WEB BASED MOTOR TRAFFIC FINE AND DRIVER POINT MANAGEMENT SYSTEM

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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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This is to certify that this thesis is based on the work of Ms. Ahdilah Ismathdeen under my supervision. The thesis has been prepared according to the format stipulated and is of an acceptable standard.

Certified by:
Supervisor Name: Dr. D. A. S. Atukorale

Signature: Date: 30/11/2021

Abstract

The Web-Based Motor Traffic Fine and Driver Point Management System is developed to have an efficient motor fine management system and to improve the discipline of the Sri Lankan motorist through implementing a Driver Point System which will lead to a drastic reduction of traffic violations in Sri Lanka.

The system addresses key drawbacks of the current motor traffic fine enforcement procedure and aims to provide a viable solution by automating the current manual spot fine and fine payment process. It will be also directly linked to a Driver point system which will be implemented for 22 offenses under the Motor Traffic Act from the extraordinary gazette numbered 1726/12 dated 05.10.2011 on Driver Improvement Points System and the amended by the Sections 133 “a” and “b” of the Motor Traffic (Amendment) Act No. 18 of 2017.

Once a driving license holder violates a traffic offense, the traffic policeman will have the ability to issue a spot fine through the system, view the status of the driving license (active or suspended), view the driving license holder's past traffic offense records, and received demerit points. In the Driver Point Management System, once an offense is recorded against a driving license holder the allocated demerit points for that offense are recorded. Each fine is connected to a point system. The system will also calculate the total fine amount to be paid (for more than one offense) and accumulated driving points for a particular driver.

The System provides the driving license holder to pay the fine anytime through the online gateway instead of paying at the post office which only operates during a specified time and days. Also, the driving license holder can view the details of the fine issues and their accumulated driving points, past offense history, driving license status, and request a certificate of merit for not violating traffic offenses during the said period as a disciplined driver.

Web-Based Fine and Point Management system is designed using the class diagram, sequence diagram, ER diagram and developed using MVC architecture, HTML5/Bootstrap, PHP 7.4, MySQL Database, XWAMP Server, and Laravel 8 Framework.

The system is tested based on the black box test strategy with unit, integration, and system testing, cross-browser compatibility, and usability testing. Also, acceptance and evaluation of the system was carried out through questionnaires and a graphical representation of the responses is presented.

As a result of the successful implementation, it not only reduces the cumbersome process of motor fine issue and driver fine payment process and also automatically increases the level efficiency of collecting motor traffic fines to the Department of Police (Traffic Division). Furthermore, due to the Driver Point management system linked with the automatic fine issue, it brings a systematic approach towards disciplining the driving license holders which will reduce the number of road accidents in Sri Lanka.

Acknowledgment

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Finally, I would like to thank my family for their constant support and encouragement given to me throughout the entire project.

Table of Contents

List of Figures

List of Tables

List of Acronyms

Apache	Apache HTTP Server
API	Application Programming Interface
AJAX	Asynchronous JavaScript And XML
CSRF	Cross-Site Request Forgery
CSS	Cascading Style Sheets
ERD	Entity Relationship Diagram
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
JSON	JavaScript Object Notation
MVC	Model, View and Control
MySQL	My Structured Query Language
ORM	Object Relational Mapper
PHP	Personal Home Page
UML	Unified Modeling Language
URL	Uniform Resource Locator
XAMPP	Cross-platform, Apache, MySQL, PHP and Perl

Chapter 1: Introduction

1.1. Introduction

This chapter provides an outline for the entire project. It presents the necessary background, the need of the project, objectives, scope of the study, and the feasibility studies are discussed within the chapter. In the end, the structure of the report will be illustrated, to give the reader an overall idea of the report's content.

1.2. Project Overview

At present, the Department of Police (Traffic Division) in Sri Lanka uses a manual process for motor traffic fine management and there is no mechanism to discipline the driving license holders. This has resulted in a drastic increase in road accidents and it also has contributed to the inefficiency of the Department of Police (Traffic Division) especially in the process of collecting fines. It is also a time-consuming process for the driving licence holder to make payments since the payments can be only made at the post office.

The proposed Web-Based Motor Traffic Fine and Driver Point Management System automates how the spot fine statement is issued and provides a new platform for the payment of traffic fines through the online gateway. Further, the system sends time to time email notifications to the Driving License Holder on their online payment, the status of Demerit points as required by the regulation. Additionally, it also accelerates the process of generating reports relevant to the Department of Police (Traffic Division).

Once a driving license holder violates a traffic offense the policeman will have the ability to issue a spot fine through the system, view the status of the driving license (active or suspended), view the driving license holder's past traffic offense records, and receive demerit points.

The System provides the driving license holder to pay the fine anytime through the online gateway instead of paying at the post office, view the details of the fine and accumulated driving points, past offense history, driving license status, and request a certificate of merit for not violating traffic offense during the said period as a disciplined driver.

In the Driver Point Management System, once an offense is recorded against a driving license holder the allocated demerit points for that offense are recorded. Each fine is connected to a point system. The system will also calculate the total fine amount to be paid (for more than one offense) and accumulated driving points for a particular driver.

The proposed system involves the Department of Police (Traffic Division) and the Department of Motor Traffic. Department of Police involves offense detection and recording/imposing of fines, confiscating/returning the Driving Licence, analyzing motor traffic violation details, and maintaining the records of policeman details.

The Department of Motor Traffic is responsible for maintaining the records of offenses and demerit points, driving license holders' details, recalling driving license which is under suspension, and issuing the Certificate of Merit. These two institutions will work collectively to detect and deter traffic offenses as well as increase the level of road safety by disciplining the drivers.

1.3. Background of Study

In recent years, there has been a rapid increase in motor traffic violations in Sri Lanka due to the indiscipline behavior of motorists. Even though there are fines and rules enforced in making sure to limit the number of violations of traffic rules by the motorist, due to the inefficient time consuming manual fine collection process and inadequate measurements taken to regulate motorist behavior, many motorists have managed to slip through the law and continue to violate the rules and regulations.

At present where there is less than perfect enforcement of the law, it could lead to abuse and provide unnecessary leverage to and for the police and the motorist. The system of enforcing, collecting motor fines, and regulating motorist driver behavior should be done reasonably and effectively.

1.4. Motivation

The current process of obtaining the motor fine receipts and payment procedure is very time consuming as well as a cumbersome task for both the motorist and the police. Once the driver breaks the traffic rules, the police confiscate the driving license and issue a manual spot fine statement. The driver has to receive a fine payment form and pay the fine to the post office which he will receive a receipt. Finally, to acquire the driving license, the driver has to show the receipt at the respective police station and the police will return the driving license. The period for a driver to make the payment for a spot fine is 14 days and if the post office is closed and not in operation due to a postal strike or in a pandemic situation there is no way of the driver paying the fines on time.

Managing traffic offenses is a major responsibility of the Traffic Police. This doesn't only limit the traffic police in enforcing traffic rules and regulations and penalizing the driver in case of violating traffic rules. They are also responsible for making sure,

- To have adequate information of all traffic offenses that have been committed by road users
- To maintain the database of the driver details of their traffic offenses.
- To maintain and collect details of the fines payments.

However, at present, these are done manually where it is only recorded in books and not monitored efficiently.

As such to address the above problems it is important to automate the motor fine enforcement process with an e-payment to pay the fines for the offenses imposed at the time of the violation of road rules of motor traffic which are not referred to the courts of law. Further, this automation process will be linked to a driver behavior Demerit Point based system where each traffic offense will be assigned demerit points which will lead them to be more disciplined drivers and reduce road accidents.

1.5. Objective

The main objective of the proposed project is to develop an efficient motor fine management system and to improve the discipline of the drivers through the demerit point system which will lead to reducing the number of traffic violations.

i. To speed up and reduce the hassles of the motor fine issuing process through automating the current fine management process

ii. To improve the discipline of drivers through implementing the driver point management mechanism by providing reward and demerit points.

iii. To have a convenient faster mechanism in paying the fines through the e-payment

iv. To track and monitor information regarding the drivers and their traffic offenses

1.6. Scope of the Study

The proposed system will automate the motor traffic spot fine process and allocate demerit points for the violated offense. The proposed system consists of 3 main stakeholders

1. Policeman
   - Issue Spot fines at the sight of the offense through the system
   - The system will calculate the spot fine amount and update the relevant demerit point for the specific offense
   - The ability to search driving license holder's details and offense history.

2. Driving License Holder
   - Can view, update his/her personal details
   - Check the status of driving license, the accumulated driver points, and offense history
   - Check the outstanding fine amount and make an e-payment for the offenses

3. Commissioner General of Motor Traffic/Administrator
   - Maintain the records of policeman and driving license holders
   - Maintain the offense details, points, and fine amounts and rewards
   - Generating reports and sending email notifications.

The point-based system will be only implemented for the 22 offenses which are under the Motor Traffic Act from the extraordinary gazette numbered 1726/12 dated 05.10.2011 on Driver Improvement Points System and the amended by the Sections 133 "a" and "b" of the Motor Traffic (Amendment) Act No. 18 of 2017. The process of allocation of the points, the criteria that need to be followed when suspending a driving license, rewards for good driver behavior will be followed as per the above-mentioned gazette. (Government Information Center, 2011) (Traffic Police, 2018)

1.7. Structure of the Dissertation

1.7.1. Chapter 2: Background

This chapter discusses the existing fine management process, its drawbacks, and the proposed method of the demerit point system in Sri Lanka. Also, a detailed analysis of different counties' fine and point management systems is presented. It also provides an insight into the system requirements and selection of technologies and design strategies to implement the system.

1.7.2. Chapter 3: Design

This chapter involves details of the design stage for the development. It also includes the software design with class diagram, sequence diagram, ER diagram, and the system architecture is presented.

1.7.3. Chapter 4: Implementation

This chapter involves program code developed including the database, email, payment gateway environment setting code, and describes how each main functionality, was implemented referring to the diagram which was drawn up in the design.

1.7.4. Chapter 5: Testing and Evaluation

The chapter details the testing based on the black box test strategy which is carried out as unit, integration, and system testing, cross-browser compatibility, and usability testing. Furthermore, this chapter will include a test plan, test data, test case, and test results. This chapter also highlights the acceptance and evaluation of the system through questionnaires and a graphical representation of the responses.

1.7.5. Chapter 6: Conclusion

The chapter discusses problems encountered, benefits gained from the project and future enhancements proposed.

1.8. Summary

The introduction chapter provided the reader with an overview of the project. It highlighted the problems that are addressed in the project. The motivation of the project, objectives, and scope and feasibility of the project was also clearly stated. The chapter concludes with an explanation of the structural elements of this report. The next chapter is devoted to requirement analysis, literature review on different counties' fine and point management systems and related technologies.

Chapter 2: Background

2.1. Introduction

This chapter converse about the facts gathered from the literature survey and gives a brief introduction to the traffic fine payment process, issues and drawbacks of the existing manual process, and proposed method of point management process in Sri Lanka. The chapter identifies functional and non-functional requirements and proceeds with a comparison of different countries' fine management and driver point improvement system. And this chapter concludes by identifying necessary technology and designing strategies for the implementation of the project.

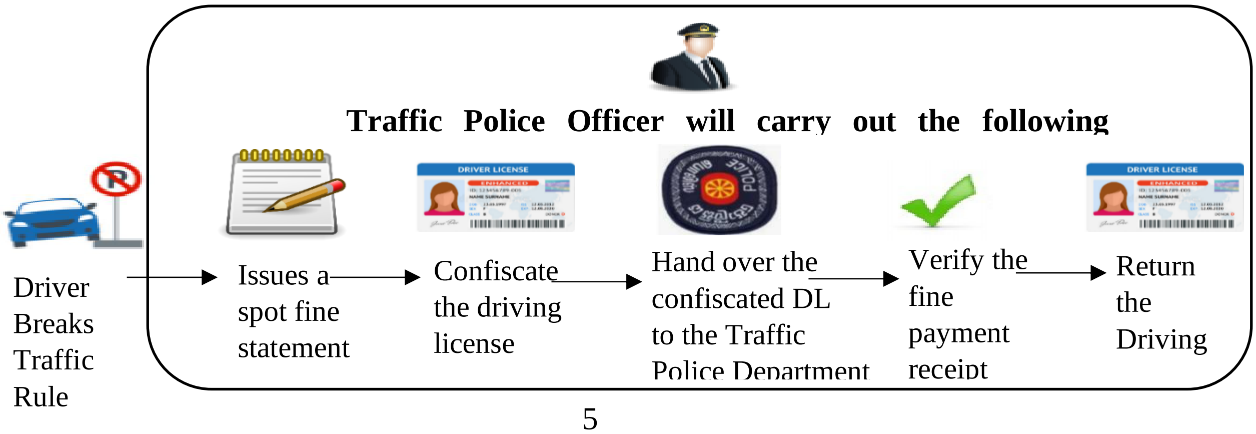
2.2. The Traffic Fine Management Process in Sri Lanka

The Traffic Police is a specialized unit of the Sri Lankan Police responsible for overseeing and enforcing traffic safety compliance on roads and highways. The implementation and enforcement of regulation and law come through powers vested on the Police by the Motor Traffic Act of 1951. (Traffic Police, 2018)

Every police station presently maintains a traffic branch. The main function of that branch is to enforce traffic law, prevent violations of traffic regulations and prosecution of offenders, investigate accidents, and control traffic on highways

In Sri Lanka, when a valid driving license holder breaks a traffic rule the following steps are carried as depicted in Figure 2.1;

1. The Police officer issue a spot fine statement and confiscate the drivers driving license
2. The driver goes to the post office and pays fines within 14 days for which he/she receives receipts.
3. The driver goes to the police station (Traffic Division), shows receipt and police return the driving license.
4. If the driver didn't pay the fine within 14 days he/she will be submitted to the court.
5. If the driver hasn't a driving license. Police issue another permit (police 405-Code of Criminal Procedure Section 109(6) Act, No. 15 of 1979).


Traffic Police Officer will carry out the following
Driver Breaks Traffic Rule
Issues a spot fine statement
Confiscate the driving license
Hand over the confiscated DL to the Traffic Police Department
Verify the fine payment receipt
Return the Driving

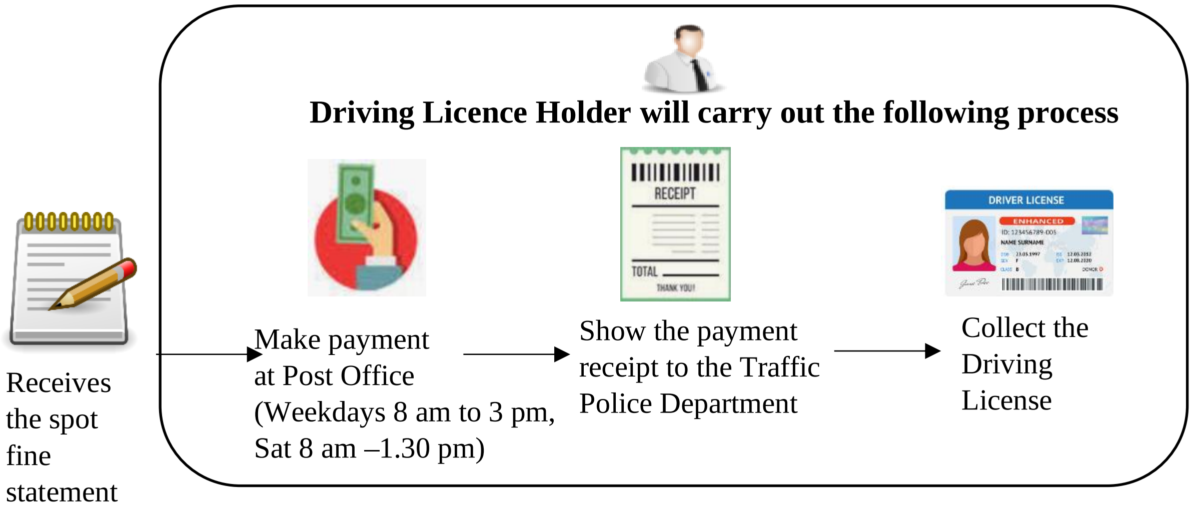

Driving Licence Holder will carry out the following process
Receives the spot fine statement
Make payment at Post Office (Weekdays 8 am to 3 pm, Sat 8 am –1.30 pm)
Show the payment receipt to the Traffic Police Department
Collect the Driving License

Figure 2. 1: Existing traffic fine collection process

2.3. The Main Issues and Drawbacks of the Current Process

Table 2.1 depicts the main issues and drawbacks of the current process under five (5) factors.

Factors	Issues and Drawbacks
Process	The present **manual spot fine process** is completely paper-based. It is a time-consuming process that leads to a lot of issues in the: Collection of fines, recording and maintaining of the fine details, delivering accurate information regarding individual driver offenses, and as well violation of motor traffic rules.
Time	▪ High consumption of time taken (Approximately min.10minutes) to issue and record the details of the traffic violation of a driving license holder. ▪ The Driving license holder has to spend a lot of time making the payments through the post office.
Payment Process	The inefficient cumbersome payment process for the Driving license holder; ▪ The payment can be only made to the Post office and during a set period and date. (Weekdays 8.00am to 3.00pm and Saturday 8.00am to 1.00pm) ▪ If the offense is made out of city limits or on a holiday, the driving license holder has to face difficulties in making the payment since the payment can be made at the post office only.
Record keeping	All the records are maintained by the Traffic Police in their **manual record books**. As such there can be many errors in recording and difficulties in maintaining, retrieving records regarding traffic violations
Tracking system	▪ There is **no proper tracking system** for the traffic police and the driving license holder for the collection of fines and payment ▪ The traffic police are unable to track the individual driving license holders past traffic violations ▪ Traffic police cannot track traffic violation details regarding their relevant areas on-site at any given time since all details are in manual books ▪ The driving license holder is unable to know about his past fine details

Table 2. 1: Issues and Drawbacks of the current process

2.4. Proposed Method of Point Management Process in Sri Lanka

According to the Gazette Extraordinary of the democratic socialist republic of Sri Lanka 15.01.2018 3A part 1, there are 33 spot fine offenses that are currently imposed in Sri Lanka. Which is annexed in Appendix A. Out of the 33 spot fines, 22 spot fines have been allocated demerit points by the Motor Traffic Act from the extraordinary gazette numbered 1726/12 dated 05.10.2011 on Driver Improvement Points System. For the project purpose for the remaining 11 spot fines, hypothetically allocated 3 demerit points each.

2.4.1. Demerit System

According to the extraordinary gazette numbered 1726/12 dated 05.10.2011 the process of assigning demerit points are as follows:

1. If a regular Driving License (DL) holder accumulates more than 18 points and less than 24 points, the system will send the Driving License holder a warning through SMS or email.
2. If a regular Driving License (DL) holder accumulates more than 24 points the DL will be suspended for one year and the Commissioner-General of Motor Traffic shall inform the DL holder to surrender immediately. ·
3. If the holder of a regular Driving License exceeds every additional four-driver improvement point after accumulating twenty-four driver improvement points, such holder of a Driving License shall be liable to the suspension of one month in addition to the twelve months suspension.

2.4.2. Rewarding System

According to the extraordinary gazette numbered 1726/12 dated 05.10.2011 the following rewarding system will be applied to all types of Driving License holders.

1. All demerit points will be erased if the driver remains free from traffic offenses for the 24 months following his last offense.
2. Issue certificate of Merit to every motorist who maintains a clean driving record (no offense recorded) consecutively for three years. A Certificate of Merit (COM) has an 8 digit number generated by the system to show that a person has been driving safely for the past 3 years. A driver can obtain a certificate of merit through the system by requesting a certificate of merit.

2.5. Requirement Analysis

The Web-Based Fine and Point Management system has identified the following users and the system requirements.

Three principal actors interact with the Web-Based Fine and Point Management System. They are:

1. System Administrator: The administrator is the Deputy Inspector of General of Police-Traffic (DIG-Traffic) or an assigned Senior Traffic Police Officer on behalf of the DIG in a particular police station-traffic police.
2. Policeman: On duty area in charge Traffic Police officer
3. Driving License Holder: a driving license holder with a valid license number.

2.5.1. DriSri System Functional Requirement

DriSri Systems functional requirements are as follows;

1. Ability to log in to the website anytime, from anywhere using their email address and password.
2. User login will be validated with a different access level.
3. The system will be able to calculate the total fine amount to be paid (for more than one offense) and accumulated driving points for a particular driving license holder.
4. The administrator will be able to perform the following functionalities
    a. Able to add/ view/update/search/delete Policeman details
    b. Able to add/ view/update/search/suspend/activate regular driving license holder
    c. Able to add/view/update/search offense details, points, and fine amounts
    d. Able to issue an online spot fine for an offense to a driver
    e. Able to update the status of the driving license after handing over the driving license with payment verification
    f. Able to update the status of the driving license after completing the suspension period
    g. Able to generate reports of;
        - The fine collected amount for the selected police division
        - The Overdue fines amount
        - Police Offense summary report based on the type of offends and type of vehicle category
2. List of active and suspended driving license holders
3. The policeman will be able to perform the following functionalities
    a. Able to view/update Policeman Details
    b. Able to search driving License Holder
    c. Able to view Driving license holders offense history
    d. Able to issue an online spot fine for an offense to a driver
    e. Able to update the status of the driving license after handing over the driving license with after the suspension period is completed
4. Driving license Holder will be able to perform the following functionalities
    a. Able to update Driving license holders personal details (address/contact number changes)
    b. Able to view Driving license Status
    c. Able to view accumulated driver points
    d. Able to request certificate of merit
    e. Able to view History- offense and payment
    f. Able to make an online payment for the fine
5. The system should be able to send email notifications for;
    a. When the offense is recorded
    b. When the certificate of merit is issued
    c. Acknowledgment when payment is received and the license is collected

Figure 2.2 demonstrates the use case diagrams of the functional requirements mentioned above.

