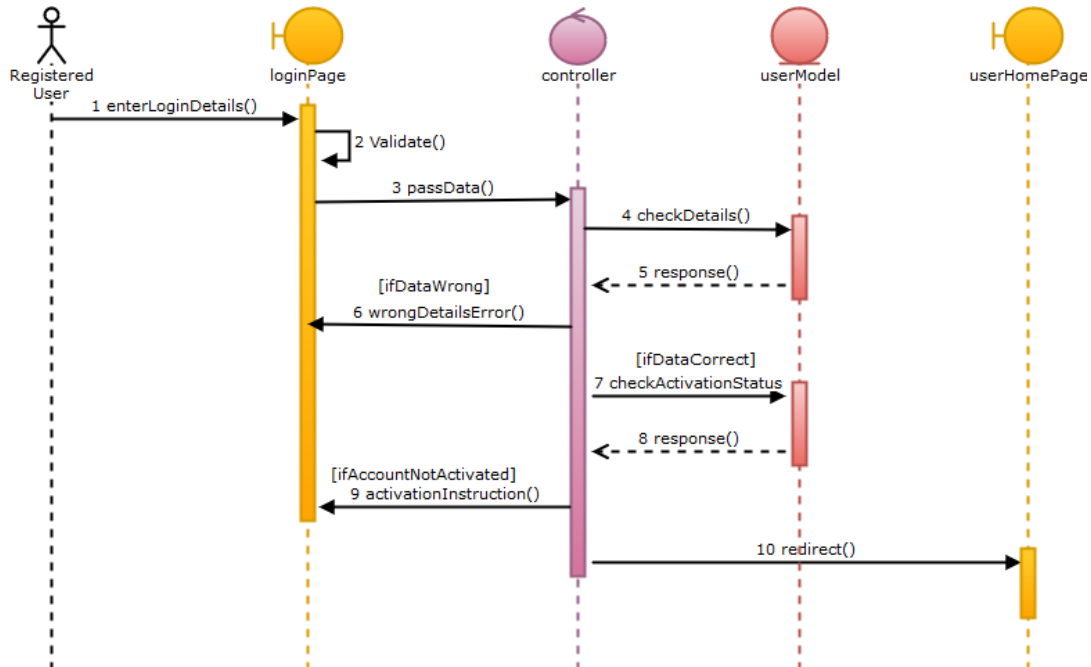
Crime Case investigation related Scenarios