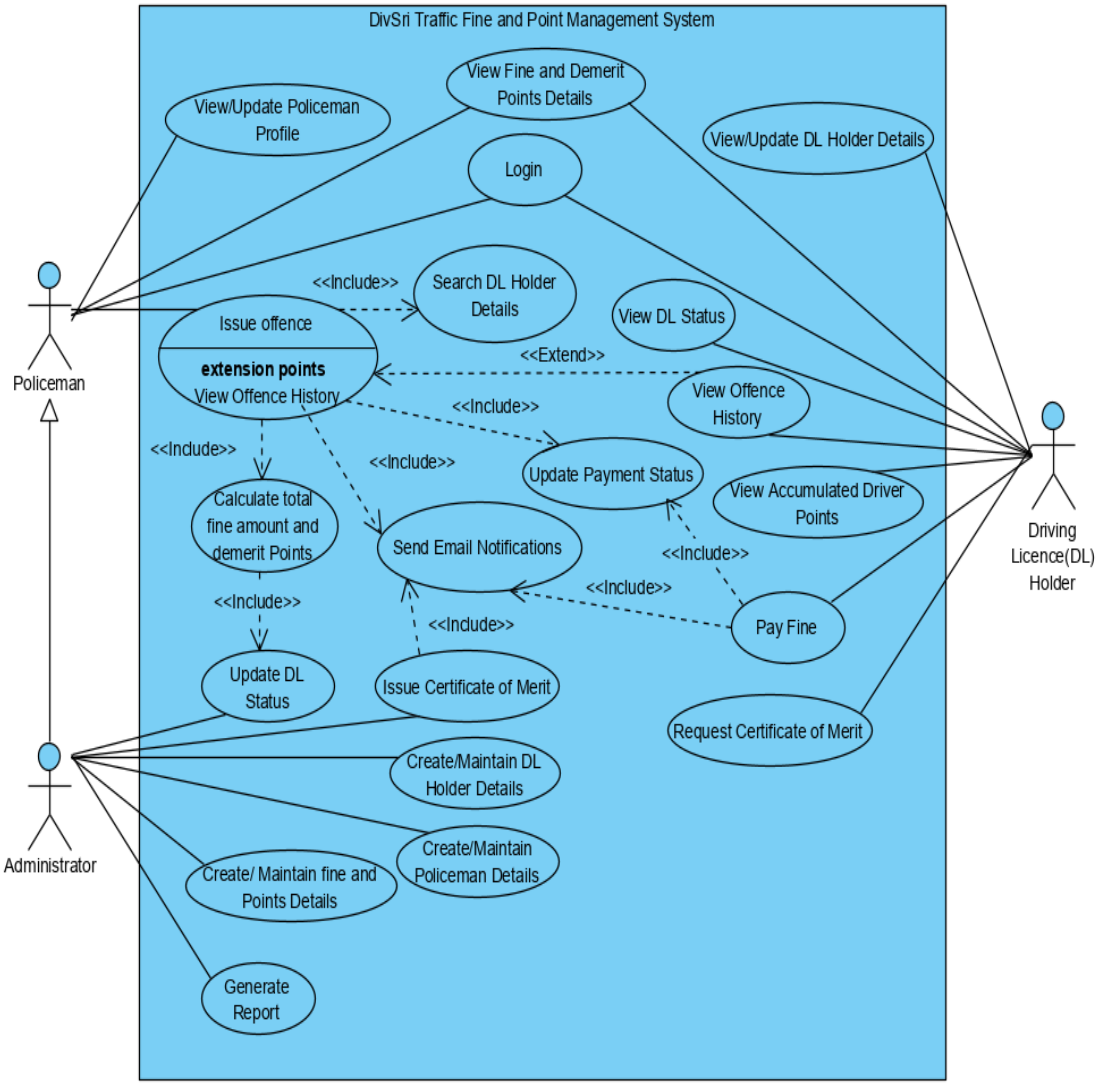

DivSri Traffic Fine and Point Management System
View Fine and Demerit Points Details
View/Update Policeman Profile
View/Update DL Holder Details
Login
Policeman
<<Include>>
Search DL Holder Details
View DL Status
Issue offence
extension points
View Offence History
<<Extend>>
View Offence History
<<Include>>
<<Include>>
<<Include>>
Update Payment Status
View Accumulated Driver Points
Driving Licence(DL) Holder
Calculate total fine amount and demerit Points
Send Email Notifications
<<Include>>
<<Include>>
<<Include>>
Pay Fine
<<Include>>
Update DL Status
Issue Certificate of Merit
Request Certificate of Merit
Create/Maintain DL Holder Details
Administrator
Create/Maintain Policeman Details
Create/ Maintain fine and Points Details
Generate Report

Figure 2. 2: Use Case Diagram of the Proposed System

2.5.2. Use Case Narratives

Use Case Narratives are detailed textual descriptions of the use cases and how the user will interact with the system to accomplish the task (Sommerville, 2016). Table 2.2 to Table 2.6 illustrates the high-priority use case narratives.

Use-Case Name:	Issue Offence
Use-Case ID:	ID001
Brief Description	This use case describes the process of how the motor traffic police officer uses the system to issue an offense for a road rule violation by the driving license holder.
Primary Actors:	Police Officer
Pre-conditions:	1. The police officer should log in to the System. 2. The system has already created the license holder details 3. The driving license holder Status should be Active

Main Flow:	1. The Police officer clicks on Offence Menu and selects Add submenu 2. The Police officer enters the “Driving License ID” Driving license ID is Valid The system will display in the relevant Driving license details: License holder name, mobile number Else, The system will display (E-1) “Invalid Driving License ID” 3. The police officer will select the vehicle class 4. The system will display the current date as a fine issue date and calculate the payment due date by adding 14 days to the issued date. 5. The police officer will enter the Section of Act and the system will allow selecting multiple selections. 6. The system will calculate the total fine amount and demerit points 7. The police officer clicks on the ‘submit button. 8. The system displays “Spot fine is issued successfully”
Alternative flows	E-1: An Invalid License holder id number is entered. The police officer can re-enter a valid license ID or terminate the use case.
Postcondition	1. The system will calculate the total demerit points, total fine amount due and update the license holders status 2. The system will send an email to the driving license holder notifying the offense details, total demerit point, total fine amount, and due date to pay

Table 2. 2:Use Case Narrative for Issue Offence

Use-Case Name :	Update DL Status
Use-Case ID :	ID002
Brief Description	This use case describes the process of how the automatically update the DL status when an offense is recorded by the police officer.
Primary Actors :	System
Pre-conditions :	1. The police officer records/issues offenses
Main Flow:	1. The System will calculate the accumulated demerit points by adding the DL holders’ total demerit points with the new demerit points. 2. The system will check the total demerit point If total demerit points < 24 The license holder status will be Active If the total demerit point is between 24 to 27 The license holder status will be Suspend for 12 months The license holder status between 28 or more The license holder status will be Suspend for 16 months 3. The System will update the DL status

Table 2. 3: Use Case Narrative for Update DL Status

Use-Case Name :	Pay Fine
Use-Case ID :	ID003
Brief Description	This use case describes the process of how the license holder uses the system to make payments for the offense he/she committed.
Primary Actors:	License Holder
Pre-conditions:	1. The license holder should log in to the system. 2. The police officer has issued an offense. 3. The payment status should be pending or overdue.
Main Flow:	1. The License holder clicks on "Pay Fine". 2. The system will displays offense details: offence id, issued police division, section of act, fine issue date, payment due date, fine amount, payment status 3. The license holder will clicks on "Pay Now" button 4. The license holder selects needs to selects the payment method Credit/Debit Card Payment, Mobile Wallet, Internet Banking If the mode of payment is debit/credit card the license holder enters the following details: Select card type, card holders name, Debit/Credit card number, Security Code, expiry date If the mode of payment is Mobile Wallet the license holder enters the following details: Select mobile wallet type, wallet card number, Security Code 5. The license holder clicks on the "Pay" button 6. The system displays "Payment Approved" 7. The system will redirect to the offense and fine payment details page and update the fine amount to zero, payment status to paid
Post condition	1. The system will update the license holder's total due fine amount 2. The system will update the payment status 3. The system will send an email to the driving license holder notifying the payment details received.

Table 2. 4:Use Case Narrative for Pay Fine

Use-Case Name:	Create Fine and demerit points
Use-Case ID:	ID004
Brief Description	This use case describes the process of creating fine and demerit points by the System Administrator
Primary Actors:	System Administrator
Pre-conditions:	The system administrator should login to the System.
Main Flow:	1. The System Administrator clicks on "Fine/ add" menu 2. The system administrator enters section of act, provision/description, fine amount 3. Section of act, provision, fine amount is empty The system will display (E-1) "Empty Field" 4. The system administrator selects the demerit points 5. The system administers click on Submit
Alternative Flow	E-1: Error Message "Empty Field". The System Administrator can re-enter or terminate the use case.
Post Condition	The system display "Fine details successfully added"

Table 2. 5:Use case narrative for create Fine and demerit points

Use-Case Name:	Request Certificate of Merit
Use-Case ID:	ID005
Brief Description	This use case describes the process of requesting certificate of merit by the driving license holder.
Primary Actors:	Driving License Holder
Pre-conditions-:	1. The license holder should login to the System.
Main Flow:	1. The License Holder clicks on "Certificate of Merit" Menu 2. The system will check If the total demerit points are less than 5 The system will display the "request" button Else, The system will display (E-1) "Your accumulated demerit point is more than 5" 3. The license holder clicks on request button 4. The system displays "successfully requested certificate"
Alternative flows	E-1: When the total demerit points is more than 5. The system will not allow to request the certificate.
Post condition	The system will send a request for certificate for the system Administrator

Table 2. 6: Use case narrative for Request Certificate of Merit

2.5.3. Non-Functional Requirements

The non-functional requirements of the system are;

1. Availability: The system will be available 365 days online.
2. Reliability: The system can work all the time without failures apart from network failure. Also, the Mean Time between Failures for the system will be 24 hours.
3. Accuracy: The system has to perform all operations without errors. The calculation of demerit points, rewarding process, e-payment process, and other functions should be performed 100% accurately.
4. Performance
    a. The response time for a change occurring will be no more than 5 seconds for 95% of requests made to the system.
    b. The response time for access the database will be no more than 5 seconds.
5. Security*:* The system will have password-protected access to different levels of users. This ensures that users have access to only what they need and reduce the aspect of security being compromised.
6. Recovery
    a. Recovery time scales- The response time will be less than 30 seconds for 95% of requests made to the system
    b. Backup frequencies - The backup is scheduled to run automatically at 1.00am daily.
7. Portability: The system will run on different operating systems and different web browsers Mozilla Firefox, Opera, Safari, and Google Chrome.

2.6. User Characteristics

The System will provide the user the basic information about the system and its functionalities. The user of the system should be able to understand instructions which are in English language & he/she can understand and make online payments without any errors. The user also requires a small knowledge of computers to perform the e-payment by filling in the necessary bank card details.

2.7. Fine and Point Management Systems Worldwide

Many countries have adopted a penalty point or demerit point system under which a person’s driving license is canceled or suspended based on the number of points accumulated by them over a period of time. The demerit point's schemes of each jurisdiction vary. These demerit schemes are usually in addition to fines or other penalties that may be imposed for a particular offense or infringement, or after a prescribed number of points have been accumulated.

Many countries in the world have successfully implemented the Motor Traffic Fine Management system with the integration of Driver Improvement / Demerit Points Systems. Developed countries such as the USA, United Kingdom, Australia, New Zeeland, Canada, and most of the European Union countries and some Asian countries such as Singapore, Japan, Malaysia, Hong Kong, and UAE have already implemented the fine and point system successfully.

2.7.1. Point System of Australia

In Australia, all drivers start with zero demerit points. If a traffic offense is committed, demerit points are added to the driving record as penalties and the license holder pays the penalty through the online gateway. However, the demerit points remain active for up to 3 years. Once the driver exceeds the demerit point limit the license will be suspended. When the suspension period is over, the driving license holder can drive as long as their driver's license has not expired. (Northern Territory Government Australia, 2020)

Police can suspend and confiscate a license either on the spot or within 48 hours of a person being charged. Depending on certain traffic offenses, the license can also be automatically canceled. If cancellation happens the driver needs to reapply for a new license after completing the period of license disqualification or suspension. (Transport for NSW Australia, 2020)

2.7.2. Point System of United Kingdom

The UK Driver Vehicle License Agency (DVLA) manages the drivers, vehicles, fines, and driver point system. The driving license is endorsed if the driver has been convicted of an offense. An endorsement may also be accompanied by several points that can remain on the license for 4 to 11 years. If the total of points on a license equals or exceeds 12 or more within a period of 3 years the driving license will get suspended for a period of time. If a new driver, in the 2 years after passing their first practical test, accumulates 6 points, their license is revoked by the DVLA, and the driver has to reapply and pay for the provisional license, drive as a learner, and take the theory and practical tests before receiving a full license again. Through the DVLA website, the drivers can pay their online fine and check their driving point history. (Government of UK, 2020)

2.7.3. Point System of Singapore

In Singapore, the Driver Improvement Points System (DIPS), was implemented by the Traffic Police in 1983. Under DIPS, any driver who accumulates 24 demerit points within 24 months (2 years) will be suspended from driving. Driver license has been classified into two categories as regular drivers and new or probationary drivers. Based on the category the demerit points are offered. Through the SingPass system, the driver's license holder can make online payments and perform all the operations related to traffic offenses. (Singapore Police Force, 2020)

It is also used as a reward system where any demerit points will be erased if the driver remains free from traffic offenses for the 12 months following his last offense. The best incentive will be the Certificate of Merit, issued to every motorist who maintains a clean driving record consecutively for three years. This reward entitles him/her to a five percent discount on his/her motor insurance premium upon renewal, on top of any No-Claim Bonus, provided his/her insurer participates in the above-mentioned scheme and he/she did not file any policy claims in the last three years. (Singpass , 2021)

2.7.4. Point System of UAE

In the UAE there is a motor traffic fines and black point system. The Black points are stringent penalties to discourage drivers from breaking the law. These points are issued in combination with a fixed fine. If an offense is committed the traffic police adds the black points to the driver within 48 hours and it is notified with an SMS. The driver can access the details of the offense and pay the fine amount through the UAE Police Website. If the total number of black points on the license exceeds 24 points, the license is suspended for a fixed period and the driver cannot drive any vehicle during that period. Each black point stays on the motorist's license for a year even if the fine is paid. (Emirates Vehicle Gate, 2021)

2.8. Critical Analysis of Fine and Point Management System

Table 2.7 depicts a summary of the critical analysis of different counties' fine and point management systems requirements been compared with the proposed system by ranking the requirements' by using two scales Yes/No or Available/Not Available.

Requirements	UK	Australia	Singapore	UAE	Proposed System
Maintain driver details	Yes	Yes	Yes	Yes	Yes
Maintain offense and penalty points details	Yes	Yes	Yes	Yes	Yes
Maintain policeman details	Yes	Yes	Yes	Yes	Yes
Issue spot fine on sight	Yes	Yes	Yes	Yes	Yes
Issue spot fine via nationwide road cameras and sensors	Yes	Yes	Yes	Yes	No
Calculating accumulated driver points	Yes	Yes	Yes	Yes	Yes
Maintain driver offense/ driver points history	Yes	Yes	Yes	Yes	Yes
Maintain the status (suspension/ cancellation) of driving license	Yes	Yes	Yes	Yes	Yes
Check the status of outstanding traffic fine amount	Yes	Yes	Yes	Yes	Yes

Requirements	**UK**	**Australia**	**Singapore**	**UAE**	**Proposed System**
Check demerit points	Yes	Yes	Yes	Yes	Yes
Pay fine online	Yes	Yes	Yes	Yes	Yes
Reward obedient drivers	No	Yes	Yes	No	Yes
Collect driving license and returning	Yes	No	No	No	Yes
Sending notification via email or SMS	Yes	Yes	Yes	Yes	Yes
Generating Reports	Yes	Yes	Yes	Yes	Yes

Table 2. 7:Requirement Analysis of the existing and proposed System

Compared to other developed countries, with the rapid advancement of technology, Sri Lanka has not been able to implement a proper Motor Traffic Fine Management System and yet following the age-old manual mechanism. This has made the fine enforcement process with a lot of paperwork and it also has given a loop hold for the driving license holders to continue driving offenses without any discipline. Even though Sri Lanka has attempted to initiate a point-based system in 2011 however, it has not been implemented and many factors have not been considered such as the necessary infrastructure development and the necessary tracking devices (cameras and sensory devices).

2.9. Related Technologies

Table 2.8 depicts some possible technology solutions and compares each technology against the system requirements.

Technology	**Possible Solution**	**Features**
User Interface Design	HTML5	HTML 5 is mobile-friendly and supported by all major web browsers and Scalable Vector Graphics (SVG) is an integral part of HTML 5 and allows JavaScript to run in the background.
	CSS	A style sheet language used for describing the presentation of a document written in HTML. The developer should write the code from scratch and there is no grid system. However, provides more control over the layout.
	Bootstrap	A free and open-source front-end framework to create a responsive design that is more presentable with a 12-column grid system and contains already designed classes. The developer can use them to add styling to the elements without writing code from the beginning which speeds the development process.
Server-Side Scripting Language	PHP	PHP is a server-side scripting language that is open source. It is multi-threaded which means it blocks I/O to carry out multiple tasks concurrently. PHP execution is faster since it uses in-built memory space and easier to learn and understand.
	ASP.NET	ASP.NET is a paid Microsoft provided web application framework. ASP.NET is a bit slow compared to PHP as it is built on the COM-based system. ASP.NET can be quite a challenge to learn and understand for a beginner and takes time

		to master.
Technology	**Possible Solution**	**Features**
Web Framework	Laravel	Laravel provides a built-in authentication mechanism, caching mechanism, unit testing mechanism and provides unmatched quality session control. Laravel dependency manager fully composer based and it is easy to integrate with 3rd party libraries.
	CodeIgniter	CodeIgniter is object-oriented, event-driven functional, and easy to learn for beginners. However, it doesn't offer any built-in modularity features. Therefore, the developers need to create and maintain modules by using the modular extension.
Database	Microsoft SQL Server	Relational database management system developed by Microsoft and supports Windows, Linux and containers. MS SQL requires more disk space.
	MySQL	Open-source relational database management system developed by Oracle and supports Windows, Linux, and Mac. Requires very little disk space and can be easily used by beginners.
Server	XAMPP	XAMPP is an AMP (Apache, MySQL, PHP, Perl) stack with some additional administrative software tools such as phpMyAdmin (for database access), FileZilla FTP server, Mercury mail server, and JSP Tomcat server.

Table 2. 8:Comparison of related technologies

Based on the above comparison Web-Based Fine and Point Management system will be developed using HTML5/Bootstrap, PHP 7.4, MySQL Database, XWAMP Server, and Laravel 8 Framework.

2.10. Related Design Strategies

Table 2.9 depicts some possible solutions and compares design strategies.

Design Strategy	**Possible Solution**	**Application**
Development of Component	Use of Open-source component	Open-source components provide a range of pre-built core features with reusable components and numerous add-ons extensions, plugins. However, there can be high initial costs and provides limited customization.
	Development component from Scratch	Can develop a unique application to suit the requirements by implement clean and flexible code to improve data privacy, security, and compliance with the standard. However, it can be more time consuming and might require intensive development.
System Deployment	Stand-alone	The proposed system portability is a key requirement and stand-alone computers are not portable. However, standalone applications don't require the Internet for their operations. They have faster access to records and more secure from data hacking and virus attacks.
	Web-Based	Web-based systems make it easier to provide access to real-time information without the installation of software on the local machine or mobile device. The users can

		access a web-based system anywhere with an Internet connection and a web browser. It eliminates the need for a powerful client PC as processing is carried out at the host server. Also, it can attract a large number of users and relatively inexpensive to uses.
	Mobile Application	A mobile application can provide interactive user interfaces and make use of phone features such as location and camera services. However, Mobile apps only work for their specific operating system therefore it is required to develop the app for different platforms (android and iOS). Also, the mobile app needs to be downloaded from the Play Store or App Store and installed. The main drawback is not all Sri Lankan drivers have high-performance sophisticated smartphones with sufficient mobile storage.
System Architecture	Client-Server	Centralized system with all data in a single place. It is cost-efficient, less maintenance cost, and data recovery is possible. However, data packets may be spoofed or modified during the transaction, and sever are prone to Denial of Service (DOS) attacks.
	3-Ter	3-Tier architecture patterns never communicate directly with the data layer. All the data communication must pass through the middle tier. Widely used in web applications where the client, data, and middleware run on the physically separated platform.
	MVC	MVC architecture is a triangular architecture that allows the data (model) to change independently of its representation (view) and vice versa. Supports presentation of the same data in different ways with user changes made in one representation shown in all of them. MVC model components can be tested separately from the user. However, can involve additional code and code complexity when the data model and interactions are simple
System Software	Windows	It is paid operating system developed by Microsoft company. It has rich graphical user interfaces which make the OS easy to use for anyone. The hardware drivers can be easily plug in with windows computers due to the availability of all kinds of hardware drivers.
	Linux	Linux open-source operating system anyone can download it for free of charge. However, Linux based driver is not available easily as its open source. This creates a problem to use a particular hardware device. Also, Linux has lesser memory for storage and file name are case sensitive compare to Windows 10.