D.3 Sequence diagram of new case registration scenario
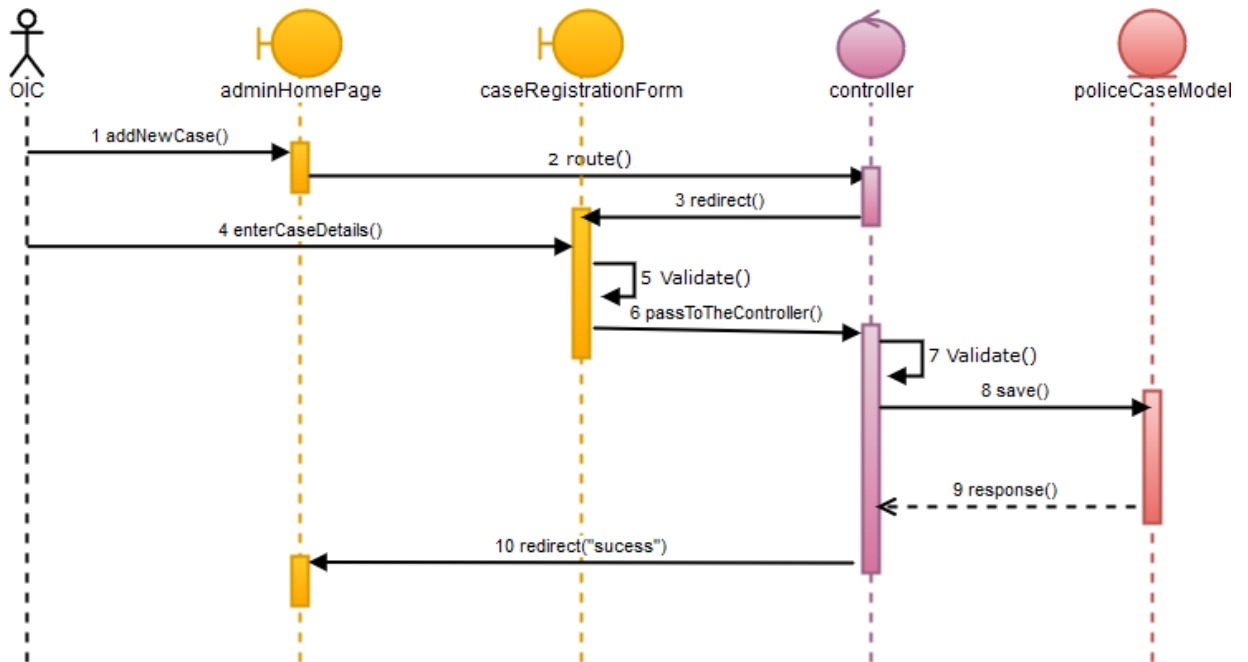
D.4 Sequence diagram of add evident into the police case
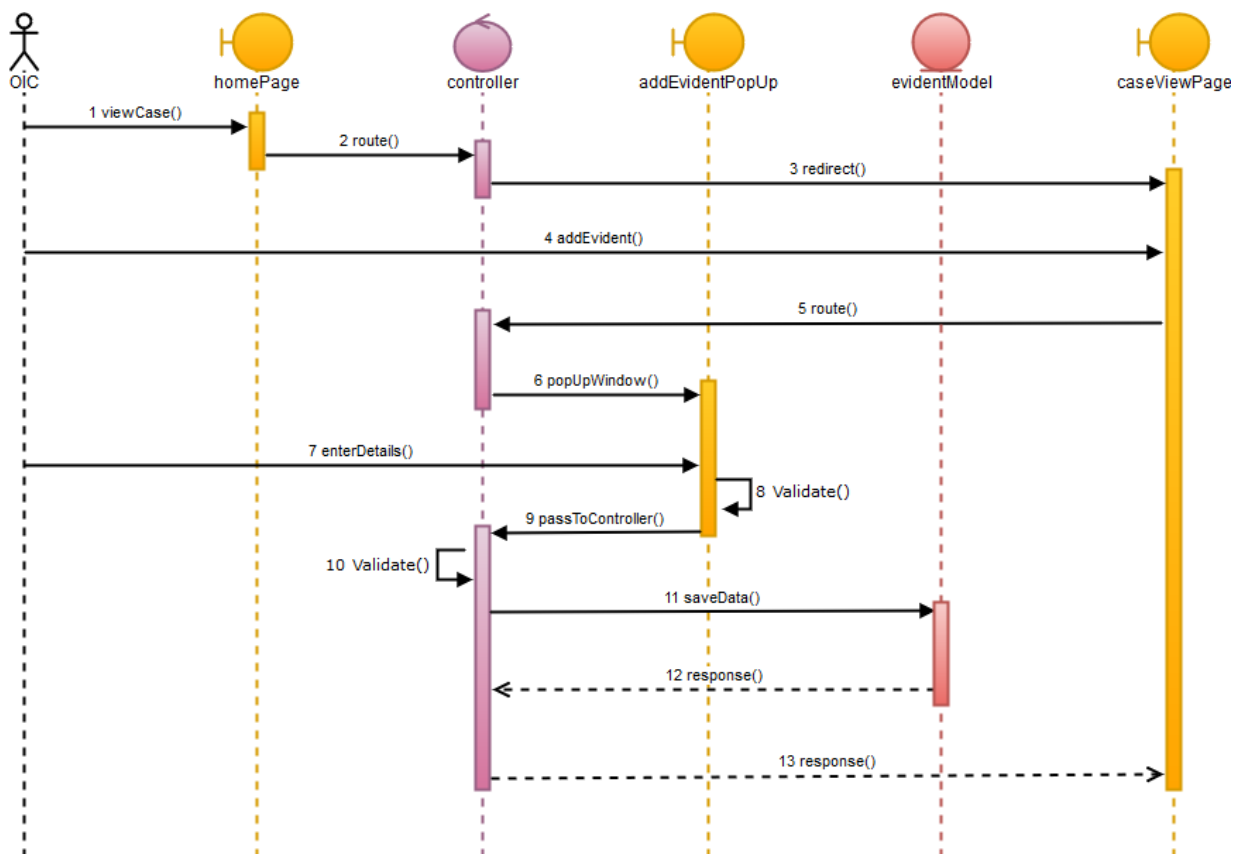
D.5 Sequence diagram of add crime type into the police case
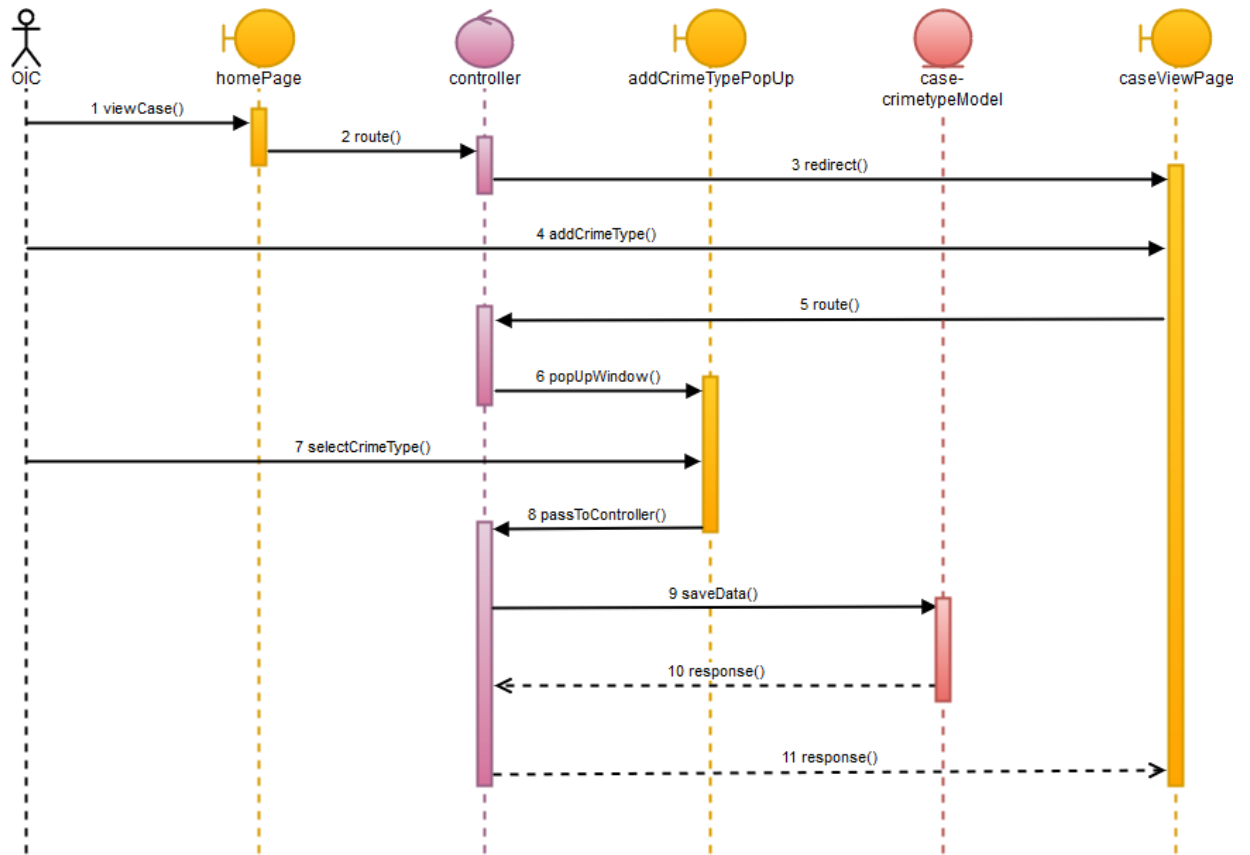
D.6 Sequence diagram of add crime related individuals into the police case
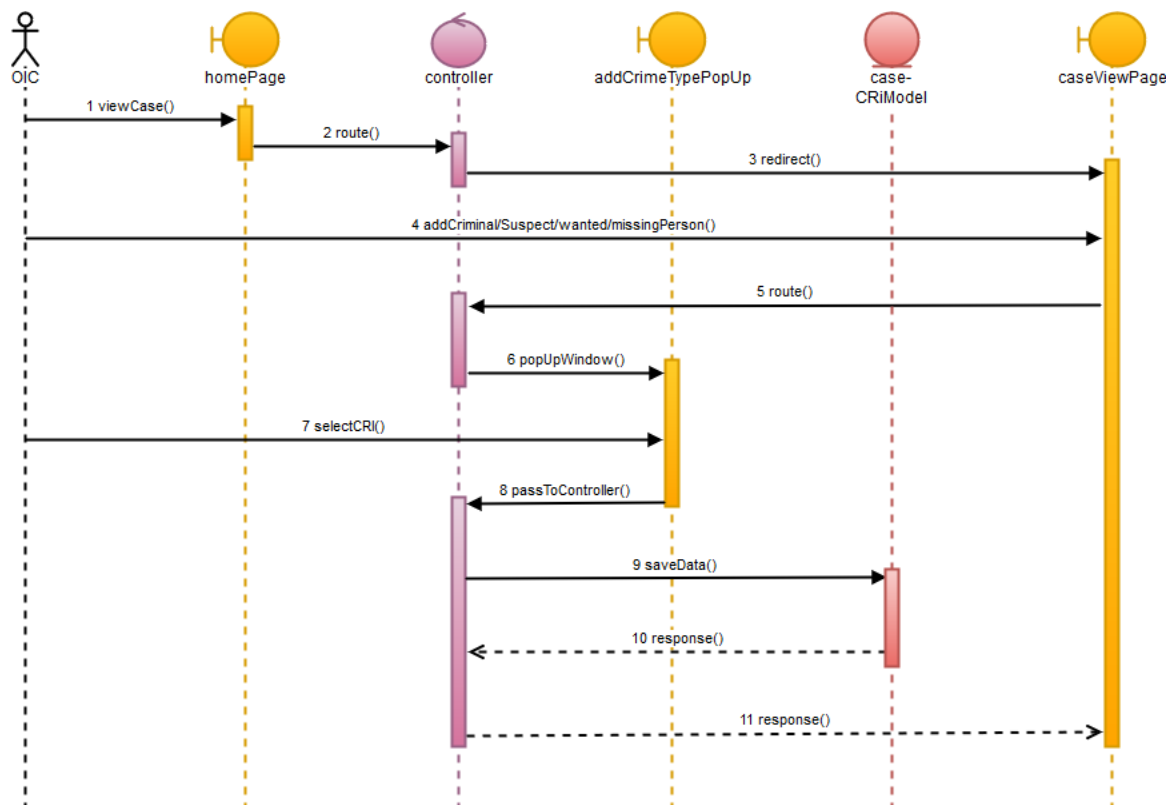
Public security related scenario