Table 2. 9: Comparison of related Design Strategies

Based on the above comparison Web-Based Fine and Point Management system will be a web-based application development from scratch using MVC architecture on a Windows 10 Operating system.

2.11. Development Methodology

Iterative Incremental model was selected as a development methodology as the project requires a vast amount of referencing, learning and experimenting throughout the development life cycle and a prototype has to be develop within a limited time frame. To meet the changing requirement throughout development life cycle and to achieve successful project development this model was selected.

The Iterative Incremental model allows a partial implementation of a total system and increased functionality can be added. The defects found from the previous delivery can be fixed and the development process is repeated until the entire system is completed. (Tutorialspoint, 2017)

2.12. Summary

The chapter presented the importance of implementing the Web-Based Fine and Point Management System and how the point management system will be implemented. Furthermore, the system requirements were defined by specifying the function, non-functional. The proposed system will be developed using Iterative Incremental model, HTML5/Bootstrap, Laravel 8 Framework, PHP 7.4, MySQL Database, and XWAMP Server using MVC architecture.

The next chapter will introduce the design of the proposed solution, keeping in mind the requirements identified in this chapter.

Chapter 3: Design

3.1. Introduction

This chapter will impart the work conducted in the process of designing the system considering the requirements identified in the previous chapter. This chapter presents the software architecture, database modeling using ER diagram and ER diagram to relational mapping. Also, the system will be model using the class diagram and sequence diagram. Furthermore, this chapter sets out various Human-Computer Interaction factors that were considered in user interface design are discussed.

3.2. System Architecture

Web-Based Fine and Point Management System is implemented using Laravel Framework 8 and MySQL Database. The Laravel is a PHP framework to create full-featured web applications using Model View Controller (MVC) architecture.

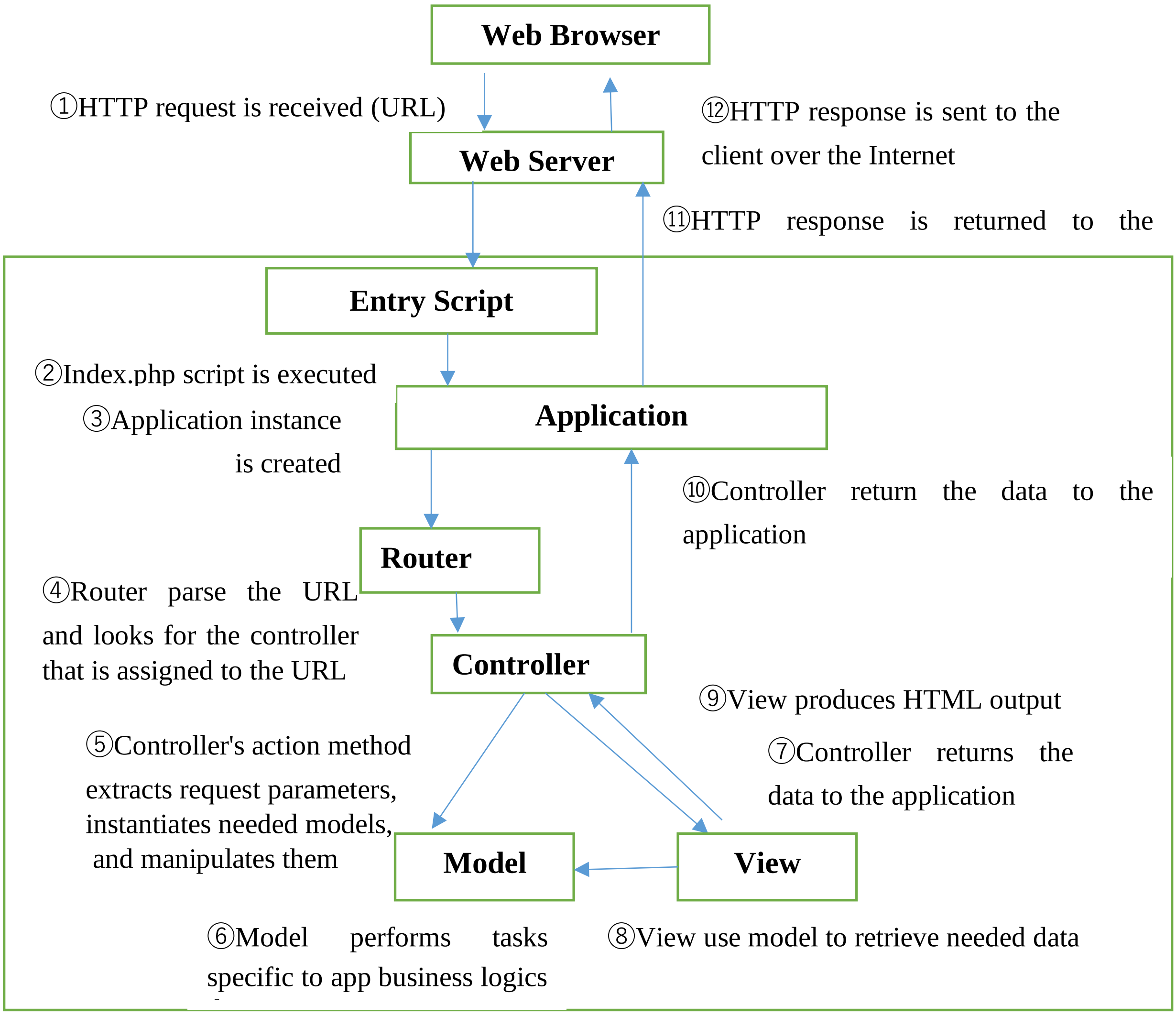

Web Browser
①HTTP request is received (URL)
⑫HTTP response is sent to the client over the Internet
Web Server
⑪HTTP response is returned to the
Entry Script
②Index.php script is executed
③Application instance is created
Application
⑩Controller return the data to the application
Router
④Router parse the URL and looks for the controller that is assigned to the URL
Controller
⑨View produces HTML output
⑤Controller's action method extracts request parameters, instantiates needed models, and manipulates them
⑦Controller returns the data to the application
Model
View
⑥Model performs tasks specific to app business logics
⑧View use model to retrieve needed data

Figure 3. 1: System Architecture

As shown in Figure 3.1, the *Model* component corresponds to all the data related logic that the user work with and performs tasks specific to application business logic. The *View* component contains web pages and page fragments like header and footer which were developed using HTML/Bootstrap. These web pages can be viewed through the computer, mobile devices, and various other devices. These pages are accessed by the System Administrator, Policeman and Driving License Holder. The *Controller* is the intermediary between the Model and the View to process the HTTP request and generate the web pages. All the requests received by the controller are passed on to the models and view to process the information. Further, *the Router* parses the URL and looks for the controller that is assigned to the URL and navigates the view to the relevant controllers. (Sellarès, 2019)

The software architecture for the Web-Based Fine and Point Management system is divided into 6 main components,

1. Offense component –This is one of the main components which is used by the Policeman to record the motor traffic offence when a Driving License Holder violates a motor traffic rule. The Policeman will log in to the system using his username and password and then enter the Driving License Holders number, select the vehicle type, violated section of acts for the committed offenses. This component also allows the user, to view the issued offences history by an police officer.

2. Fine component- This component is used by the Policemen, to select the fines and section of act when the Driving License Holder commits a road rule violation to issue an offence. Each fine has section of act, fine amount and demerit points which will be used to calculate the total fine amount and accumulated demerit points obtained by a Driving License holder. The System Administrator can add new fine, update fine and delete fine records. The Policeman and Driving License holder can only view all the fine details.

3. Demerit and Reward points' component- Demerit and Reward point calculations are interconnected with the fine component and the offense component. Each fine has a demerit point which will be simultaneously calculated with the total fine amount and total demerit points for each offense recorded by the police officer. Both the Driving License Holder and the Policeman can view the accumulated demerit points. The system will automatically update the driving license holder status depending on the accumulated demerit points and apply reward scheme when the driving license holder does not commit any offense for a period of time.

4. Payment component – This component is used by the Driving License Holder, to pay the fine amount for the violated motor traffic offense. The Driving License Holder will log in to the system, view the motor traffic offence history, and make the payment through the payment gateway.

5. Notification component- This component will send email notifications to the Driving License Holder when the motor offence is recorded when the payment is received and certificate of merit is issued.

6. Report component – This component primary will be used by the System Administrator to generate reports.

Through the MVC pattern, each component is implemented by separating the input logic, business logic and user interface logic.

3.3. Data Modeling

The database structure for the web-based traffic fine and point management was modeled as an Entity Relationship Diagram (ERD). Figure 3.2 depicts the entities within the system and the relationship between those entities.

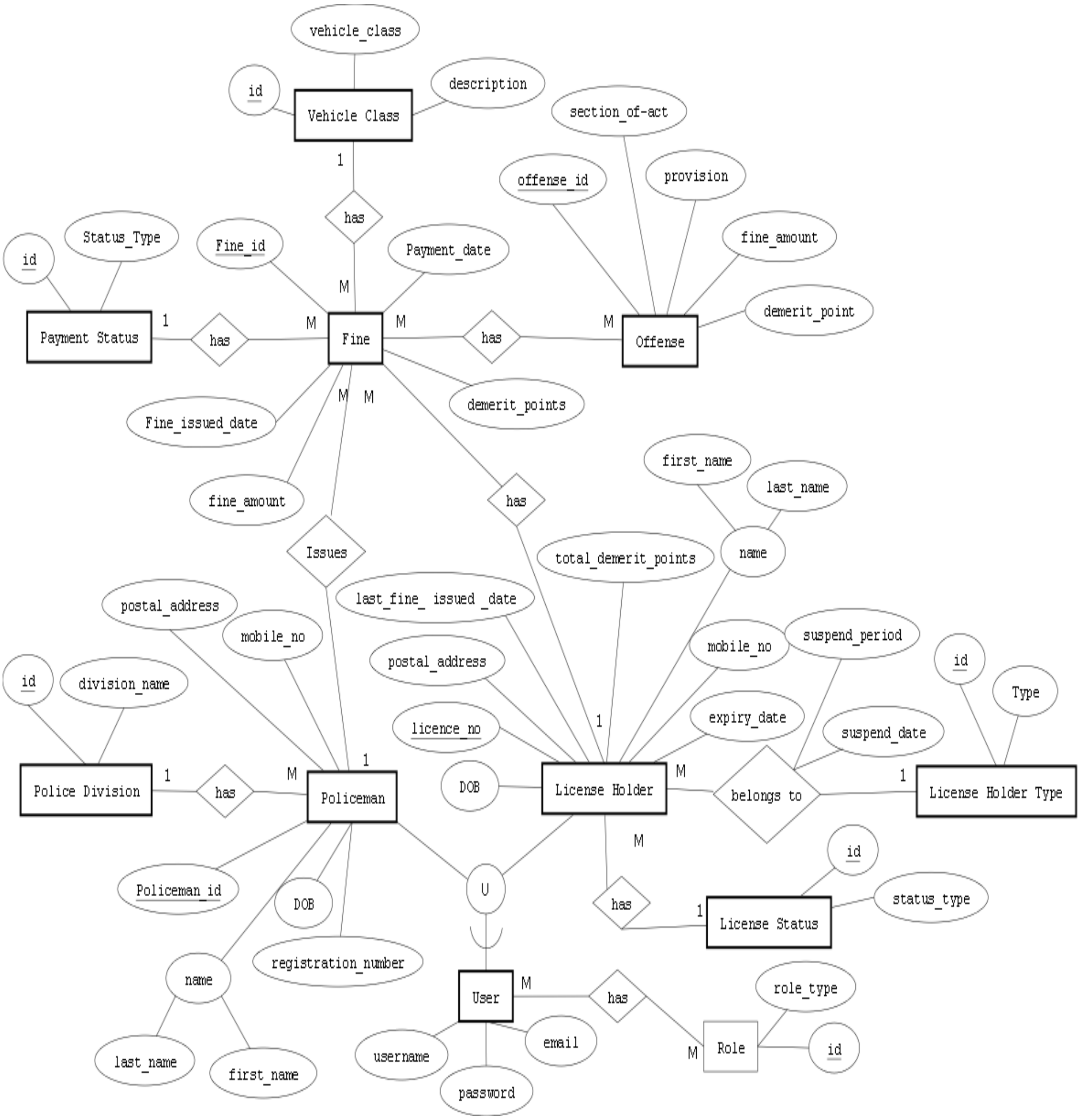


Figure 3. 2: ER Diagram

3.4. Relational Database Design

Translating an ER schema into a collection of tables is the basis for deriving a relational database schema from an ER diagram. (Davis, 2019) Figure 3.2 was mapped into a set of normalized relations as shown in Table 3.1.

Table Name	**Field Name**	**Description**
User (Store information about the user)	user_id	PRIMARY KEY
	Username	
	Email	
	Password	
Role (Store information about roles)	role_id	PRIMARY KEY
	role_name	The Role name are licensed holder, policeman, administrator
User_Role	user_id	COMPOSITE PRIMARY KEY
	role_id	COMPOSITE PRIMARY KEY
Policeman (Stores details about the policeman and assigned police division)	user_id	FOREIGN KEY
	policeman_id	PRIMARY KEY
	first_name	
	last_name	
	DOB	
	mobile_no	
	postal_address	
	registration_number	
	division_id	FOREIGN KEY
Police_Division (store information of police division)	division_id	PRIMARY KEY
	division_name	Division name are Dehiwela, Kohuwala, Moratuwa, Colombo 1 to Colombo 15
Licence_Holder (Stores details about licensed holders, license status, previous fine details, total demerit points)	user_id	FOREIGN KEY
	licence_no	PRIMARY KEY
	first_name	
	last_name	
	DOB	
	postal_address	
	mobile_no	
	expiry_date	
	licence_status_id	FOREIGN KEY
	total_demerit_points	Accumulated demerit points
	last_fine_issued _date	The last date the fine was issued
License_Status	license_status_id	PRIMARY KEY
	status_type	The types are Active, Suspend
Fine (stores details about the fine with the assigned fine amount and demerit points)	fine_id	PRIMARY KEY
	section_of_act	
	Provision	The description of the fine
	fine_amount	
	demerit_point	The amount of demerit points allocated

Offence (store information about offence to a particular driving license holder)	Offence_id	PRIMARY KEY
	licence_holder_id	FOREIGN KEY
	policeman_id	FOREIGN KEY
	vehicle_class_id	FOREIGN KEY
	fine_issued_date	
	payment_date	
	payment_status	FOREIGN KEY
	total_fine_amount	
	total_demerit_points	
Offense_has_fines	Id	PRIMARY KEY
	offense_id	FOREIGN KEY
	fine_id	
Vehicle_ Class	vehicle_class_id	PRIMARY KEY
	vehicle_class	The vehicle class are A1,A,B1,C1,C,CE,DE,G1,G,J
	Description	Description of the vehicle class. Eg: A1 description is Light motorcycles of which Engine Capacity does not exceeds 100CC Light
Payment_Status	payment_status_id	PRIMARY KEY
	status_type	The types are Pending, paid, overdue
Request_certifications (store information about license holders certificate of merit requested)	Request_id	PRIMARY KEY
	License_holder_id	FOREIGN KEY

Table 3. 1: Database Table Structure

The develop drivri database scheme is annex in Figure B.1.Appendix B: Database Design

3.5. Class Diagram

After analysis of the uses case diagram in Figure 2.2, the class diagram was designed for the system. The following classes, attributes, and methods were identified to be implemented as shown in Figure 3:3.

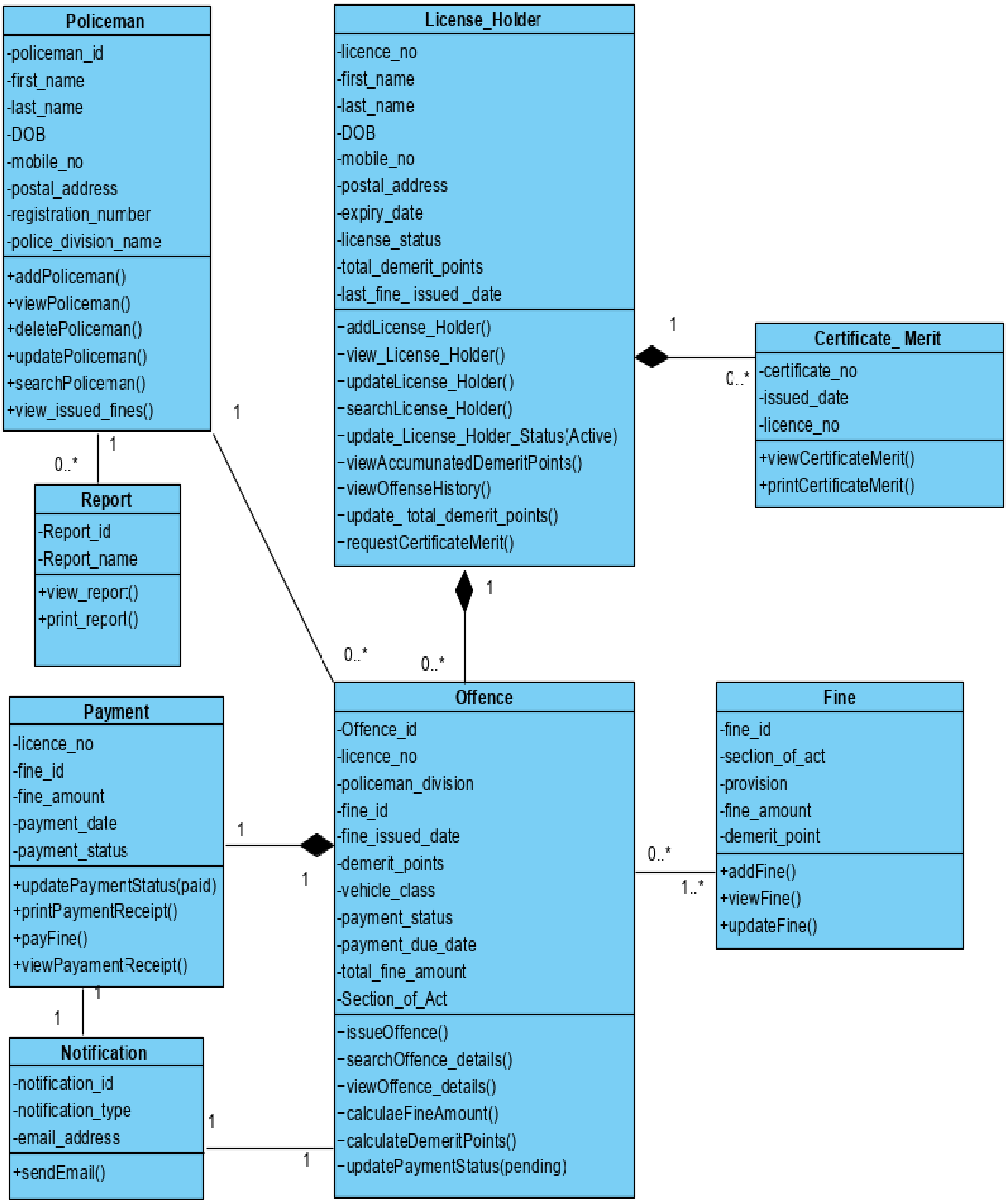
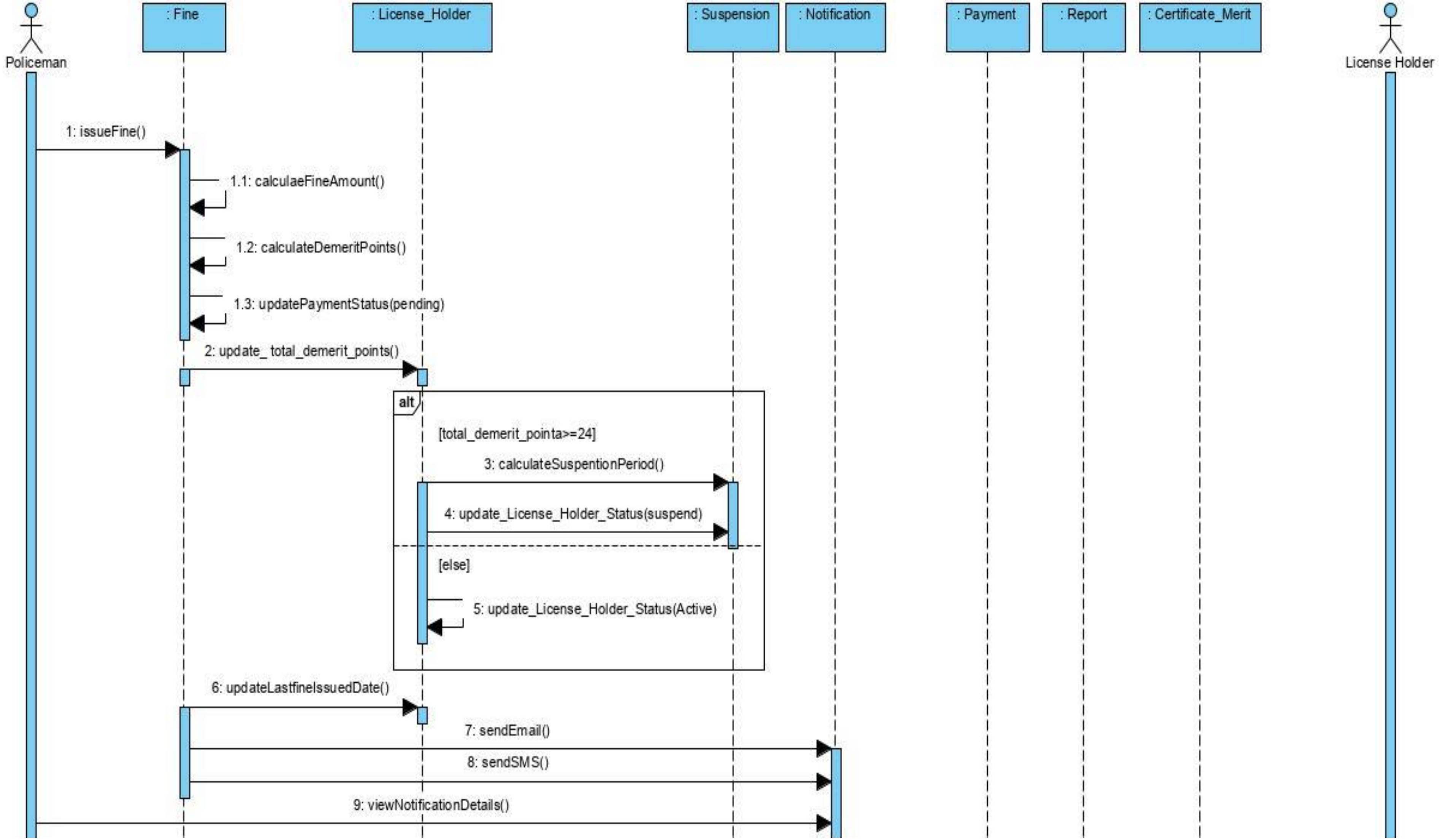


Figure 3. 3: Class Diagram

3.6. Sequence Diagram

Figure 3:4 shows the sequence of messages exchanged between the objects needed to carry out the functionality of the entire system.


Policeman
: Fine
: License_Holder
: Suspension
: Notification
: Payment
: Report
: Certificate_Merit
License Holder
1: issueFine()
1.1: calculaeFineAmount()
1.2: calculateDemeritPoints()
1.3: updatePaymentStatus(pending)
2: update_ total_demerit_points()
alt
[total_demerit_pointa>=24]
3: calculateSuspentionPeriod()
4: update_License_Holder_Status(suspend)
[else]
5: update_License_Holder_Status(Active)
6: updateLastfineIssuedDate()
7: sendEmail()
8: sendSMS()
9: viewNotificationDetails()

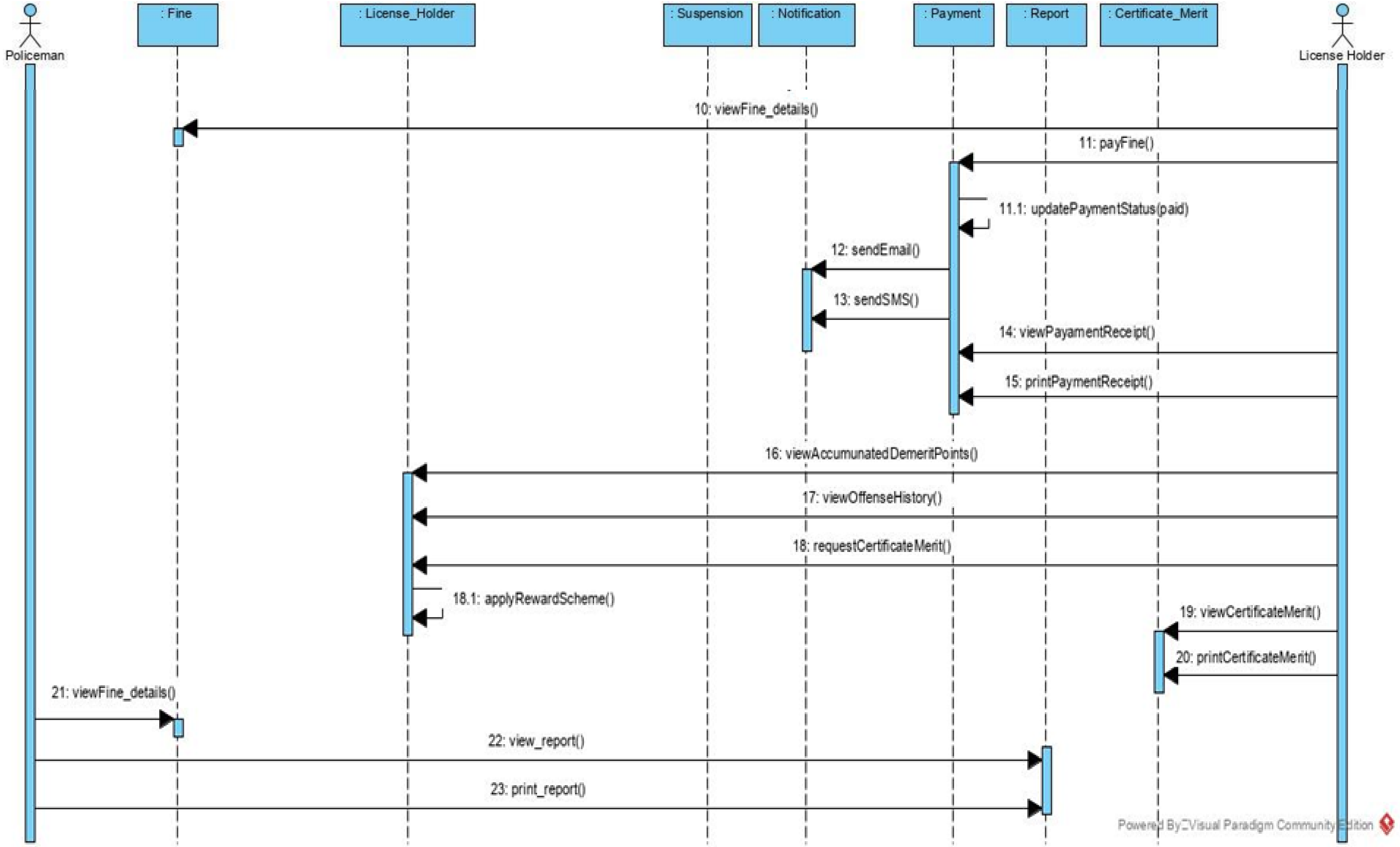

Policeman
: Fine
: License_Holder
: Suspension
: Notification
: Payment
: Report
: Certificate_Merit
License Holder
10: viewFine_details()
11: payFine()
11.1: updatePaymentStatus(paid)
12: sendEmail()
13: sendSMS()
14: viewPayamentReceipt()
15: printPaymentReceipt()
16: viewAccumunatedDemeritPoints()
17: viewOffenseHistory()
18: requestCertificateMerit()
18.1: applyRewardScheme()
19: viewCertificateMerit()
20: printCertificateMerit()
21: viewFine_details()
22: view_report()
23: print_report()
Powered By Visual Paradigm Community Edition

Figure 3. 4: Sequence Diagram

3.7. User Interface Design

The user interface of a system is often the yardstick by which that system is judged. An interface that is difficult to use will, at best, result in a high level of user errors. At worst it will cause the software system to be discarded, irrespective of its functionality. (Sommerville, 2016)

Human-Computer Interaction (HCI) is a vital factor while considering designing the user interfaces. The user interface design was done taking into account all usability characteristics and, experience, capabilities, physical and mental limitations of all the users.

Following usability characters and factors were taken into consideration (Mazur, 2003)

1. Effectiveness – the website should be useful and helps users achieve their goal accurately.
2. Efficient – The speed with accuracy with which work can be done
3. Engaging – The use of heavy graphics was avoided; choose the option for lighter .gif and .jpg files when necessary or to use simple colours and maintain consistency through the website to make the web application pleasant and interesting.
4. Error tolerant - The error messages do not show the actual technical errors but show the user-friendly understandable error messages that explain the error that occurred. This provides novice users to quickly understand the system. The designing principle used here is the minimal surprise. The user needs to be informed and not surprised; hence the error messages are displayed in normal font size.
5. Easy to learn- The interface provides user familiarity and guides the user, giving all the necessary details, even a novice can easily understand what the screen is used for.

Figure 3.5, shows the login interface of the DriSri website. It allows the System Administrator, policeman, or a driving license holder to log in to the system.

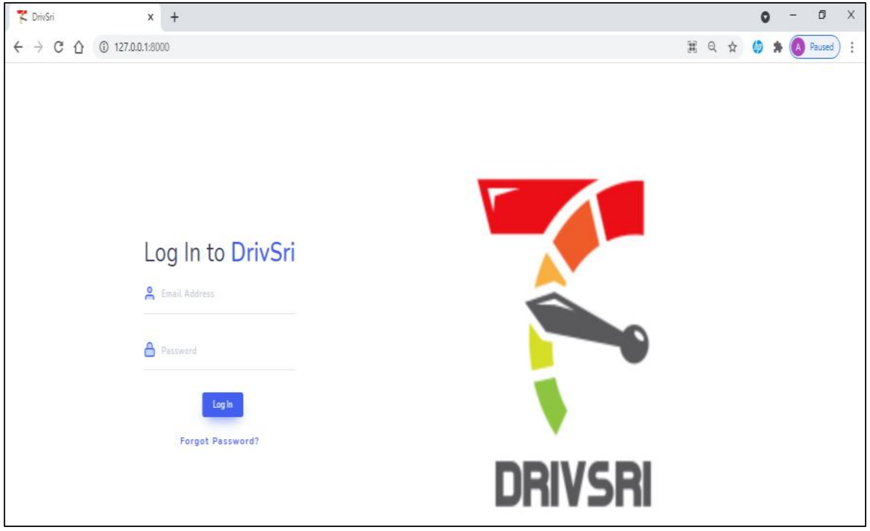
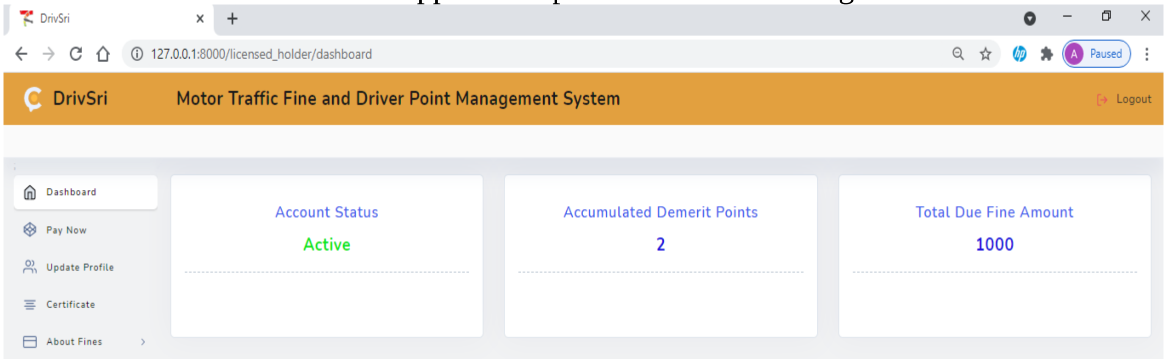


Figure 3. 5:Login Interface

The driving license holder is allowed to make a payment online, view, update driving license holders' details, and offence history, check driving license status, and demerit points, total due fine amount. The Figure 3.6 UI was design provides easy navigation and easy to learn through the left menu layout and the consistency through the website is maintained to make the web application pleasant and interesting.



Motor Traffic Fine and Driver Point Management System

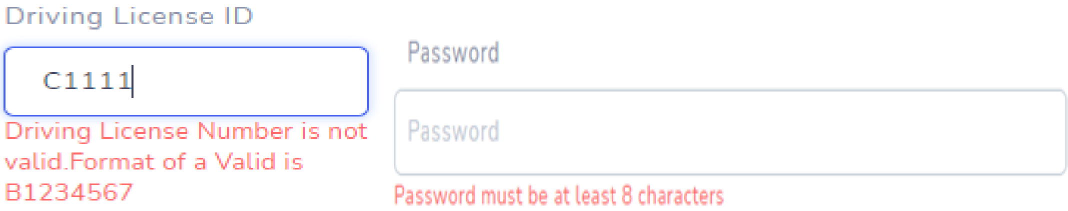
Account Status
Active

Accumulated Demerit Points
2

Total Due Fine Amount
1000

Figure 3. 6: Dashboard of a License Holder

All the form in the system are validated and error messages are shown as Figure 3.7 and they do not show the actual technical errors but show the user-friendly understandable error messages that explain the error that occurred.



Driving License ID

C1111

Driving License Number is not valid.Format of a Valid is B1234567

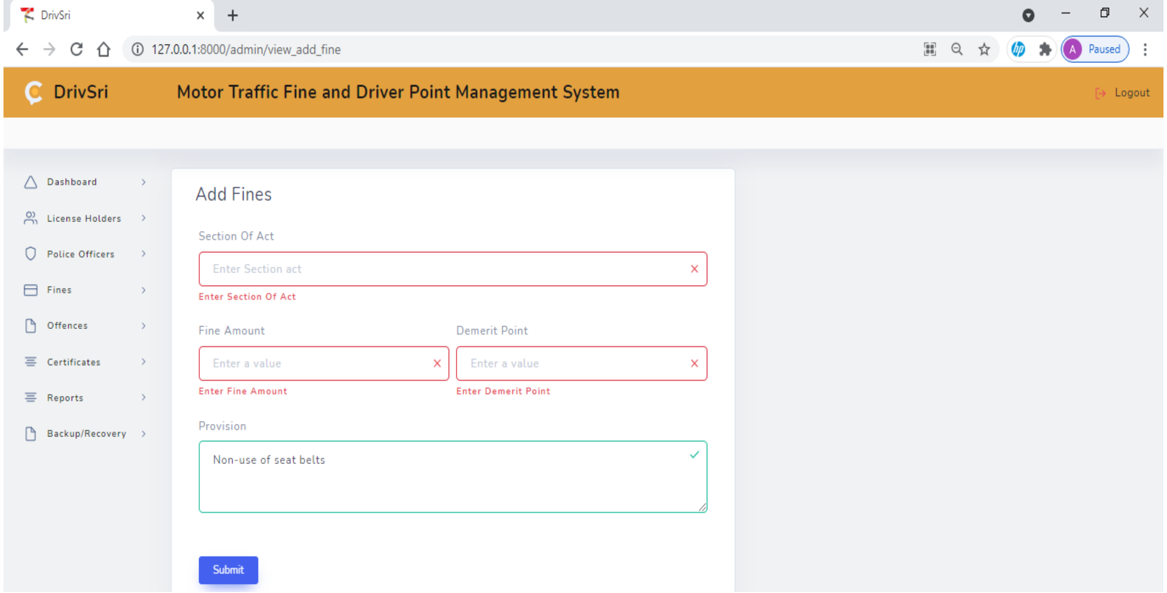
Password

Password

Password must be at least 8 characters

Figure 3. 7: User-friendly error Messages

Further, the error messages are displayed in normal font size with the field is highlighted in red colour box with a cross on the corner. The success validation fields are displayed in green colour with a tick in the corner as shown in Figure 3.8.



Motor Traffic Fine and Driver Point Management System

Add Fines

Section Of Act
Enter Section act ×
Enter Section Of Act

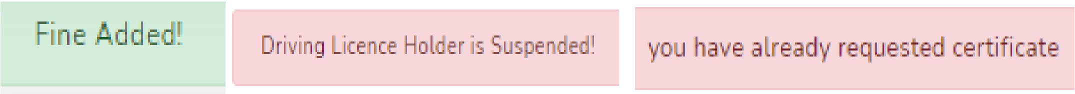
Fine Amount
Enter a value ×
Enter Fine Amount

Demerit Point
Enter a value ×
Enter Demerit Point

Provision
Non-use of seat belts ✓

Figure 3. 8: Add Fine Details

The success and warning messages are display in two different colour (green message for success and pink/red for warning) with the same font size to apply the designing principle minimal surprise for the user as shown in Figure 3.9.



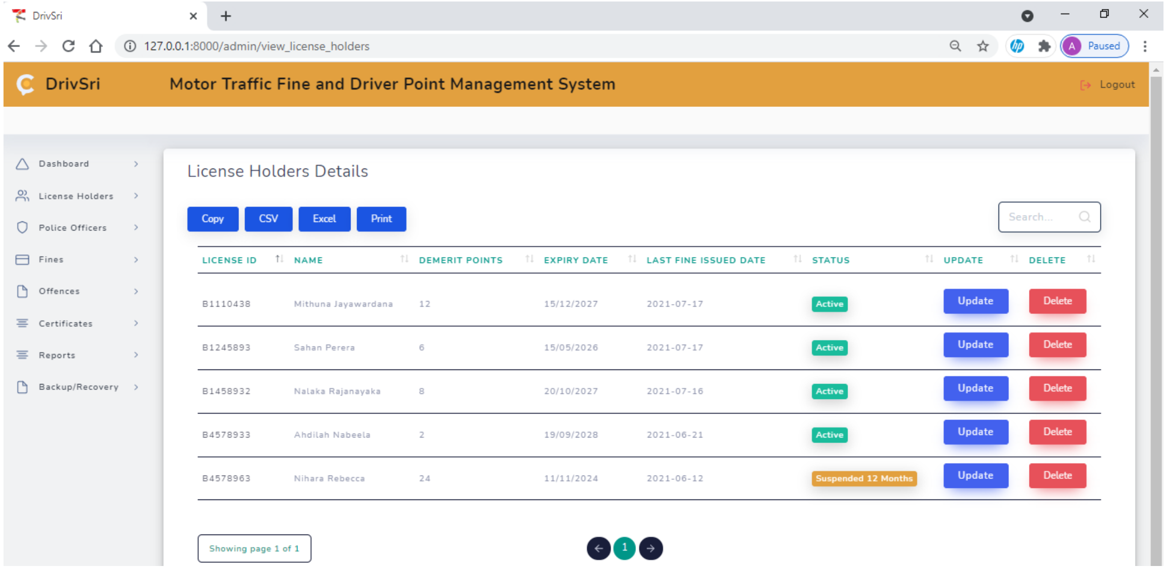
Fine Added!

Driving Licence Holder is Suspended!

you have already requested certificate

Figure 3. 9: Success and error messages

To engage the users the system use a white background colour and uses red colour button with clear message "delete" and to update buttons are in blue color with the message "delete. The details information is displayed using data table and the user can navigate to the front and backwards of the pages with the arrows on the bottom. The data tables display maximum 7 records per page to avoid the scrolling through the website. Further the number of pages is displayed on the left corner as shown in Figure 3.10.



Motor Traffic Fine and Driver Point Management System

License Holders Details

LICENSE ID	NAME	DEMERIT POINTS	EXPIRY DATE	LAST FINE ISSUED DATE	STATUS	UPDATE	DELETE
B1110438	Mithuna Jayawardana	12	15/12/2027	2021-07-17	Active	Update	Delete
B1245893	Sahan Perera	6	15/05/2026	2021-07-17	Active	Update	Delete
B1458932	Nalaka Rajanayaka	8	20/10/2027	2021-07-16	Active	Update	Delete
B4578933	Ahdilah Nabeela	2	19/09/2028	2021-06-21	Active	Update	Delete
B4578963	Nihara Rebecca	24	11/11/2024	2021-06-12	Suspended 12 Months	Update	Delete

Showing page 1 of 1

Figure 3. 10: License Holder Details on System Administrator Login

The overall UI of drivSri provides user familiarity and guides the user, giving all the necessary details, even a novice can easily understand what the screen is used through having a simple design layout and maintain consistency through the website to make the web application pleasant and interesting to use.

3.8. Summary

The chapter is presented with an overview of the software architecture. The static and dynamic view of the system is model using the class diagram and sequence diagram. Furthermore, relational database structure and designing of the user interface using GUI and considering HCI concepts such as effectiveness, efficiency, engagement, error-tolerant, easy to learn, consistency, minimal surprise, and recovery are applied.

The next phase of the project would be discussing implementing the solution and issues.

Chapter 4: Implementation

4.1. Introduction

The chapter will discuss the hardware and software implementation environment, and Laravel framework. Furthermore, it will provide the reader with a brief description of the main functionality of each code including database connection, issue offence, demerit point process, email notification, e-payment, tracking driving license holder's offence and details and issue of certificate of merit process.