D.7 Sequence diagram of register new complaint by Public User
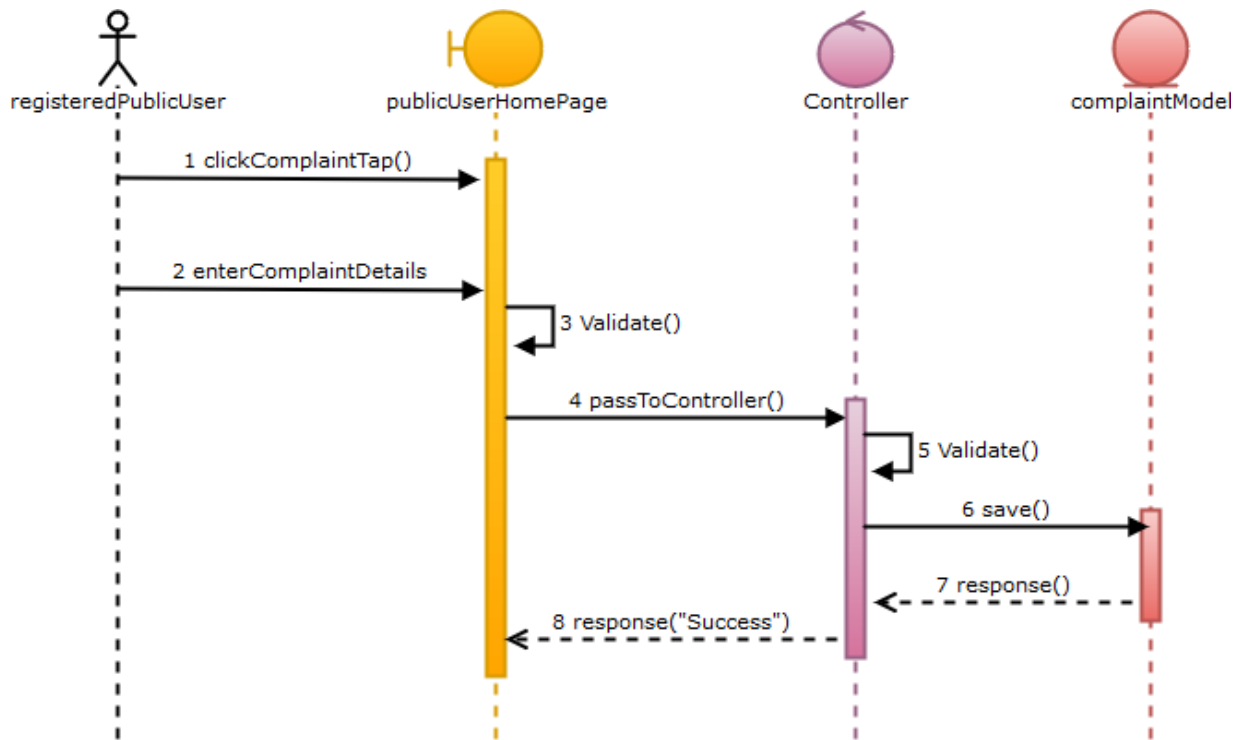
D.8 Sequence diagram of make response to a complaint by OIC