4.2. Implementation Environment

To implement the DriSri Traffic Fine and Point Management System the following hardware requirement in Table 4.1 and software requirement in Table 4.2 was required. Section 2.9 Related Technologies justifies the selection of technologies.

Hardware Module	**Requirement**
Processor	Intel Core i5 2GHz or higher
RAM	4GB or Higher
Hard Disk	20GB or more disk space

Table 4. 1: Hardware Requirement

Software Module	**Requirement**
Operating System	Windows
Development Languages	PHP 7.4, JavaScript, BootStrap,CSS,AJAX
Development Framework	Laravel Framework 8 with composer
IDE	Visual Studio Code
Web Server	XWAMP Server
Database	MY SQL 8.3 or higher

Table 4. 2: Software Requirement

4.3. Implementation using Laravel Framework

The Laravel framework uses MVC architecture. The drivsri database tables were created with code using migration files and relationships are handled with models. Each database table has a corresponding "Model" which is used to interact with that table.

Controllers are basic PHP files that manipulate the database models using a series of functions and return a collection of data to a specific view. These functions can be access using the web.php file through a series of routes. Routes are responsible for the actions of a controller's function when a specific URL is accessed. Laravel uses RESTful routes to provide a mapping between HTTP and the controller function.

The following 4 functionalities implantation will be discussed

1. Development Environment
2. Fine issuing process
3. Driver point management mechanism by providing reward and demerit points
4. Email Notification
5. e-payment process
6. Track the drivers and their traffic offenses

4.4. DrivSri Development Environment

The Laravel configuration file/.env file is used to configure database connection, email server information as show in Figure 4.1. The DrivSri system uses sandbox versions of the PayHere Payment gateway and sandbox versions of the SendGrid email service.

```
DB_CONNECTION=mysql
DB_HOST=127.0.0.1
DB_PORT=3306
DB_DATABASE=drivsri
DB_USERNAME=root
DB_PASSWORD=
MAIL_DRIVER=smtp
MAIL_HOST=smtp.sendgrid.net
MAIL_PORT=587
MAIL_USERNAME=apikey
MAIL_PASSWORD=SG.IqkPD6uATW2lcIfZgzfbTg.zKWjQj49ImtFUOoLqRJXPzE7gwrcJkH
EH0qIvrh93cA
MAIL_ENCRYPTION=tls
MAIL_FROM_ADDRESS=ahdilah@gmail.com
MAIL_FROM_NAME="Drive Sri"
```

Figure 4. 1: Database and Email Configuration

4.5. Fine Issuing Process

Through the creation of migration file the “offence” database table was created. This migration file show in Figure C.1 has all the scheme information needed to build a MySQL table. When the command $php artisan migrate is ran Laravel will call the up () function and the framework will access that database and create the table.

Once the database table was created the relationship was established with “Offense.php” model file as show in Figure 4.2. The Eloquent ORM (Object Relational Mapping) provided with Laravel includes a simple PHP Active Record implementation which the system database queries with a PHP syntax. Several relationships are set up between the “Offense.php” model and other models in the system.

```
class Offense extends Model
{  use HasFactory;      protected $table = 'offenses';
   protected $primarykey = 'id';
   protected $fillable = ['license_holder_id', 'policeman_id',
'vehicle_class_id','fine_issued_date', 'payment_status', 'payment_date',
'total_fine_amount','total_demerit_points'];
   public function paymentStatus()
   { return $this->belongsTo(PaymentStatus::class, 'payment_status');  }
   public function licensedHolder()
   {       return $this->belongsTo(LicenseHolder::class, 'license_holder_id');    }
   public function police()
   {       return $this->belongsTo(Policeman::class, 'policeman_id');    }
   public function vehicle()
   {       return $this->belongsTo(Vehicle_class::class, 'vehicle_class_id');    }
  public function fine()
  {  return $this->belongsToMany(Fine::class, 'offences_has_fines','offences_id','fine_id');
  }}
```

Figure 4. 2: Offense Model

To issue a fine in the system a route is set up to call a showAddOffences() function in the “PoliceController”. Routes map controller function to URL’s as show in Figure 4.3. A get request is sent to view_add_offences which will be called the showAddOffences() function in the PoliceController.

```
Route::get('/view_add_offences',[PoliceController::class,'showAddOffences']);
```

Figure 4. 3: add offences route

The showAddOffences() in PoliceController will get all records of license holder, vehicle class, payment status and fines, policeman id and return a view add_offcece.php file located in 'police/offences/add_offence.blade.php as show in Figure 4.4.

```
public function showAddOffences() {
        $id = Auth::id();
        $license_holder = LicenseHolder::all();
        $policemen = Policeman::where('user_id', $id)->first();
        $vehicle_class = Vehicle_class::all();
        $payment_status = PaymentStatus::all();
        $fines = Fine::all();
        return view('police.offences.add_offence', [
            'license_holders' => $license_holder, 'policemens' => $policemen,
            'vehicle_class' => $vehicle_class, 'payment_status' => $payment_status,
             'fines' => $fines    ]);     }
```

Figure 4. 4: PoliceController showAddOffences() function

The view file add_offence.blade.php, use the Laravel Blade templating engine which allows PHP and HTML to interact, In the view we can access $license_holder, $policemen, $vehicle_class, $payment_status, $fines variables and display the content.

Figure 4.5 code segment display all the license holders number in a dropdown list and allow the user to perform a live search while entering the license number.

```
<select name="license_holder_id" class="form-control selectpicker"
id="license_holder_id" data-live-search="true"> <option>Enter License No</option>
 @foreach ( $license_holders as $license_holder )
   <option value="{{$license_holder->id}}">{{$license_holder->license_no}}</option>
  @endforeach  </select>
```

Figure 4. 5: Retrieving all License holders Numbers

Once the policeman selects the license holder the Figure 4.6 Ajax code will send a URL request to /policemen/license_holder_name/find which will call the PoliceController, findLicenseHolderName() function as show in Figure 4.7.

```
    $('select[name="license_holder_id"]').on('change', function() {
        var license_holder_id = $(this).val();
        $.ajax({   url: "{{url('/policemen/license_holder_name/find')}}",
            method: "POST",
            data: "license_holder_id=" + license_holder_id,
            dataType: 'JSON',
            success: function(response) {
                if (response.success) { $("#license_holder_name").val(response.name);
                    $("#mobile_no").val(response.mobile_no);   }
                if (!response.success) {    }           }       });
```

Figure 4. 6: AJAX code to retrieve license holder name and mobile number

```
 public function findLicenseHolderName(Request $request)
   {
      $license_holder_id = $request->input('license_holder_id');
      $license_holder = LicenseHolder::find($license_holder_id);

      $res['success'] = true;
      $res['name'] = $license_holder->first_name . " " . $license_holder->last_name;
      $res['mobile_no'] = $license_holder->mobile_no;
      return response($res);
   }
```

Figure 4. 7: PoliceController findLicenseHolderName() function

Figure 4.8 show the retrieving all records of vehicle class.

```
<select name="vehicle_class_id" class="form-control" id="vehicle_class_id" data-live-
search="true">
 @foreach ($vehicle_class as $vehicle_class )
  <option value="{{$vehicle_class->id}}">{{$vehicle_class->vehicle_class}}</option>
 @endforeach
</select>
```

Figure 4. 8: Retrieving all records of vehicle class

Figure 4.9 shows the JavaScript code to display the current date as Fine Issue Date and display payment due date by adding 14 dates for the current date.

```
<script>
 var today = new Date();
 var date = today.getFullYear() + '-' + (today.getMonth() + 1) + '-' + today.getDate();
 document.getElementById("basicFlatpickr2").value = date;
 var date1 = today.getFullYear() + '-' + (today.getMonth() + 1) + '-' +
(today.getDate()+14);
   document.getElementById("basicFlatpickr").value = date1;
</script>
```

Figure 4. 9:Display Fine issue date and Payment Due Date

Figure 4.10 retrieves all the fine details including section of act and description and allow multiple selection of fines. Once the policeman selects the one or more fines the Figure 4.11 Ajax code will send a URL request to /policemen/calculate/fine' which will call the PoliceController, calculateAmount() function as show in Figure 4.12 and calculate the total demerit point and total fine amount.

```
<select class="form-control selectpicker" id="fines" name="fines[]" multiple data-live-
search="true">
 @foreach ($fines as $fine)
   <option class="fine_op" value="{{$fine->id}}">{{$fine->section_of_act}}&nbsp;-
{{$fine->provision}}</option>
 @endforeach
</select>
```

Figure 4. 10: Multiple Selection of Fines

```
   $('select[name="fines[]"]').on('change', function() {
      var fines = $(this).val();
      console.log(fines);
      $.ajax({
         url: "{{url('/policemen/calculate/fine')}}",
         method: "POST",
         data: "fines=" + fines,
         dataType: 'JSON',
         success: function(response) {
            if (response.success) {
               $("#fine_amount").val(response.final_amount);
               $("#demerit_points").val(response.demerit);
            }
            if (!response.success) {   }           }       });
```

```
Route::post('/calculate/fine', [PoliceController::class, 'calculateAmount']);
```

Figure 4. 11: AJAX code to send the URL to calculate fine amount and demerit points

The calculateAmount() function as show in Figure 4.12 and calculate the total demerit point and total fine amount.

```
public function calculateAmount(Request $request)
   {  $fines = $request->input('fines');
      $fine_collection = explode(',', $fines);
      $final_amount = 0;
      $demerit = 0;
      if ($fines !== null) {
         foreach ($fine_collection as $key => $fine_id) {
            $fine = Fine::where('id', $fine_id)->first();
            $final_amount = $final_amount +  $fine->fine_amount;
            $demerit = $demerit + $fine->demerit_points;  }
      } else {   $final_amount = "";
        $demerit = ""; }
      $res['success'] = true;
      $res['final_amount'] = $final_amount;
      $res['demerit'] = $demerit;
      return response($res);
   }
```

Figure 4. 12: PoliceController calculateAmount () function

Once the submit button of issue offence is click the Figure 4.13 code segment action url will be executed.

```
 <form class="needs-validation"
action="{{URL('/policemen/save_offence/'.$policemens->id)}}" method="POST" >
```

Figure 4. 13: Issue Offence Action URL

The URL below will route the save_offence() with police id and be executed the function in Figue 4.14 in the PoliceController

```
Route::post('/save_offence/{id}',[PoliceController::class,'saveOffence']);
```

```
public function saveOffence(Request $request, $policemen_id)
    {  $fines = $request->input('fines');
         $license_holder_id = $request->input('license_holder_id');
        $vehicle_class_id = $request->input('vehicle_class_id');
        $payment_date = $request->input('payment_date');
        $issue_date = $request->input('issue_date');
        $demerit_points = $request->input('demerit_points');
        $fine_amount = $request->input('fine_amount');
       //finding and retrieving the demerit points of the license holder
        $license_holder = LicenseHolder::where('id', $license_holder_id)->first();
        $user_demerit =$license_holder->total_demerit_points;
```

Figure 4. 14: PoliceCOntroller saveOffence function

4.6. Driver Point Management Process

Once the policeman click the submit button the saveOffence function Figure 4.14 will be executed. This function checks the demerit points of the driving license holder and if the demerit points are below 24 it will store records to the database offense table and total demerit points, license status fields in license holder table and fine has offence table as shown in Figure 4.15.

```
        $license_holder = LicenseHolder::where(‘id’, $license_holder_id)->first();
        $user_demerit =$license_holder->total_demerit_points;
        if ($user_demerit<24) {
            $offence = new Offense();
            $user_demerit = $user_demerit + $demerit_points;
            $offence->license_holder_id = $license_holder_id;
            $offence->policeman_id = $policemen_id;
            $offence->vehicle_class_id = $vehicle_class_id;
            $offence->fine_issued_date = $issue_date;
            $offence->payment_status = 1;
            $offence->payment_date = $payment_date;
            $offence->total_fine_amount = $fine_amount;
            $offence->total_demerit_points = $demerit_points;
            $offence->save();
            $license_holder->total_demerit_points = $user_demerit;
            $license_holder->save();
            $offence_id = $offence->id;
            foreach ($fines as $key => $fine_id) {
                $has_fine = new OffenceHasFine();
                $has_fine->offences_id = $offence_id;
                $has_fine->fine_id = $fine_id;
                $has_fine->save();            }
            if ($user_demerit>= 24 && $user_demerit <28 ) {
                $license_holder->status_id =2;
                $license_holder->save();             }
            else if ($user_demerit>= 28) {
                $license_holder->status_id =3;
                $license_holder->save();            }
```

Figure 4. 15: Demerit Point System and license holder status

4.7. Email Notification

Email notification is issued when an offence is recorded, payment is made and certificate of merit is issued. After the offence records are stored in the database as in Figure 4.14, 4.15, the $data variable stores all the data required to send the email as shown below.

```
$data = [  'name' => $license_holder->first_name,
            'email' => $license_holder->user->email,
            'issue_date' => $issue_date,
            'payment_date' =>  $payment_date,
            'fine_amount' => $fine_amount,
            'demerit_points' => $demerit_points,
            'total_demerit_points' => $user_demerit  ];
         try {
            Mail::to($data['email'])->send(new sendmail($data));
              } catch (Exception $ex) { Log::error($ex); }
         return redirect('policemen/view_add_offences')->with('status', 'Spot Fine is issued
Successfully!');
```

The email send by Laravel is represented by Mailable class and the mail configuration is done in the build() and from, subject, view methods are called as show in Figure 4.16. Using php artisan make:mail sendmail the following class is created.

```
class sendmail extends Mailable
{  use Queueable, SerializesModels;
   public $data;
   public function __construct($data)
   {$this->send_mail_data = $data;}

 public function build() {
       return $this->from('ahdilah@gmail.com','Sri Lanka Motor Traffic Police')
                 ->subject('You have Received A New Offences')
                 ->view('emails.offences_add', ['mail_data'=>$this->send_mail_data]);}
}
```

Figure 4. 16: Email configuration of issue offence

The issue offence email uses the template in emails/offence_add.blade.php file to render its contents as show in Figure 4.17

```
 <h1 style=”text-align: center;”><a href=”#” style=”color: #FE6652;">You have
Received A New Offences</a></h1>
<div class="text"> <p style="font-size:14px;colour:black;">Dear {{$mail_data['name']}}
check your offence details below</p>
  <h4>Isuue Date : {{$mail_data['issue_date']}}</h4>
   <h4>Payment Due Date : {{$mail_data['payment_date']}}</h4>
   <h4>Fine Amount : Rs: {{$mail_data['fine_amount']}}</h4>
   <h4>Demerit point : {{$mail_data['demerit_points']}}</h4>
   <h4>Accumulated Demerit Points : {{$mail_data['total_demerit_points']}}</h4>
 </div>
```

Figure 4. 17: Content of email via of emails/offence_add.blade.php file

4.8. E-Payment Process

Once the Driving License Holder clicks on “Pay Now” in main menu, a route is set up to call showAllOffences() function in the LicenseHolderController and get all offence record of a particular driving license holder and return a view view_offceces.php file located in 'license_holder/offences/view_offences.blade.php as show in Figure 4.18

```
public function showAllOffences()
   {
      $user_id = Auth::user()->id;
      $license_holder = LicenseHolder::where('user_id', $user_id)->first();
      $offences = Offense::where('license_holder_id', $license_holder->id)->get();
      return view('license_holder.offences.view_offences', ['offences' => $offences]);
   }
```

Figure 4. 18: Retrieving Offence Detail of driving license holder

when the user clicks on Pay Now button the following data is pass to the https://sandbox.payhere.lk/pay/checkout page as shown in Figure 4.19 and updatePaymentStatus() method is called as show in Figure 4.20

```
<form class=”needs-validation” action="https://sandbox.payhere.lk/pay/checkout"
method="POST" novalidate>
   @csrf
<input type="hidden" name="merchant_id" value="1216105">
 <input type="hidden"name="return_url"value="{{URL('/licensed_holder/offences_all')}}">
 <input type="hidden" name="cancel_url" value="{{URL('/licensed_holder/offences_all')}}">
 <input type="hidden" name="notify_url" value="{{URL('/payhere/notify')}}">
<inputtype="hidden" name="first_name" value="{{$offence->licensedHolder->first_name}}">
<inputtype="hidden" name="last_name" value="{{$offence->licensedHolder->last_name}}">
<br>
<input type="hidden" name="email" value="{{$offence->licensedHolder->user->email}}">
 <input type="hidden" name="phone" value="{{$offence->licensedHolder->mobile_no}}">
<br>
<input type="hidden" name="address" value="{{$offence->licensedHolder-
>postal_address}}">
<input type="hidden" name="city" value="Colombo">
 <input type="hidden" name="country" value="Sri Lanka">
<input type="hidden" name="order_id" value="{{$offence->id}}">
<input type="hidden" name="items" value="{{$offence->id}}">
<input type="hidden" name="currency" value="LKR">
```

Figure 4. 19: Value pass to Sandbox version of Payhere

Figure 4.20 includes the payhere credentials and will fetch the license holders particular offence details to make payment and once the payment status is made the payment will be completed and the Figure 4.21 code segment will excute.

```
public function updatePaymentStatus(Request $request)
   {
      $merchant_id         = $request->input('merchant_id');
      $order_id            = $request->input('order_id');
      $payhere_amount      = $request->input('payhere_amount');
      $payhere_currency    = $request->input('payhere_currency');
      $status_code         = $request->input('status_code');
      $md5sig              = $request->input('md5sig');

// Payhere Merchant Secret number
      $merchant_secret= '4JIP66MS4ZQ8LM2QDoAqOK4uR4BUZbxgP48VIdZHDygF';

      $local_md5sig = strtoupper(md5($merchant_id . $order_id . $payhere_amount .
$payhere_currency . $status_code . strtoupper(md5($merchant_secret))));
      $user = Auth::user();
      $license_holder = LicenseHolder::where('user_id', $user->id)->first();
      if (($local_md5sig === $md5sig) and ($status_code == 2)) {
         $offence = Offense::where('id', $order_id)->first();
         $offence->payment_status = 3;
         $offence->save();
      }
   }
```

Figure 4. 20: UpdatePaymentStatus() function in LicenseHolder Controller

Once the payment is completed the notify_url will route the Route::post('payhere/notify',[\App\Http\Controllers\HomeController::class, 'payhereNotify']) and call the payhereNotify() function in the HomeController. The payment remaining fine amount is calculated by subtracting the total fine amount from the paid amount and payment status is set to 2(paid) and updated into the offence database as show in Figure 4.21

```
public function payhereNotify(Request $request)
   {
      Log::info($request->all());
      $status_code = $request->input('status_code');
      if ($status_code === '2') {
         $offense_id = $request->input('order_id');
         $payment_id = $request->input('payment_id');
         $paid_amount = $request->input('payhere_amount');
         $status_message = $request->input('status_message');
         $offence =  Offense::where('id', $offense_id)->first();
         // will subtract the paid amount from total fine amount
         $remaining_fine_amount = $offence->total_fine_amount - $paid_amount;
         // payment status is set to paid
         $offence->payment_status=2;
         $offence->total_fine_amount = $remaining_fine_amount;
         $offence->save();
```

Figure 4. 21: PayhereNotify() function in HomeController

4.9. Monitor Driving License Holder and their Offenses

The Policeman and System Administrator can monitor driving license holder and their offences details. The below route code segment will call the showLicenHolders() function in the PoliceController as Figure 4.22.

```
Route::get('/license_holders',[PoliceController::class,'showLicenHolders']);
```

```
public function showLicenHolders()
   {
    $license_holder = LicenseHolder::all();
     return view('police.license_holder.view_license_holders', ['license_holders' =>
$license_holder]);
   }
```

Figure 4. 22 :PoliceController showLicenHolders() function

Figure 4.23 will show all the records of driving license holders in the view_license_holders,blade.php file located in 'police/license holder.

```
<table id="html5-extension" class="table table-hover non-hover" style="width:100%">
<thead><tr>
   <th>ID</th><th>Name</th><th>License No</th><th>Demerit Points</th>
   <th>Due Fine Amount</th><th>Last Fine Issued Date</th> <th>Status</th>
</tr></thead>
<tbody>
@foreach ($license_holders as $license_holder)
 <tr>
      <td>{{$license_holder->id}}</td>
      <td>{{$license_holder->first_name}} &nbsp; {{$license_holder->last_name}}</td>
      <td>{{$license_holder->license_no}}</td>
      <td>{{$license_holder->total_demerit_points}}</td>
      <td>{{$license_holder->totalDemerit($license_holder->id)}}</td>
      <td>{{$license_holder->last_fine_issued_date}} </td>
      <td>
        @if ($license_holder->status_id==1)
<span class="badge badge-success">{{$license_holder->licenseStatus->type}}</span>
        @elseif ($license_holder->status_id==2)
<span class="badge badge-warning">{{$license_holder->licenseStatus->type}}</span>
         @elseif ($license_holder->status_id==3)
<span class="badge badge-danger">{{$license_holder->licenseStatus->type}}</span>
       @endif</td>
</tr>
@endforeach
</tbody></table>
```

Figure 4. 23: View_license_holder.bade.php

4.10. Certificate of Merit

The showcertificatedetails() function in LicenseHolderController will retrieve all license holders details and return a view add_certification.blad.php located in license_holder/certification.

```
public function showcertificatedetails()
   {
      $userId = Auth::id();
      $user = User::findOrFail($userId);
      $license_holder = LicenseHolder::where('user_id', $userId)->first();
      return view('license_holder.certification.add_certification', ['user' => $user,
'license_holders' => $license_holder]);
   }
```

This pages check if the total demerit point is less than or equal to 5 to display the Request button and when the total demerit points are more than 5 an message is displayed as show in Figure 4.24.

```
  @if (($license_holders->total_demerit_points) <=5)
 <a class="btn btn-success mt-3" href="{{URL('/licensed_holder/save_certificate/'.$user-
>id)}}">Request</a>
@else
 <h5 class="text-danger">Your Accumulated Demerit Points are more than 5. </h5>
@endif
```

Figure 4. 24: check the demerit points requirement before requesting the certificate

The /save_certificate/{id}will call Viewcertificate($id) function in LicenseHolder Controller as show in Figure 4.25. This function checks whether the license holder has made a previous request and if not will create an new request and save the data in the request_cerifications table using RequestCerification model.

```
public function Viewcertificate($id)
   {
    $license_holder = LicenseHolder::where('user_id', $id)->first();
    $request_certificate = RequestCerification::where('license_holder_id', $license_holder-
>id)->first();
      if ($request_certificate != null) {
         return redirect('/licensed_holder/add_certificate')->with('status', 'you have already
requested certificated');
      } else {
         $new_request_certificates = new RequestCerification();
         $new_request_certificates->license_holder_id = $license_holder->id;
         $new_request_certificates->save();
         return redirect('/licensed_holder/add_certificate')->with('status2', 'successfully
requested certificate.');
      }
   }
```

Figure 4. 25: Viewcertificate() function in LicenseHolderController

The System Administrator will issue certificates which is route in
Route::get('/notification/{id}',[\App\Http\Controllers\AdminController::class, 'sendCertifacate']);

The sendCertificate function in AdminController will check the total demerit point and issue the certificate of merit through email as shown in Figure 4.26.

```
public function sendCertifacate($id)
   {
       $license_holder = LicenseHolder::find($id);
       $user_email = $license_holder->user->email;
       $demerit_points =  $license_holder->total_demerit_points;
       if ($demerit_points>= 5) {
return redirect('/admin/view_certificate_list')->with('status2', 'Cannot Issue Certification');
       }
       else
       {
$request_certificate   =   RequestCerification::where('license_holder_id',   $license_holder->id)->first();
           if ($request_certificate != null) {
               return redirect('/admin/view_certificate_list')->with('status', 'certificate has been already issued.');
           }
       else{
               $certificate = array(
                 'name' => $license_holder->first_name,
                 'license_number' => $license_holder->license_no
               );
               Mail::to($user_email)->send(new certificatenotify($certificate));
               return redirect('/admin/view_certificate_list')->with('status', 'Certification is sent Successfully!');
            }
       }
   }
```

Figure 4. 26: sendCertifacate() function in AdminController

4.11. Summary

In this chapter the implementation aspects of the main functionalities of the system are discussed referring to code segment of model, view and controller. Prior to implementation a number of decisions pertaining to the implementation hardware and software requirements were made. Such decisions were made after careful considerations of the systems design and implementation requirements. Having thus developed a prototype to give the proposed solution, the next chapter focuses on discussing the testing carried out with regard to the implementation.

Chapter 5: Testing and Evaluation

5.1. Introduction

Having successfully completed the implementation of the prototype, it is essential to test the system. The reader is presented with the black box test strategy in different levels of testing which is carried out in order to detect errors. Also, the system functionality, cross browser compatibility, performance and usability of the system are tested. This chapter also highlights the acceptance and evaluation of the system through questionnaires and a graphical representation of the responses.

5.2. Testing Strategy

Testing is the process used to validation and verification of the system. The main goal of testing is to detect errors in the implemented application. (Sommerville, 2016). The system test was carried out to check whether the system meets the requirement specification, whether it can operate successfully. The following 3 areas was focus during the testing phase.

1. Functionality Testing
2. Compatibility Testing
3. Usability Testing

Black box testing was carried out from the user interface point of view rather than inspecting the program code to identifying visible errors within the system. It involves executing the implemented application with test data and examines the real outcome against the anticipated outcome.

With the expectation of detecting errors, the testing begin with testing the database integrity and testing each component of the system using unit testing, integration testing, and system testing.

In unit testing, each component of the developed system was tested separately to ensure its functionality. The component will be evaluated against the requirement specification to verify wherever it meets the requirements and will be testing with random data to ensure the proper working of error handling procedures as well as the robustness of each component. The output was examined and verified against the specification for compliance.

Then the application was tested combining each component to check their proper functional integrity and dependencies. Finally, the application as a whole unit was tested to analyze the expected outcome and actual outcome were similar or not to find bugs and fix them.

5.3. Functional Testing

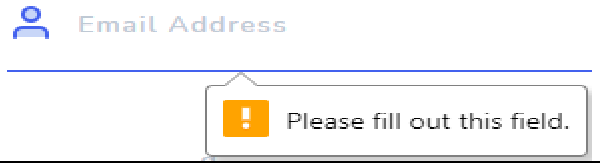
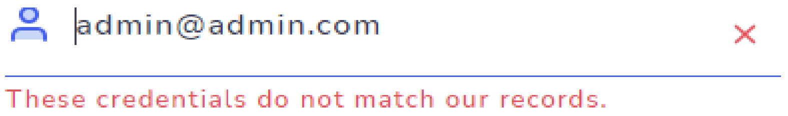
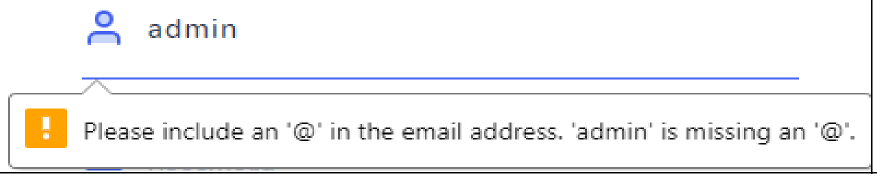
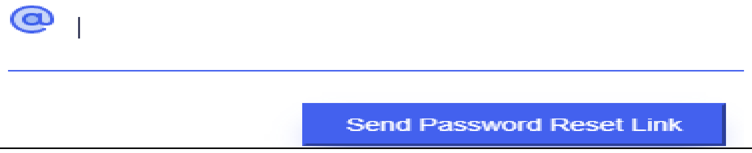
With the expectation of detecting errors, functional testing was carried out for different user roles with different access levels. The user roles are

1. System Administrator
2. Police Officer
3. Driving License Holder

The testing started with testing the database integrity and then unit testing was carried out with the created test plan and test cases were documented in **Appendix D.**

5.3.1. User Login

All users need to login to system by enter a valid email address and password. Except the System Administrators the user will receive the username and password for the system via a registration from the Department of Motor Traffic. Table 5.1 shows test results of user login process.

Test Case ID	Test Case	Expected Result	Test Status
1	Login Validation for empty	The system should display an error message and prompt the user to enter email address again  Email Address Please fill out this field.	Pass
2	Login with invalid credentials	The system should display an error message and let the user renter the correct credentials  admin@admin.com These credentials do not match our records.	Pass
3	Insert invalid email address	The system should display an error message "Please include an @ " in the email address"  admin Please include an '@' in the email address. 'admin' is missing an '@'.	Pass
4	User click on Forgot password link	The system will redirect to the password recovery web page and request the user to enter the email address and click on send password reset link.  	Pass
5	Try to access the dashboard without logging in	The system should display an error page with the message "403 User is not logged in" 403 USER IS NOT LOGGED IN.	Pass
6	Logout from the screen	The system will redirect to the login page.	Pass
7	Login with valid credentials for admin	The system will display the admin dashboard with a left slide bar with options of the license holder, police officer, fines, offenses, certificate, report, recovery/backup The dashboard consists of 3 cards that display the number of	Pass

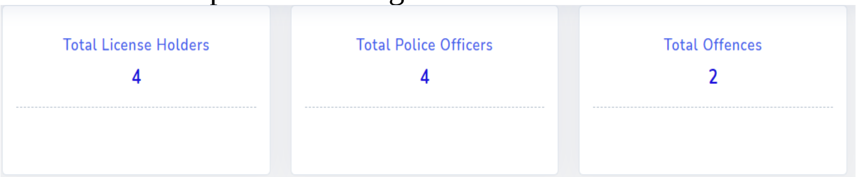
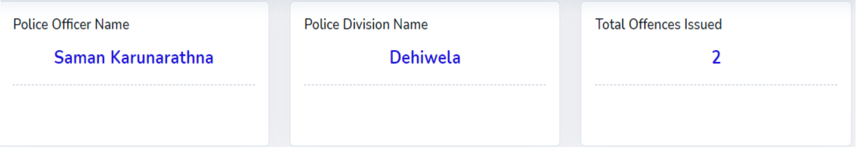
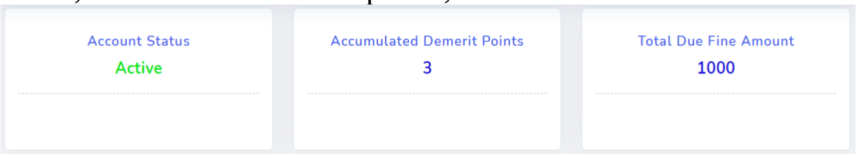
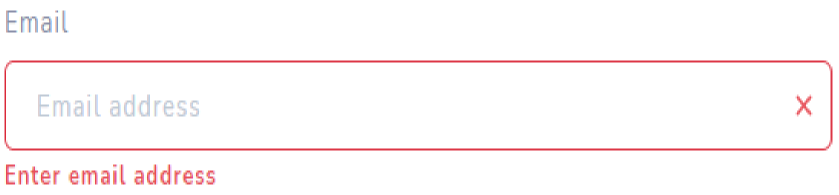
		registered police officers, license holders and total number of offence issued up-to-date along with chars.  Total License Holders 4 Total Police Officers 4 Total Offences 2	
8	Login with valid credentials for police officer	The system will display the police officer's dashboard with a left slide bar with options of view license holders' details, issue offense tickets, view offense details issued by the officer, and update the police officer profile. The dashboard consists of 3 cards that display police officer name, police division, and number of offenses issued  Police Officer Name Saman Karunarathna Police Division Name Dehiwela Total Offences Issued 2	Pass
9	Login with valid credentials for a license holder	The system will display the license holder dashboard with a left slide bar with options of pay now, update profile, request certificate of merit, and information about the fines. The dashboard consists of 3 cards that display license holders status, accumulated demerit points, the total due fine amount  Account Status Active Accumulated Demerit Points 3 Total Due Fine Amount 1000	Pass

Table 5. 1: Test Result for User Login

5.3.2. Add License Holder

The system administrator is allowed to add license holders. Table 5.2 illustrates the test results of adding a new license holder form.

Test Case ID	Test Case	Expected Result	Test Status
10	Validation of empty fields submission	The system will highlight all mandatory fields in red colour with a cross and request the user to reenter data.  Email Email address Enter email address	Pass
11	Validate the password	The system will display "Password must be at least 8 characters" and request user to reenter the password.	Pass

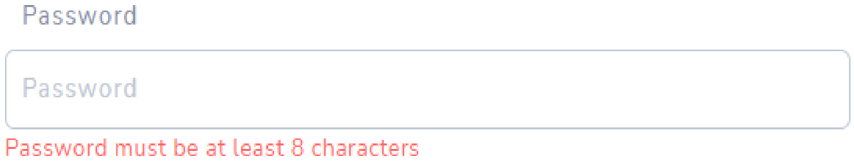
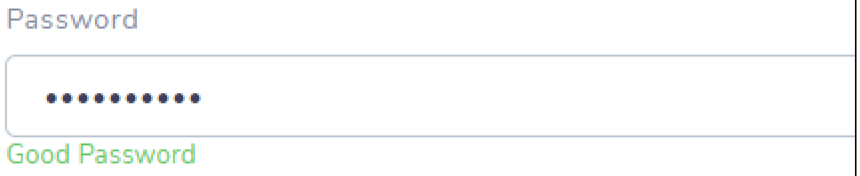
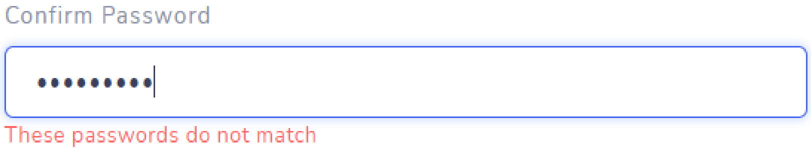
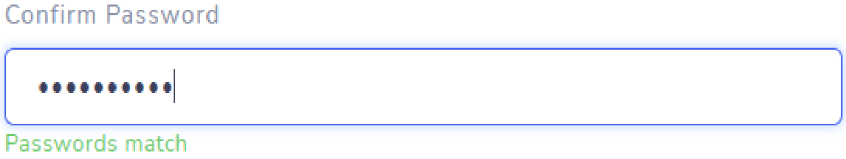
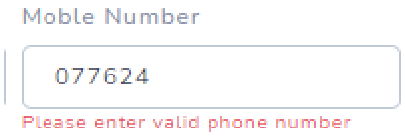
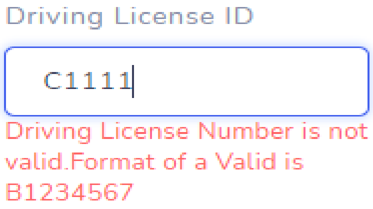
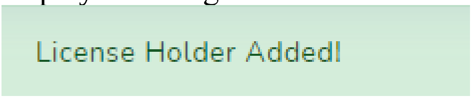
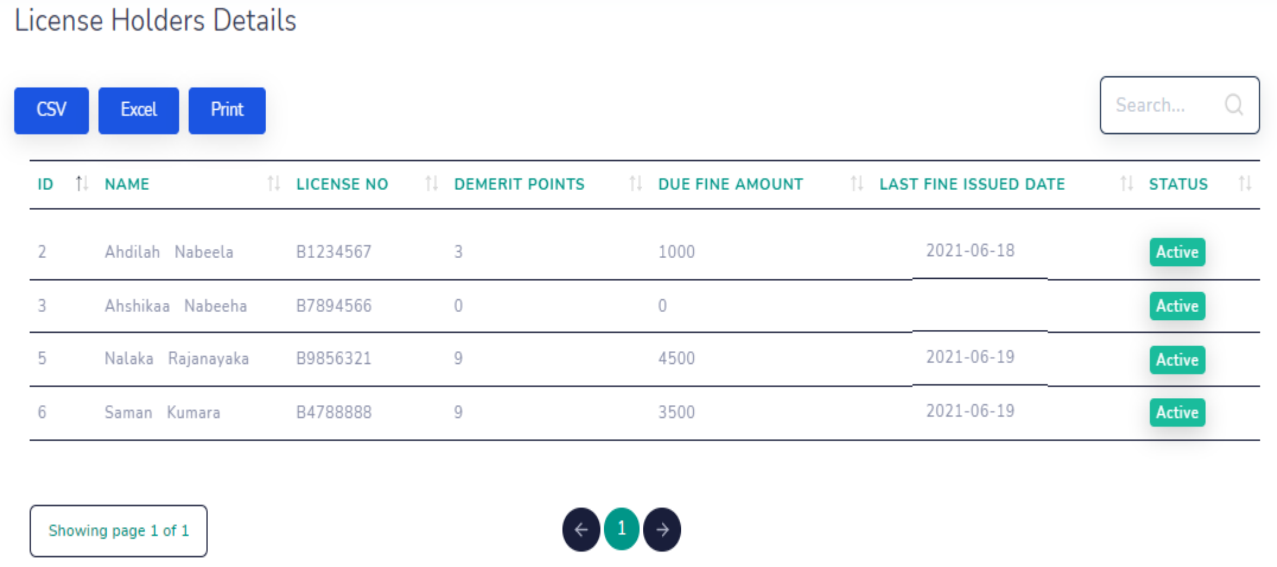
	length	 Password Password Password must be at least 8 characters The system will display “Good Password” when the password is more than 8 characters”  Password ••••••••••• Good Password	
12	Validate password and confirm password match	The system will display “These passwords do not match” for not matching password  Confirm Password ••••••••• These passwords do not match If the passwords are match the system will display “Passwords match”  Confirm Password •••••••••• Passwords match	Pass
13	Validate Mobile number	The system will not allow to enter characters and validate the filed for numbers and maximum length of 10 digit  Moble Number 077624 Please enter valid phone number	Pass
14	Validate Driving License ID	The system will validate the filed to be maximum length of 8 characters and the first character starts with letter B.  Driving License ID C1111 Driving License Number is not valid.Format of a Valid is B1234567	Pass
15	Validating click on submit button with all valid data	The system will redirect to the view license holder page and display a message “License Holder Added”  License Holder Added!	Pass

Table 5. 2:Test results for add license holder

5.3.3. Manage License Holder Details

The system administrator is allowed to add new license holder, view, update, and delete their records. Table 5.3 shows the test results of displaying details, update and deleting license holders.

<table>
<tr><th>Test Case ID</th><th>Test Case</th><th>Expected Result</th><th>Test Status</th></tr>
<tr><td>16</td><td>Display all the license holder details</td><td>The system will display license name, number, total demerit point, due fine amount, last fine issued date, and license holder states will be displayed.</td><td>Pass</td></tr>
<tr><td colspan="4">

License Holders Details

<table>
<tr><th>ID</th><th>NAME</th><th>LICENSE NO</th><th>DEMERIT POINTS</th><th>DUE FINE AMOUNT</th><th>LAST FINE ISSUED DATE</th><th>STATUS</th></tr>
<tr><td>2</td><td>Ahdilah Nabeela</td><td>B1234567</td><td>3</td><td>1000</td><td>2021-06-18</td><td>Active</td></tr>
<tr><td>3</td><td>Ahshikaa Nabeeha</td><td>B7894566</td><td>0</td><td>0</td><td></td><td>Active</td></tr>
<tr><td>5</td><td>Nalaka Rajanayaka</td><td>B9856321</td><td>9</td><td>4500</td><td>2021-06-19</td><td>Active</td></tr>
<tr><td>6</td><td>Saman Kumara</td><td>B4788888</td><td>9</td><td>3500</td><td>2021-06-19</td><td>Active</td></tr>
</table>
Showing page 1 of 1

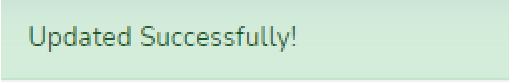
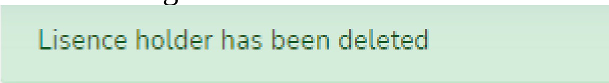
</td></tr>
<tr><td>17</td><td>Update license holder details</td><td>The system will display the selected license holders first name, last name, address, date of birth, license no, license expiry date, license holder states and allow to update records. The system will display the updated record with a message “Updated Successfully”

Updated Successfully!</td><td>Pass</td></tr>
<tr><td>18</td><td>Delete License holder details</td><td>The system will delete information about the driving license holder and display “License holder has been deleted” and display the remaining license holder details.

Lisence holder has been deleted</td><td>Pass</td></tr>
</table>

Table 5. 3:Test results for manage license holder

5.3.4. Manage Police Officers

The system administrator is allowed to add new police officers, view, update, and delete their records. Table 5.4 shows the test results of adding, displaying details, update and deleting police officers.

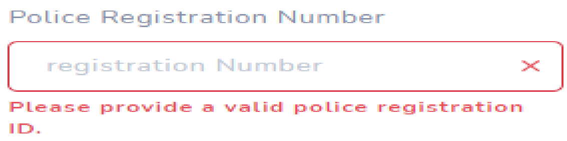
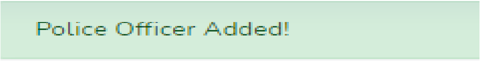
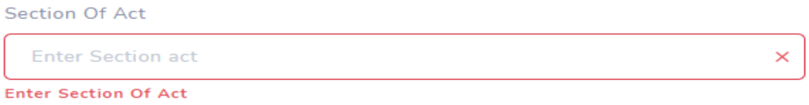
Test Case ID	Test Case	Expected Result	Test Status
19	Validation the Add Police Officer form	The system should display an error message for empty fields, mismatch password, mobile number less than 10, and registration number invalid  Police Registration Number registration Number × Please provide a valid police registration ID.	Pass
20	Submit the completed add police officer form	The system will add the entered records in the database and redirect the page to view police officer details page and display the message “Police Officer Added”. All added police officer will displayed  Police Officer Added!	Pass
21	Update the police officer details	The system will display a selected police officer details and allow updating name, address, date of birth, registration number and police division. Upon successful update “Police officer updated successfully” message will display with the update details. Police Officer Updated Successfully!	Pass
22	Delete a particular police officer	The system will delete the delete the details of a selected police officer and display the message “Policer Officer Deleted” and update the view data table. Police Officer Deleted!	Pass

Table 5. 4: Test results for manage police officer

5.3.5. Manage Fine

The system administrator is allowed to add new fines, view, and update records. Table 5.5 shows the test results of adding, displaying and update fine details.