D.9 Sequence diagram of post emergency Note/ News by OIC

Annex E – Test Plan and Test cases

E.1 Introduction

The completed Crime investigation monitoring and public security information system is s web-based system that automated the crime investigation process and ensures the public security. Police OIC, officers who are below OIC rank, general public people are the main actors and the SDIG, DIG, SSP are in supervisory roles. Inspector general of the police takes part in the system as an administrator.

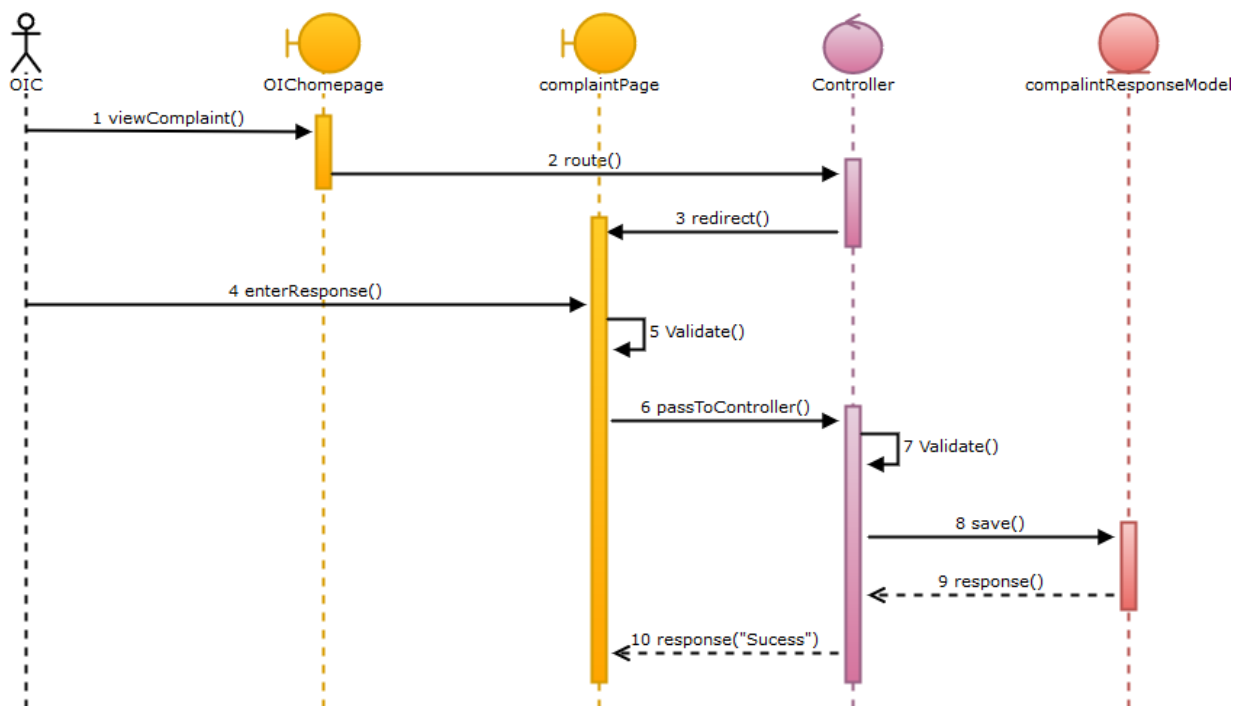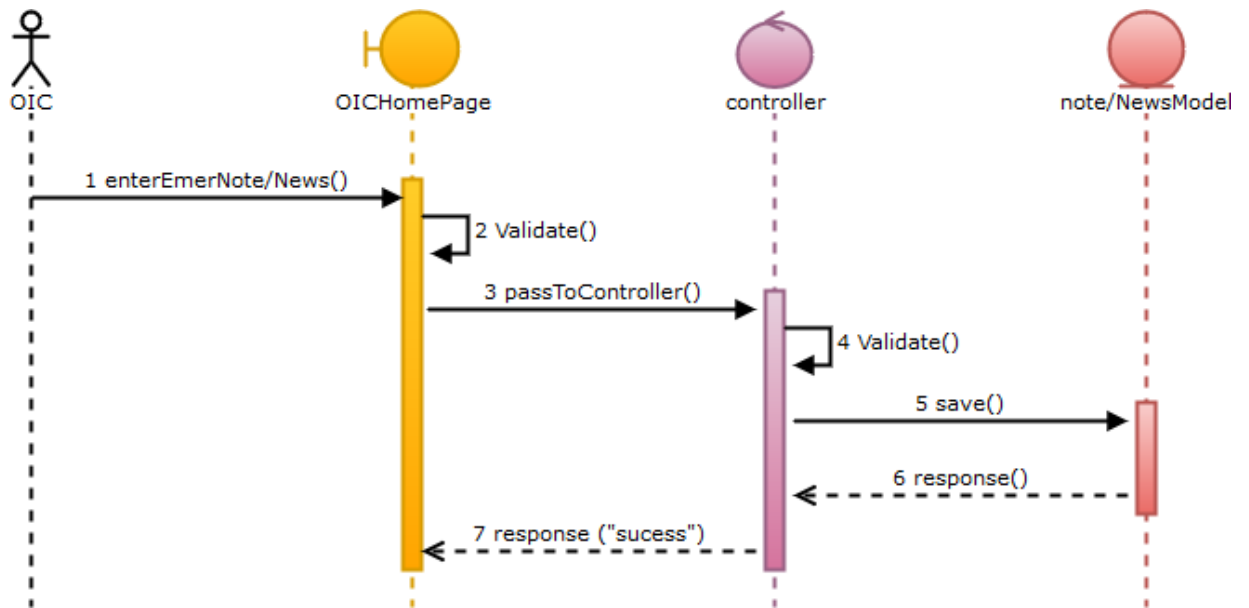## E.2 Objectives

Quality is the most valuable thing of any product. The software product is different from others by its complexity, invisibility and the limited opportunity to detect defects. By this unique characteristics, the software product requires special attention on its quality. By the IEEE definition, software quality is "The degree to which a system, component or process meets specified requirements". Software quality assurance is the key to ensure the software quality. The main part of the software quality assurance is the software testing. Main objectives of the software testing are to verify and validate the software. Verification ensures that built the software right and the validation ensure that built the right software.

E.3 Scope

The scope of this testing plan is to verify and validate the completed system before its release. Software bugs are hard to find and need a systematic approach to find and fixed those. It is an essential part to perform a testing on each unit of the system both individually and after integrated with other units. This testing process target to ensure the quality of both functional and non-functional requirements.

E.4 Testing Strategy

This testing plan follows the incremental testing strategy. This strategy allows performing the testing during small iteration. Unit testing, Integration testing, system testing, acceptance testing and usability testing are going to perform this test plan. Some of the functionalities testing that user login and case updating are going to automated by Selenium IDE.

Both unit testing and integration testing are going to perform under the black box and white box classification and the system testing, acceptance testing is needed to perform as black box classification.

E.5 Unit Testing

In this testing, each and every single unit of the system is going to test. It helps to identify the bugs at an early phase and also prevent the major issues on future development.

Participant

System developer is the person who is the responsible for this testing

Testing place

Development Lab

Software Unites which are going to testing in unit testing

User registration, user login, profile edit, password change, user account activation, complain registration, Complaint response, register case, add/remove crime type, add/remove evident, add/remove criminal, add/remove suspect, add/remove wanted person, add/remove missing persons, assign/remove investigation officers, crime related individual registration, post news and notes, make visible the CRI and evident, add court details, transfer case, transfer police officers, close the case modules need to test individually.

Methodology

First performing a white box testing with its functionalities and if errors found, correct the error and recheck the unit until the error was solved. Then after performing the black box testing to test with an interface, input and the output of the unit.

E.6 Integration testing

Integrated units are going to test this testing methodology. This testing used to verify the integrated units' functionalities.

Participant

System developer is the person who is the responsible for this testing

Testing place

Development Lab

Methodology

Related units are integrated with each other units, and the joint functionalities are going to testing. When the error occurred, need to troubleshoot the error until the functions work perfectly.

E.7 System Testing

By this testing process, all functionalities of the completed system are going to test and verify. A prepared set of test cases are using to conduct this testing.

Participant

System developer is the person who is responsible for this testing

Testing place

Development Lab

Methodology

The tester needs to execute every test cases which are in the prepared test cases document. Tester inputs the value into the system and compares the output with the excepted output. If those values are matched, the system successfully passes the test, otherwise, need to debug the system. This testing classified as black-box testing.

E.8 Acceptance testing and usability testing

This testing used to validate the system with the user requirements. Selected group of users involving in this testing, and check the system with their requirements.

Participants

01. Police Professionals who are with designations above OIC.

02. Police Professionals who are with designations OIC.

03. Police Professionals who are with designations below OIC.

04. IT Professionals.

05. General Publics with an educational level under the (O/L)

06. General Publics with the educational level of (A/L)

07. General Publics with an educational level above (A/L)

08. General Public in the age group below 18

09. General Public in the age group between 18 – 50

10. General Public in the age group above 50

Testing place

Police Stations, Community centers, school, Developing Lab

Methodology

First, the developer explains the functionalities of the system and doing some demos. After that user are allowed using the system. The user can get clear from the raising doubts with the developer. After completion of the testing, Users need to fill a questionnaire.

E.9 Automated Testing

Testing of user login and case updating functions are going to automated because of that those need to run multiple times.

Participant

System developer is the person who is responsible for this testing

Testing place

Development Lab

Methodology

This testing uses SeleniumIDE to automate the process. First, want to record the test cases with sample input by the firebox seleniumIDE plugin. There is an option to run the recorded test cases by single button press.

E.10 Hardware requirements

Laptop with minimum 1.3 GHz Processor and 2GB of ram.

Broadband Router

E.11 Software requirements

Internet browser

Apache, PHP, MySQL

E.12 Environment requirements

Clean place with good lighting and ventilation

E.13 Major Deliverables

Test Plan

Test Cases

Test result

Test result analysis

E.14 Test cases and actual results

Test case ID	Test Objective	Pre-Condition	Steps	Test data	excepted Result	Actual Result	Status
TS_1.0	Verify starting of CIM&PSI system	Internet connection should be work	1]enter the URL in to the browser	www.arakshawa.org	welcome page should be opened	welcome page opened	pass
TS_1.1				arakshawa.org	welcome page should be opened	welcome page opened	pass
User registration							
TS_2.0	Verify the user registration stage 1	1]Internet connection should be work	1]enter name	dinesh	input field should be green color	green color input field	pass
TS_2.1		2]welcome page is opened		11111	input field should be red color with error message	red color input field with error message	pass

TS_2.2			2]enter email address	any correct format	input field should be green color	green color input field	pass
TS_2.3				any incorrect format of email	input field should be red color with error message	input field should be red color with error message	pass
TS_2.4			3]click the button next to the type input field	No Need	drop down should be appeared	dropdown opened	pass
TS_2.5			4]enter the password	xyzabc	input field should be green color	green color input field	pass
TS_2.6			5]enter the confirm password	xyzabc	input field should be green color	green color input field	pass
TS_2.7				wwweree	error message that password not match should show	error message that password not match should showed	pass
TS_2.8			6]click create account button		page should be redirected to second registration form	page redirect to second registration form	pass
TS_3.0	Verify the user registration stage 2	user registration stage 2 page opened	1]click back button		page should be redirected to first registration form	page redirected to the first registration form	pass