Test Case ID	Test Case	Expected Result	Test Status
23	Validation the Add Fine Details	The system should display error messages for empty fields of section of act, fine amount and demerit point.  Section Of Act Enter Section act × Enter Section Of Act	Pass

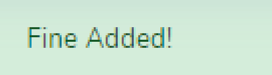
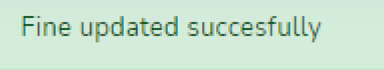
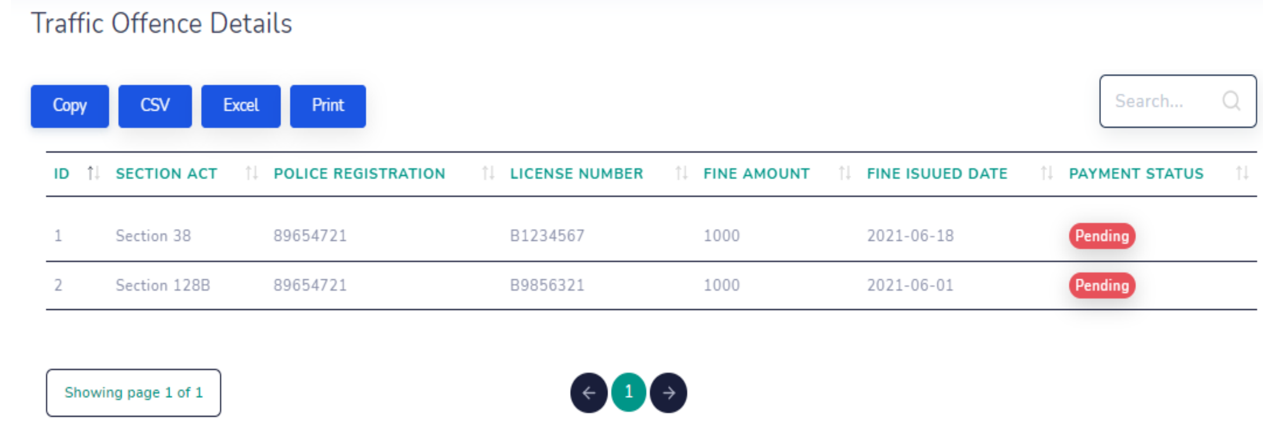
Test Case ID	Test Case	Expected Result	Test Status
24	Submit the completed add fine details	The system will add the entered records in the database and redirect the page to view fine details page and display the message “Fine Added”. All added fine details will displayed.  Fine Added!	Pass
25	Update the fine details	The system will display all fine details and user selected a particular fine record and allows updating section of act, fine amount, demerit point and provision. Upon successful update “ Fine updated successfully” message will display with the update details.  Fine updated succesfully	Pass

Table 5. 5:Test results for manage fine details

5.3.6. View Traffic Offense Details

The system administrator is allowed to view all traffic offences issued. Table 5.6 shows the test results.

Test Case ID	Test Case	Expected Result	Test Status
26	View traffic offence details	The system should display offence ticket id, section act, police registration, license number, fine amount, fine issued date and payment status of all lawbreakers.	Pass



Traffic Offence Details

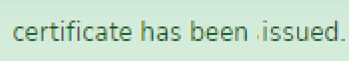
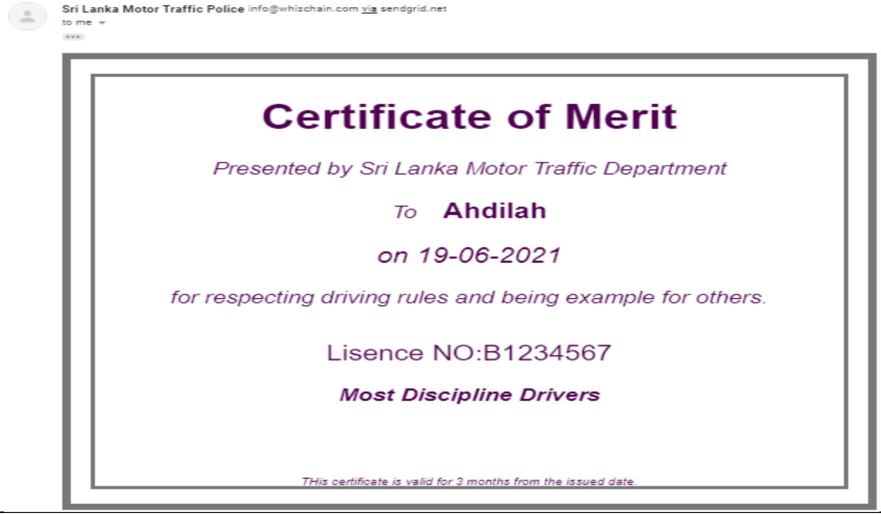
ID	SECTION ACT	POLICE REGISTRATION	LICENSE NUMBER	FINE AMOUNT	FINE ISUUED DATE	PAYMENT STATUS
1	Section 38	89654721	B1234567	1000	2021-06-18	Pending
2	Section 128B	89654721	B9856321	1000	2021-06-01	Pending

Showing page 1 of 1

Table 5. 6:Test results for view Traffic Offences

5.3.7. Certificate of Merit

The system administrator will issue certificate of merit for driving license holder less than 5 demerit points. Table 5.7 shows the test results.

Test Case ID	Test Case	Expected Result	Test Status
27	Issue certificate of merit	The system should display details of the requested license holders. The system admin click on the button issue certificate merit and the system will send an email automatically.  certificate has been issued.	Pass
			

Sri Lanka Motor Traffic Police info@whizchain.com via sendgrid.net
to me

Certificate of Merit

Presented by Sri Lanka Motor Traffic Department

To Ahdilah

on 19-06-2021

for respecting driving rules and being example for others.

Lisence NO:B1234567

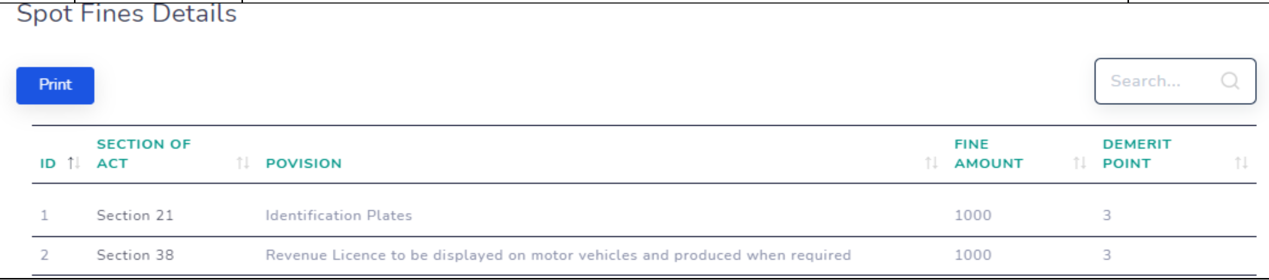
Most Discipline Drivers

THis certificate is valid for 3 months from the issued date.

Table 5. 7:Test results for Issue certificate of merit

5.3.8. Spot Fines Details

The license holder can view spot fine information about the section of act, provision, fine amount and demerit points for each fine. Table 5.8 shows test results for view spot fine details.

Test Case ID	Test Case	Expected Result	Test Status
30	View Spot fine details	The system should display the section of act, provision, fine amount and assigned demerit points for each spot fine and allow the user to print or search spot fine.	Pass
			

Spot Fines Details

ID	SECTION OF ACT	POVISION	FINE AMOUNT	DEMERIT POINT
1	Section 21	Identification Plates	1000	3
2	Section 38	Revenue Licence to be displayed on motor vehicles and produced when required	1000	3

Table 5. 8:Test Results of spot fine details

5.3.9. Update License Holder Profile

The license holder can update basic details of his/her profile. Table 5.9 shows the test results of update profile of license holder.

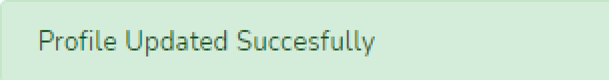
Test Case ID	Test Case	Expected Result	Test Status
31	Update license holder profile	The system should display all details of the driving license holder and allow to update his/her personal details such as email address, postal address, contact number and DOB only.  Profile Updated Succesfully	Pass

Table 5. 9:Test results of update profile of license holder

5.3.10. Request Certificate of Merit

The license holder can request certificate of merit if they have obtained less than 5 demerit point and the System Administrator will verify and send the certificate via email. Table 5.10 shows test results for Request for certificate of merit

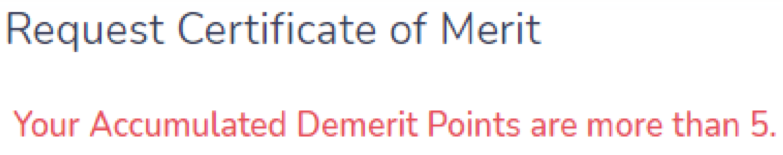
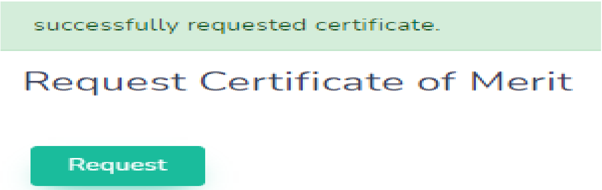
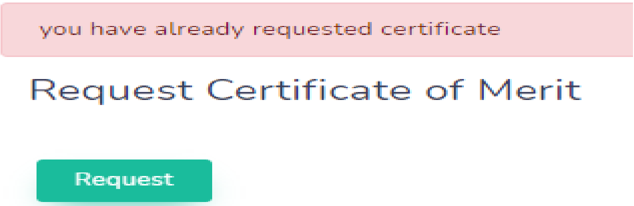
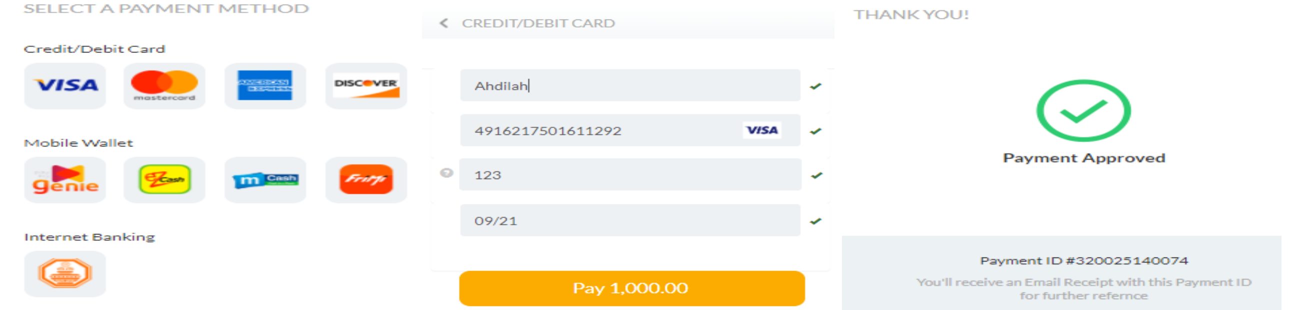
Test Case ID	Test Case	Expected Result	Test Status
32	Request certificate of merit when demerit points >5	The system will disable the request button and show the message "your accumulated demerit points are more than 5"  Request Certificate of Merit Your Accumulated Demerit Points are more than 5.	Pass
33	Request certificate of merit when demerit points <5	The system will send a request to System administrator and wait for approval. A message will display "successfully requested certificate"  successfully requested certificate. Request Certificate of Merit 	Pass
34	Request certificate of merit more than once.	The system display " you have already requested certificate"  you have already requested certificate Request Certificate of Merit 	Pass

Table 5. 10:Test results for Request for certificate of merit

5.3.11. Pay Offence

The license holder can pay offence by clicking “Pay Now”. Table 5.11 shows the test result for Payment of offence by a driving license holder.

Test Case ID	Test Case	Expected Result	Test Status
35	Validating online payment through sandbox of Payhere	The system will direct to sandbox of payhere and request to select a payment method “Credit/Debit card, mobile wallet or Internet Banking” and request to fill below details and click on pay. Payment will be approved and email will be received.	Pass


SELECT A PAYMENT METHOD

Credit/Debit Card

Mobile Wallet

Internet Banking

CREDIT/DEBIT CARD

Ahdilah ✓

4916217501611292 VISA ✓

123 ✓

09/21 ✓

Pay 1,000.00

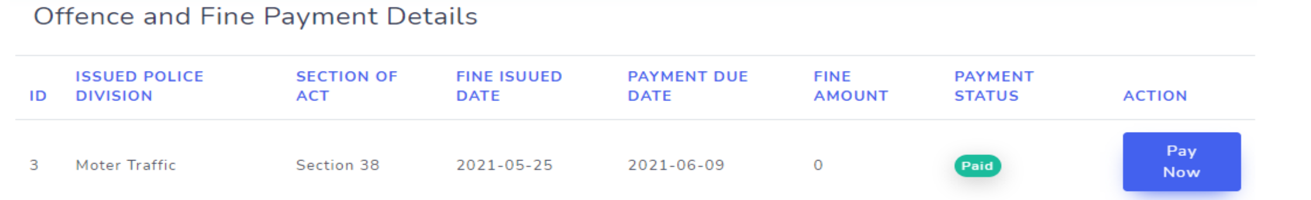
THANK YOU!

Payment Approved

Payment ID #320025140074

You'll receive an Email Receipt with this Payment ID for further refernce

36	Payment status update and total due amount reduces.	The system will update the total due amount, fine amount to zero and status of the payment will be changed to paid	Pass


Offence and Fine Payment Details

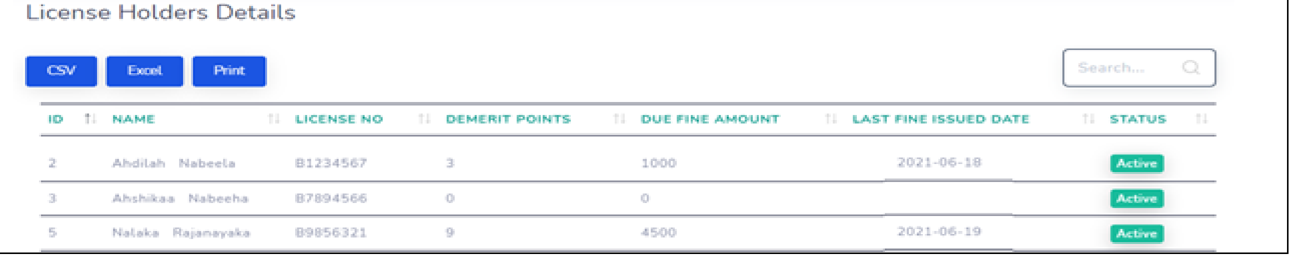
ID	ISSUED POLICE DIVISION	SECTION OF ACT	FINE ISUUED DATE	PAYMENT DUE DATE	FINE AMOUNT	PAYMENT STATUS	ACTION
3	Moter Traffic	Section 38	2021-05-25	2021-06-09	0	Paid	Pay Now

Table 5. 11:Test result for Payment of offence by a driving license holder

5.3.12. View License Holder Details

The police officer can view license holder details before issuing a spot fine ticket. Table 5.12 shows the test result for View License Holders Details.

Test Case ID	Test Case	Expected Result	Test Status
37	Display license holder details	The system will display license holder no, name, demerit point, due fine amount, last fine issued date, status of the license holder.	Pass


License Holders Details

ID	NAME	LICENSE NO	DEMERIT POINTS	DUE FINE AMOUNT	LAST FINE ISSUED DATE	STATUS
2	Ahdilah Nabeela	B1234567	3	1000	2021-06-18	Active
3	Ahshikaa Nabeeha	B7894566	0	0		Active
5	Nalaka Rajanayaka	B9856321	9	4500	2021-06-19	Active

Table 5. 12:Test result for View License Holders Details

5.3.13. Issue Offense Ticket

Police officer can issue spot fine ticket for road rule violation of an active license holder only. Table 5.13 shows the test result for Issue spot fine ticket process.

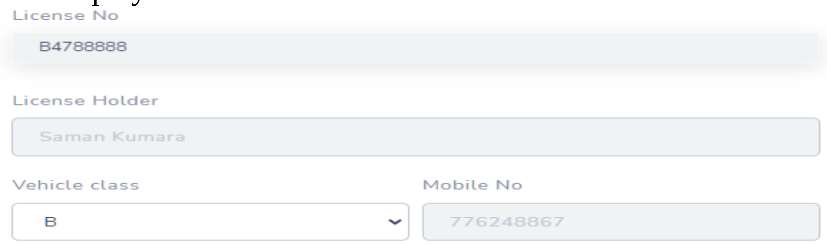
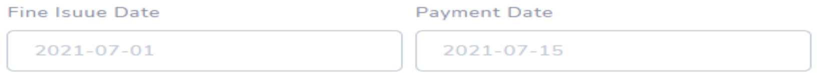
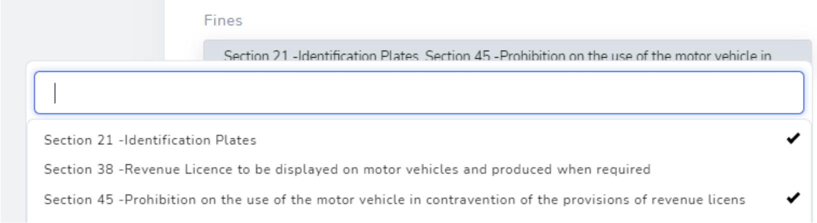
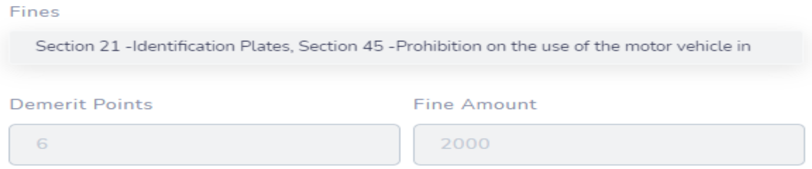
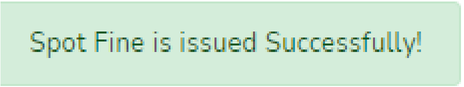
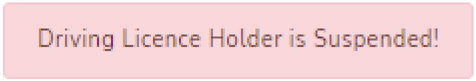
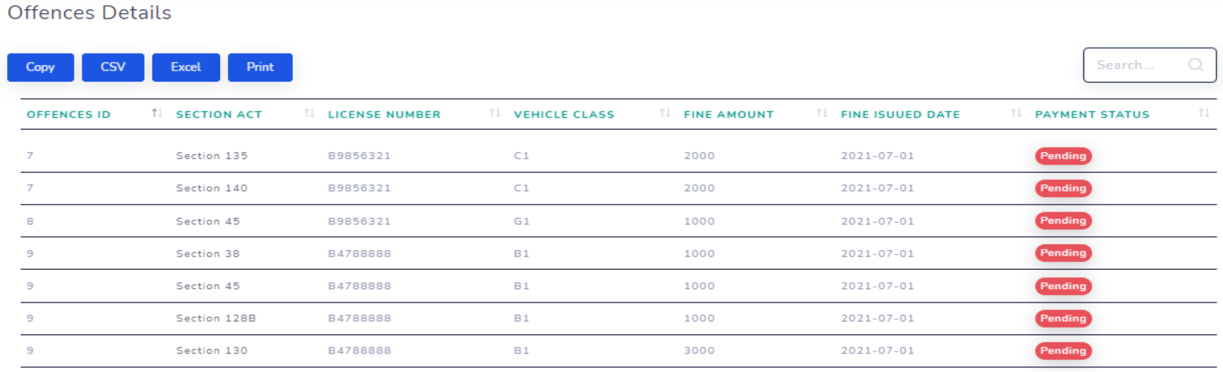
Test Case ID	**Test Case**	**Expected Result**	**Test Status**
38	Validation of License Holder details	The police officer enters the license holder number and system will display the license holder details  License No B4788888 License Holder Saman Kumara Vehicle class: B Mobile No: 776248867	Pass
39	Validation of spot fine issue date , due payment date	The system will automatically display the current date as issue fine date and 14 days will be added to the current date to display due payment d ay.  Fine Isuue Date: 2021-07-01 Payment Date: 2021-07-15	Pass
40	Validation on multiple fine and calculate the total fine amount for the ticket	The system will allow multiple fine section of action selection and will calculate the total demerit points and total fine amount to be issued for a particular ticket.  Fines Section 21 -Identification Plates, Section 45 -Prohibition on the use of the motor vehicle in Section 21 -Identification Plates ✓ Section 38 -Revenue Licence to be displayed on motor vehicles and produced when required Section 45 -Prohibition on the use of the motor vehicle in contravention of the provisions of revenue licens ✓ After selection the form appears as  Fines Section 21 -Identification Plates, Section 45 -Prohibition on the use of the motor vehicle in Demerit Points: 6 Fine Amount: 2000	Pass
41	Issuing spot fine for Active License holder	The system display “spot fine is issued successfully” for active license holders.  Spot Fine is issued Successfully!	Pass
42	Issuing spot fine for Suspended license holder	The system will not allow to issue spot fine and will display a message “Driving License Holder is Suspended!”  Driving Licence Holder is Suspended!	Pass

Table 5. 13:Test results for Issue Spot Fine Ticket process

5.3.14. View issued spot fine details

Police officer can view all offense details issued by him. Table 5.14 shows the results for View issued offense details of a particular police officer.