TS_3.1			2]click next button with empty form field		fields are should be become red color	fields are turned as green	pass
TS_3.2			3]completed the form and click next button		page should be redirected to the welcome page with account activation instruction	page redirected to the welcome page with account activation instruction	pass
User Login							
TS_4.0	To verify the user login	user login page is opened	1]enter wrong username and password	email:testdata@gmail.com, Password: test	the error message that "These credentials do not match our records." should be show	the error message that "These credentials do not match our records." showed	pass
TS_4.1			2]enter correct username and wrong password	email:user@gmail.com, Password: test	the error message that "These credentials do not match our records." should be show	the error message that "These credentials do not match our records." showed	pass
TS_4.2			3]enter correct username	email:user@gmail.com, Password:111111	please activate your account	please activate your account	pass

		and password			page should be opened	page opened	
TS_4.3		user login page is opened and the user account is activated	1]enter correct username and password	email:user@gmail.com, Password:111111	user homepage should be opened	user homepage opened	pass
Use cases Related to OIC							
TS_4.0	To verify the function of new case registration	1]user loge din as OIC 2] OIC homepage opened	1]click the "add new Case" button on the homepage		case registratio n page should be opened	case registratio n page opened	pass
TS_4.1			2]enter the details and press submit button	case Number: case 1, date of occurrence, remarks	Page should be redirected to home page with success notificatio n	Page redirected to home page with success notificatio n	pass
TS_5.0	To verify the case maintainin g function	1]user logged in as OIC 2] OIC homepage opened	1]click the view button to any of the case		Page should be redirected to case single view	Page redirected to case single view	pass
TS_5.1		1]user logged in as OIC 2] case single	1]click "add crime type" Button		popup window should be opened with list of	popup window opened with list of the all	pass

		view page opened			the all crime types	crime types	
TS_5.2		1]user logged in as OIC 2] case single view page opened 3] crime type popup window opened	1]click "add" button		popup window should be closed and selected crime type appeared in case file	popup window closed and selected crime type appeared in case file	pass
TS_5.3		1]user logged in as OIC 2] case single view page opened	1]click "add criminal" Button		popup window should be opened with list of the all crime related individual s	popup window opened with list of the all crime related individual s	pass
TS_5.4		1]user logged in as OIC 2] case single view page opened 3] crime related individual 's popup window opened	1]click "add" button		popup window should be closed and selected crime related individual appeared in case file as criminal	popup window and selected crime related individual appeared in case file as criminal	pass

TS_5.5		1]user loge din as OIC 2] case single view page opened	1]click "add suspect" Button		popup window should be opened with list of the all crime related individual s	popup window opened with list of the all crime related individual s	pass
TS_5.6		1]user logged in as OIC 2] case single view page opened 3] crime related individual 's popup window opened	1]click "add" button		popup window should be closed and selected crime related individual appeared in case file as suspect"	popup window and selected crime related individual appeared in case file as suspect"	pass
TS_5.7		1]user logged in as OIC 2] case single view page opened	1]click "add missing person" Button		popup window should be opened with list of the all crime related individual s	popup window opened with list of the all crime related individual s	pass
TS_5.8		1]user logged in as OIC 2] case single view page opened 3] crime	1]click "add" button		popup window should be closed and selected crime related individual	popup window and selected crime related individual appeared	pass

		related individual's popup window opened			appeared in case file as missing person"	in case file missing person"	
TS_5.9		1]user logged in as OIC 2] case single view page opened	1]click "add wanted person" Button		popup window should be opened with list of the all crime related individuals	popup window opened with list of the all crime related individuals	pass
TS_5.10		1]user logged in as OIC 2] case single view page opened 3] crime related individual's popup window opened	1]click "add" button		popup window should be closed and selected crime related individual appeared in case file as wanted person"	popup window and selected crime related individual appeared in case file missing person"	pass
TS_5.11		1]user logged in as OIC 2] case single view page opened	1]click "assign police officer" Button		popup window should be opened with list of the all police officer who work under the	popup window opened with list of the all police officer who work under the OIC's	pass

					OIC's Police station	Police station	
TS_5.12		1]user logged in as OIC 2] case single view page opened 3] police officers detail popup window opened	1]click "add" button		popup window should be closed and selected police officer appeared In case file	popup window closed and selected police officer appeared In case file	pass
TS_5.13		1]user logged in as OIC 2] case single view page opened	1]click "add evident" Button		popup window should be opened which contain file uploading link	popup window opened which contain file uploading link	pass
TS_5.14		1]user logged in as OIC 2] case single view page opened 3] evident upload popup	1]select the file to upload 2] enter detail 3] click upload button		file upload success message should be show	file upload success message showed	pass

		window opened					
TS_5.15		1]user logged in as OIC 2] case single view page opened	1]click "Close the case" button		popup window should be opened with the warning message "this action cannot reversible"	popup window opened with the warning message "this action cannot reversible"	pass
TS_5.16		1]user logged in as OIC 2] case single view page opened 3] warning message popup opened	1]click the cancel button		action should be cancelled and popup closed	action cancelled and popup closed	pass
TS_5.17			2] click "go ahead" Button		case should be closed and page redirect to the home page with "case closed" message	case closed and page redirect to the home page with "case closed" message	pass

TS_5.18		1]user logged in as OIC 2] case single view page opened	1]click the view button of any closed case		case single file view page should be opened without control surface	case single file view page opened without control surface	pass
TS_6.0	To verify the function of public user account activation	1]user logged in as OIC 2] OIC homepage opened	1]click view button on pending users table		detailed view of the single user should be opened	detailed view of the single user opened	pass
TS_6.1		1]user logged in as OIC 2] single user view page opened	1]click activate button		user account should be activated and "this account activated" message displayed	user account activated and "this account activated" message displayed	pass
TS_7.0	To verify the function of public user account deactivation	1]user logged in as OIC 2] OIC homepage opened	1]click view button on pending users table		detailed view of the single user should be opened	detailed view of the single user opened	pass
TS_7.1		1]user logged in as OIC 2] single user view page opened	1]click deactivate button		user account should be deactivated and "this account deactivated"	user account deactivated and "this account deactivated" message displayed	pass

					message displayed		
TS_8.0	To verify the function of below OIC officers' user account activation	1]user logged in as OIC 2] OIC homepage opened	1]click view button on pending below OIC officers table		detailed view of the single below OIC officers should be opened	detailed view of the single below OIC officers opened	pass
TS_8.1		1]user logged in as OIC 2] below OIC officers view page opened	1]click activate button		below OIC officers account should be activated and "this account activated" message displayed	below OIC officers account activated and "this account activated" message displayed	pass
TS_9.1	To verify the function of below OIC officers' user account deactivation	1]user loge din as OIC 2] OIC homepage opened	1]click view button on below OIC officers table		detailed view of the single below OIC officers should be opened	detailed view of the single below OIC officers opened	pass

TS_9.2		1]user logged in as OIC 2] below OIC officers view page opened	1]click deactivate button		below OIC officers account should be deactivated and "this account deactivated" message displayed	below OIC officers account deactivated and "this account deactivated" message displayed	pass
TS_10.0	to verify the function of edit user detail	1]user logged in as OIC 2] single user view page opened	1]click "edit details" button		page should be redirected to the user details edit form	page redirected to the user details edit form	pass
TS_10.1		1]user logged in as OIC 2] single user detail edit form opened	2]fill the details that want to edit and click "save "button		details saved and page should be redirect back	details saved and page redirect back	pass
TS_11.0	to verify the function of edit below OIC detail	1]user logged in as OIC 2] single user view page opened	1]click "edit details" button		page should be redirected to the below OIC details edit form	page redirected to the below OIC details edit form	pass
TS_11.1		1]user logged in as OIC 2] single below OIC detail edit form opened	2]fill the details that want to edit and click "save "button		details saved and page should be redirect back	details saved and page redirect back	pass

TS_12.0	To verify the function of make response to the complaint	1]user logged in as OIC 2] OIC homepage opened	1]click the view button on complaint table		single complaint page should be opened	single complaint page opened	pass
TS_12.1		1]user logged in as OIC 2] single complaint view page opened	type the response and click the "Next" button		page should be refresh and page loaded with new response and "success" message	page refresh and page loaded with new response and "success" message	pass
TS_13.0	To verify the function of add new crime related individual	1]user logged in as OIC 2] OIC homepage opened	1]click the "add new CRI" button on complaint table		CRI adding form should be opened	CRI adding form opened	pass
TS_13.1			2]fill the details and submit next button		Page redirect to the OIC homepage with "Success" message	Page redirect to the OIC homepage with "Success" message	pass
TS_14.0	To verify the case transfer	1]user logged in as Admin 2] case transfer page opened	1]search the case that want to transfer 2] select want to transfer police station 3] click		system should be shows "success" message	system should be showed "success" message	pass

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			transfer button				

E.15 Usability Test Questionnaire

<div align="center">

Questionnaire for Usability Testing

Crime Investigation Monitoring and Public Security Information System

</div>

Name : …………………………………………………………………………………..

Age : ……………………………………………………………………………………

Higher Educational Qualification : ……………………………………………………

Job Designation : ………………………………………………………………………..

OVERALL REACTION TO THE SOFTWARE		1	2	3	4	5	6		NA
1	terrible	O	O	O	O	O	O	wonderful	O
2	difficult	O	O	O	O	O	O	easy	O
3	frustrating	O	O	O	O	O	O	satisfying	O
4	dull	O	O	O	O	O	O	stimulating	O
5	rigid	O	O	O	O	O	O	flexible	O
SCREEN		1	2	3	4	5	6		NA
6 Reading characters on the screen	hard	O	O	O	O	O	O	easy	O
7 Highlighting simplifies task	not at all	O	O	O	O	O	O	very much	O
8 Organization of information	confusing	O	O	O	O	O	O	very clear	O
9 Sequence of screens	confusing	O	O	O	O	O	O	very clear	O
TERMINOLOGY AND SYSTEM INFORMATION		1	2	3	4	5	6		NA
10 Use of terms throughout system	inconsistent	O	O	O	O	O	O	consistent	O
11 Terminology related to task	never	O	O	O	O	O	O	always	O
12 Position of messages on screen	inconsistent	O	O	O	O	O	O	consistent	O
13 Prompts for input	confusing	O	O	O	O	O	O	clear	O
14 Computer informs about its progress	never	O	O	O	O	O	O	always	O
15 Error messages	unhelpful	O	O	O	O	O	O	helpful	O
LEARNABLITY		1	2	3	4	5	6		NA
16 Learning to operate the system	difficult	O	O	O	O	O	O	easy	O
17 Exploring new features by trial and error	difficult	O	O	O	O	O	O	easy	O
18 Performing tasks is straightforward	never	O	O	O	O	O	O	always	O
19 Help messages on the screen	unhelpful	O	O	O	O	O	O	helpful	O
SYSTEM CAPABILITIES		1	2	3	4	5	6		NA
20 System speed	too slow	O	O	O	O	O	O	fast enough	O
21 System reliability	unreliable	O	O	O	O	O	O	reliable	O
22 Correcting your mistakes	difficult	O	O	O	O	O	O	easy	O
23 Designed for all levels of users	never	O	O	O	O	O	O	always	O

List the most negative aspect(s):

List the most positive aspect(s):

………………………………………   …………

Signature   Date

E.16 Recorded Automated Test cases

E.16.1 Login Scenario

package com.example.tests;

import java.util.regex.Pattern;

import java.util.concurrent.TimeUnit;

import org.testng.annotations.*;

import static org.testng.Assert.*;

import org.openqa.selenium.*;

import org.openqa.selenium.firefox.FirefoxDriver;

import org.openqa.selenium.support.ui.Select;

```
public class CimpsiLoginTestCase {
  private WebDriver driver;
  private String baseUrl;
  private boolean acceptNextAlert = true;
  private StringBuffer verificationErrors = new StringBuffer();

  @BeforeClass(alwaysRun = true)
  public void setUp() throws Exception {
    driver = new FirefoxDriver();
    baseUrl = "http://epolice.lk/";
    driver.manage().timeouts().implicitlyWait(30, TimeUnit.SECONDS);
  }

  @Test
  public void testCimpsiLoginTestCase() throws Exception {
    driver.get(baseUrl + "/");
    driver.findElement(By.linkText("Login")).click();
    driver.findElement(By.id("email")).clear();
    driver.findElement(By.id("email")).sendKeys("epolicelk@gmail.com");
    driver.findElement(By.id("password")).clear();
    driver.findElement(By.id("password")).sendKeys("111111");
    driver.findElement(By.cssSelector("button.btn.btn-primary")).click();
  }

  @AfterClass(alwaysRun = true)
  public void tearDown() throws Exception {
    driver.quit();
    String verificationErrorString = verificationErrors.toString();
    if (!"".equals(verificationErrorString)) {
      fail(verificationErrorString);
    }
  }
```

```java
  private boolean isElementPresent(By by) {
    try {
      driver.findElement(by);
      return true;
    } catch (NoSuchElementException e) {
      return false;
    }
  }

  private boolean isAlertPresent() {
    try {
      driver.switchTo().alert();
      return true;
    } catch (NoAlertPresentException e) {
      return false;
    }
  }

  private String closeAlertAndGetItsText() {
    try {
      Alert alert = driver.switchTo().alert();
      String alertText = alert.getText();
      if (acceptNextAlert) {
        alert.accept();
      } else {
        alert.dismiss();
      }
      return alertText;
    } finally {
      acceptNextAlert = true;
    }
  }
}
```

E.16.2 CASE Maintenance Scenario

```java
package com.example.tests;

import java.util.regex.Pattern;
import java.util.concurrent.TimeUnit;
import org.testng.annotations.*;
import static org.testng.Assert.*;
import org.openqa.selenium.*;
import org.openqa.selenium.firefox.FirefoxDriver;
import org.openqa.selenium.support.ui.Select;
```

```java
public class CimpsiCaseTestCase {
 private WebDriver driver;
 private String baseUrl;
 private boolean acceptNextAlert = true;
 private StringBuffer verificationErrors = new StringBuffer();

 @BeforeClass(alwaysRun = true)
 public void setUp() throws Exception {
  driver = new FirefoxDriver();
  baseUrl = "http://epolice.lk/";
  driver.manage().timeouts().implicitlyWait(30, TimeUnit.SECONDS);
 }

 @Test
 public void testCimpsiCaseTestCase() throws Exception {
  driver.get(baseUrl + "/oichomepage");
  driver.findElement(By.xpath("//table[@id='policecase']/tbody/tr[2]/td[3]/a/span")).click();
  driver.findElement(By.linkText("Add Crime Type")).click();
  driver.findElement(By.xpath("(//button[@value='Save'])[2]")).click();
  driver.findElement(By.linkText("Add Criminal")).click();
  driver.findElement(By.xpath("(//button[@value='Save'])[31]")).click();
  driver.findElement(By.linkText("Add Suspect")).click();
  driver.findElement(By.xpath("(//button[@value='Save'])[32]")).click();
  driver.findElement(By.linkText("Add Missing person")).click();
  driver.findElement(By.xpath("(//button[@value='Save'])[35]")).click();
  driver.findElement(By.linkText("Add Wanted person")).click();
  driver.findElement(By.xpath("(//button[@value='Save'])[36]")).click();
  driver.findElement(By.linkText("Add Court Details")).click();
  driver.findElement(By.linkText("Add Evident")).click();
  driver.findElement(By.name("evident_file")).clear();
  driver.findElement(By.name("evident_file")).sendKeys("C:\\Users\\zeyaan\\Downloads\\Untitled drawing(2).jpg");
  driver.findElement(By.name("description")).clear();
  driver.findElement(By.name("description")).sendKeys("description");
  driver.findElement(By.xpath("//input[@value='Upload']")).click();
  driver.findElement(By.linkText("Assign Police Officers")).click();
  driver.findElement(By.xpath("(//button[@value='Save'])[38]")).click();
  driver.findElement(By.xpath("(//button[@type='submit'])[41]")).click();
  driver.findElement(By.xpath("(//button[@type='submit'])[47]")).click();
  driver.findElement(By.xpath("(//button[@type='submit'])[50]")).click();
  driver.findElement(By.xpath("(//button[@type='submit'])[55]")).click();
  driver.findElement(By.xpath("(//button[@type='button'])[8]")).click();
  driver.findElement(By.cssSelector("form > button.btn.btn-outline")).click();
 }

 @AfterClass(alwaysRun = true)
 public void tearDown() throws Exception {
```

```java
    driver.quit();
    String verificationErrorString = verificationErrors.toString();
    if (!"".equals(verificationErrorString)) {
      fail(verificationErrorString);
    }
  }

  private boolean isElementPresent(By by) {
    try {
      driver.findElement(by);
      return true;
    } catch (NoSuchElementException e) {
      return false;
    }
  }

  private boolean isAlertPresent() {
    try {
      driver.switchTo().alert();
      return true;
    } catch (NoAlertPresentException e) {
      return false;
    }
  }

  private String closeAlertAndGetItsText() {
    try {
      Alert alert = driver.switchTo().alert();
      String alertText = alert.getText();
      if (acceptNextAlert) {
        alert.accept();
      } else {
        alert.dismiss();
      }
      return alertText;
    } finally {
      acceptNextAlert = true;
    }
  }
}
```