Test Case ID	**Test Case**	**Expected Result**	**Test Status**
43	View issued offense of a valid police officer	The system will display offense id, section act, license number, vehicle class, fine amount, fine issued date and payment status	Pass



Offences Details

OFFENCES ID	SECTION ACT	LICENSE NUMBER	VEHICLE CLASS	FINE AMOUNT	FINE ISUUED DATE	PAYMENT STATUS
7	Section 135	B9856321	C1	2000	2021-07-01	Pending
7	Section 140	B9856321	C1	2000	2021-07-01	Pending
8	Section 45	B9856321	G1	1000	2021-07-01	Pending
9	Section 38	B4788888	B1	1000	2021-07-01	Pending
9	Section 45	B4788888	B1	1000	2021-07-01	Pending
9	Section 128B	B4788888	B1	1000	2021-07-01	Pending
9	Section 130	B4788888	B1	3000	2021-07-01	Pending

Table 5. 14:Test results for View issued offense details of a particular police officer

5.3.15. Update Police Officer Profile

Police officer can update personal details such as date of birth, address and mobile number. Table 5.15 shows the results for update police officer profiler.

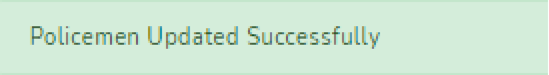
Test Case ID	**Test Case**	**Expected Result**	**Test Status**
43	Update police officer profile	The system will display the personal details of the police officer and allow him to update the date of birth, address and mobile number. Once the update are made the system display "Policemen Updated Successfully "  Policemen Updated Successfully	Pass

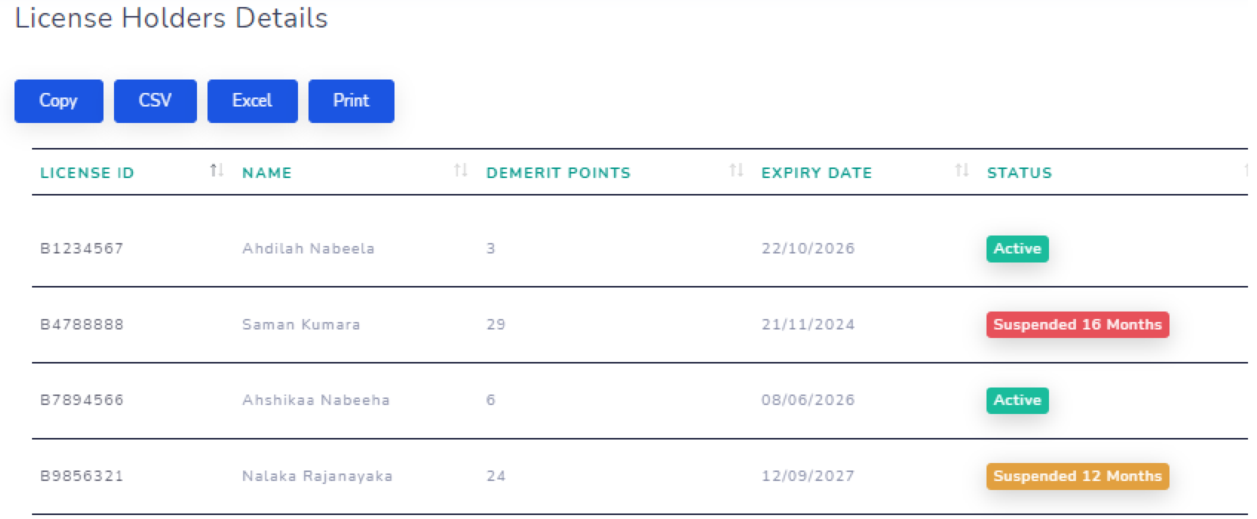
Table 5. 15:Test results for update police officer profile

5.3.16. Demerit System

When police officer issue a spot fine the demerit point is calculated and license holder status is updated. Table 5. 16 shows rest results for demerit point system.

Test Case ID	**Test Case**	**Expected Result**	**Test Status**
43	Demerit point between 0 to 23	The system will display license holder status as "active status"	Pass

44	Demerit point between 24 to 27	The system will display license holder status as “Suspended 12 Months”	Pass
45	Demerit point greater than 28	The system will display license holder status as “Suspended 16 Months”	Pass



License Holders Details

LICENSE ID	NAME	DEMERIT POINTS	EXPIRY DATE	STATUS
B1234567	Ahdilah Nabeela	3	22/10/2026	Active
B4788888	Saman Kumara	29	21/11/2024	Suspended 16 Months
B7894566	Ahshikaa Nabeeha	6	08/06/2026	Active
B9856321	Nalaka Rajanayaka	24	12/09/2027	Suspended 12 Months

Table 5. 16:Test results for demerit point system

5.4. Compatibility Testing

Compatibility testing ensures the website displays correctly across different devices and web browsers. DrivSri web application was tested across different browsers such as Google Chrome, Microsoft Edge, Safari, Opera and Firefox. Also, it was tested on desktop and android Mobile phone and Tablet PCs. Table 5.17 show test result of browser compatibility of DrivSri mobile responsive website.

Test Module	**Test Status**					
	Google Chrome	**Microsoft Edge**	**Safari**	**Opera**	**Firefox**	**Android Mobile**
1. Login	Pass	Pass	Pass	Pass	Pass	Pass
2. Admin Dashboard	Pass	Pass	Pass	Pass	Pass	Pass
3. License Holder Dashboard	Pass	Pass	Pass	Pass	Pass	Pass
4. Police Officer Dashboard	Pass	Pass	Pass	Pass	Pass	Pass
5. Manage License Holders	Pass	Pass	Pass	Pass	Pass	Pass
6. Manage Police Officers	Pass	Pass	Pass	Pass	Pass	Pass
7. Manage Fines	Pass	Pass	Pass	Pass	Pass	Pass
8. Issue Offences Ticket	Pass	Pass	Pass	Pass	Pass	Pass
9. View Offences	Pass	Pass	Pass	Pass	Pass	Pass
10.Email Notification	Pass	Pass	Pass	Pass	Pass	Pass
11.Pay offences	Pass	Pass	Pass	Pass	Pass	Pass
12.Report	Pass	Pass	Pass	Pass	Pass	Pass
13.Issue Certificate of Merit	Pass	Pass	Pass	Pass	Pass	Pass
14.Backup/Recovery	Pass	Pass	Pass	Pass	Pass	-

Table 5. 17:Test results for Browser Compatibility Testing

5.5. Usability Testing

Usability testing was carried out among 15 users (Kohuwala Motor Traffic police officers and driving license holders) using the questionnaire in Appendix E, Table E.1. The questionnaire was developed based on the DrivSri web application's navigation, web layout, performance speed, understandability of error and success messages and web micro content.

Based on the usability questionnaire given the responses from the users are summarized in Table 5.18.

	Navigation	Web Layout	Speed	Message(Error and Success)	Micro content
Excellent	4 (27%)	1 (7%)	5 (33%)	5 (33%)	4 (27%)
Good	10 (67%)	12 (80%)	9(67%)	9 (60%)	10 (67%)
Average	1 (7%)	1 (7%)	1(7%)	1 (7 %)	1 (7%)
Poor	0 (0%)	1 (7%)	0 (0%)	0 (0%)	0 (0%)

Table 5. 18:Test results on usability testing based on the user feedback

94% of the users were satisfied with the navigation, 87% users were satisfied with the web layout, 93% users were satisfied with the understandability of the error/success messages and ease of use and 94% users were satisfied with the web micro content. Due to the low level of IT literacy and Technology adaptability shifting from manual process to automated process few users were not fully satisfied.

5.6. Evaluation

Evaluation measures, the users' ability to learn and use the application to achieve their goals and their satisfactory level with the process implemented. Following evaluation technique was used to evaluate the project,

1. Questionnaire for the Driving License holders based on the following criteria's,
    1. Usefulness of the application to the driving license holder
    2. Automation of the payment process
    3. Implementation of point management system to reduce road traffic offense
    4. Ability to monitor driving license holder's demerit points, license status and payment status through the system
    5. Implementation of the rewarding system given for discipline drivers

The above user evaluation was carried out among 8 potential Driving License Holders from different social class with the questionnaire which can be found in Appendix E, Table E.3

2. Questionnaire for the Motor Traffic Police officers based on the following criteria's
    1. The comprehensiveness of the developed web application
    2. Usefulness of the application to the Motor Traffic Police
    3. The convenient of the developed web application compared to the manual fine issuing process

4. The time consumption in the process of issuing of the spot fines using the developed application.
5. The efficiency of the fine collection process from the developed system
6. Implementation of point management system to discipline the driving license holders
7. The collection and monitoring of the information regarding police division
8. The collection and monitoring of the information regarding driving license holders and their traffic offenses

The above user evaluation was carried out among 7 Kohuwala Motor Traffic police officers using the questionnaire which can be found in Appendix E, Table E.2.

5.6.1. Analysis of evaluation feedback by Driving License Holder’s

Based on the questionnaire given, the responses from the users are summarized in Figure 5.1 to Figure 5.5.

According to Figure 5.1,

- 62% of the users find the web application very useful
- 38% of the users feel the application is only partially useful due to the reluctance in adaptation and different levels of English language proficiency and technology literacy. This can be due to different levels of socio-economic levels within the users.
- 0% of responses were stating that the application was not useful.

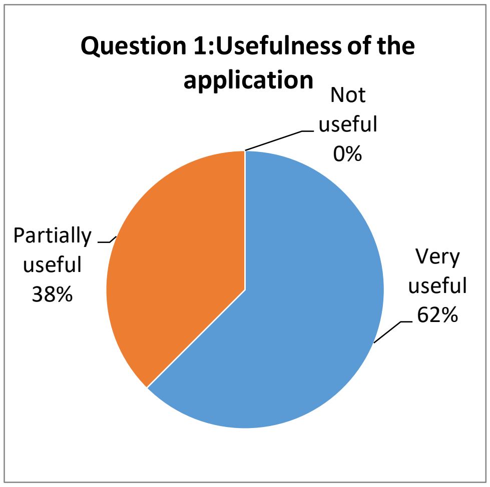


Figure 5.1: Feedback of Usefulness of the application

According to Figure 5.2,

- 87% of the users accept and consider the automation of the payment process as a highly time-saving and as an effective solution to the current tedious process of traffic fine payment, where they need to physically make the payment to the Post Office and if the Post Office is closed and not operating due to postal strike or pandemic situation there is no mechanism for the drivers in paying the fines on time.

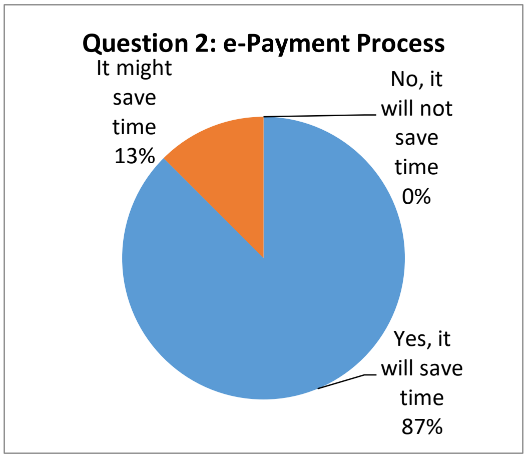


Figure 5.2: Feedback of e-payment process

According to figure 5.3,

- 37% of Driving License Holders believes that the DriSri system will reduce the traffic offenses, due to the fear of suspension/cancelation of the Driving License with demerit points
- 38% of Driving License Holders believe that it might reduce the traffic offense and 25% of the Driving License Holders believes that there will be no reduction of violation of traffic offenses due to the new system.

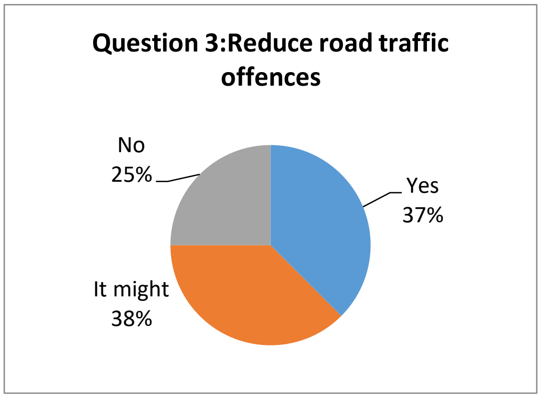


Figure 5. 3: Feedback of reducing road traffic offenses

According to figure 5.4,

- 75% of the users also find it useful to monitor their demerit points, license status, and payment status whenever they log in to the system.

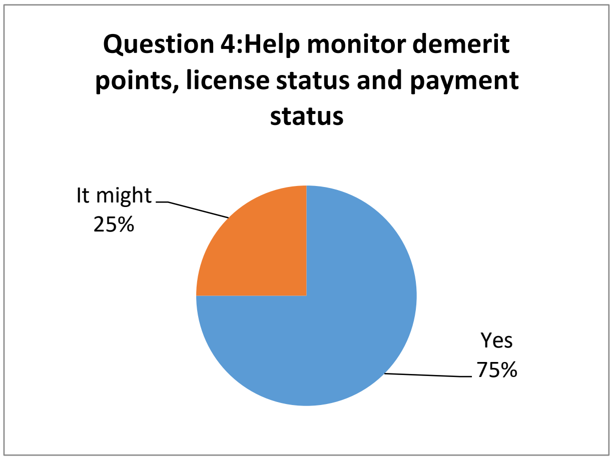


Figure 5. 4: Feedback of help monitor demerit point, license status and payment status

According to Figure 5.5,

- It shows that the majority (62%) of license holder was satisfied with the reward system of a certificate of merit.
- 25% of users were not satisfied with the reward system as it was not linked with a monetary benefit or it doesn't provide other benefits like an insurance benefit.

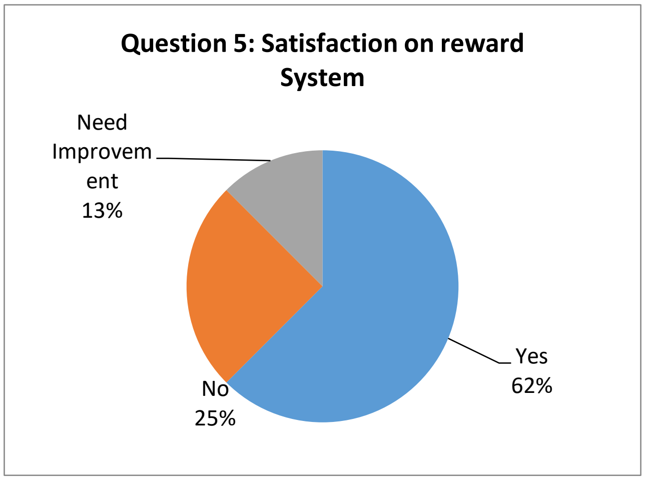


Figure 5. 5: Feedback of help monitor demerit point, license status and payment status

5.6.2. Analysis of feedback by Motor Traffic Police Officers

Based on the questionnaire given to the Motor Traffic Police Officers, the responses are summarized in Figure 5.6 to Figure 5.13

According to figure 5.6,

- 72% of the users were satisfied with the level of functionality implemented;
- 14% suggested that the system requires more functionalities such as integrating the web application with the Motor Traffic Department to automatically gain access to Driving License Holder's details and also to implement an SMS notification functionality for every function.

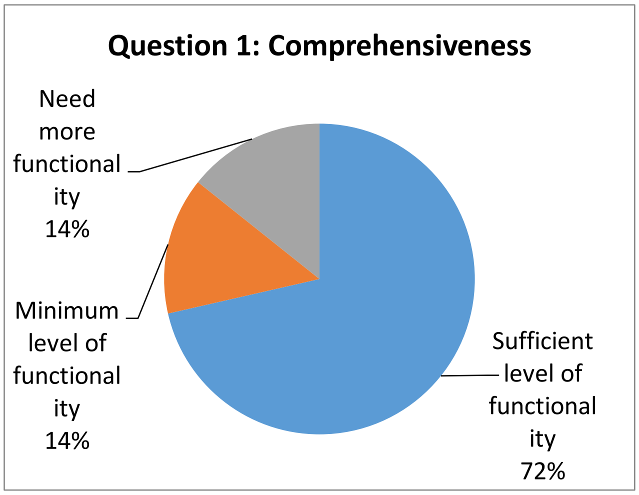


Figure 5. 6: Feedback of Comprehensiveness

According to Figure 5.7,

- 86% of the users found that the new system very useful in managing the records of traffic offenses than the manual records on books. Also, they found it very convenient in searching an offense history or finding the details of a driving license holder which can be performed within a few seconds. Further, it was also useful for the user in analyzing and generating reports for decision-making purposes.

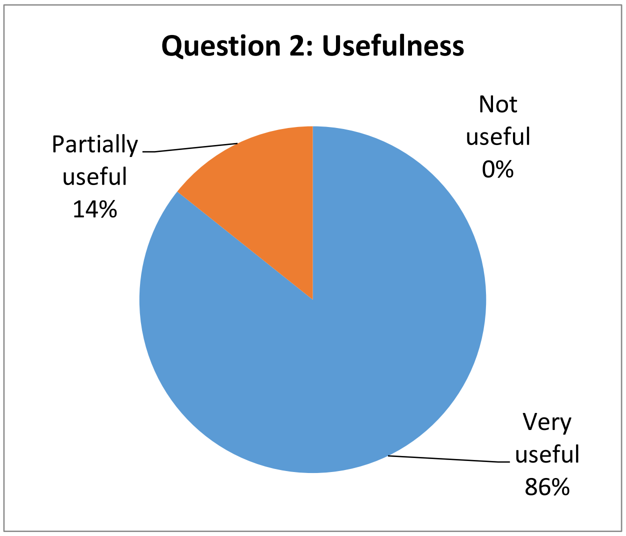


Figure 5. 7: Feedback of usefulness

According to Figure 5.8 and Figure 5.9,

- 57% of the Traffic Police Officers find the DriSri spot fine issue process as a very convenient and time-saving process, compared to the issuing and recording of the traffic offenses manually on books. Since there are only a limited number of inputs to be inserted in issuing of a fine such as license no, vehicle class, and the selection of the violated section of the act, and the system will display automatically the Driving License Holder details, fine issue date, payment due date and calculate the total fines and demerit points for multiple fines, the Traffic Police officers found it as a much more simplified convenient process of issuing the fine.

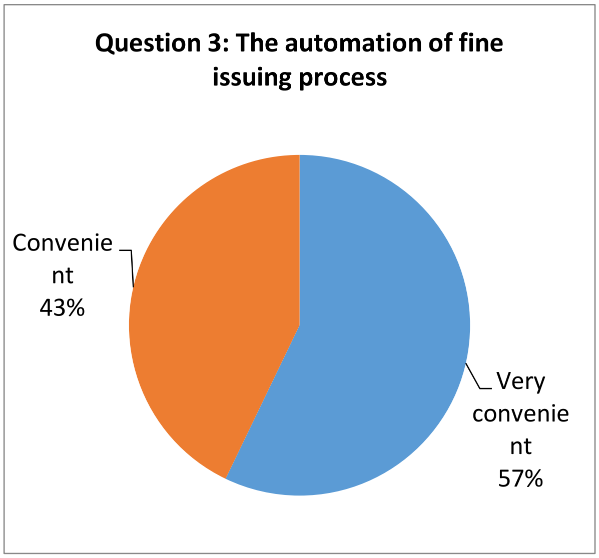


Figure 5. 8: Feedback of the automation of fine issuing process

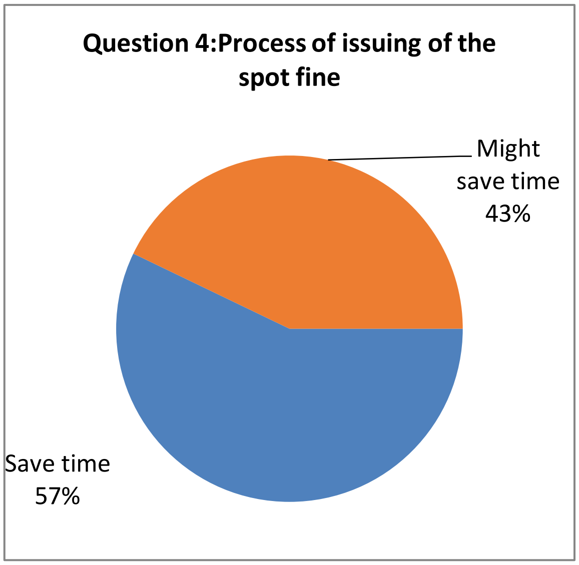


Figure 5. 9: Feedback of the process of issuing of the spot fine

According to Figure 5.10,

- 43% of the Traffic Police Officers are certain that through the system they can collect the fine payments more efficiently since the Driving License Holders are able to pay through the e-payment process.

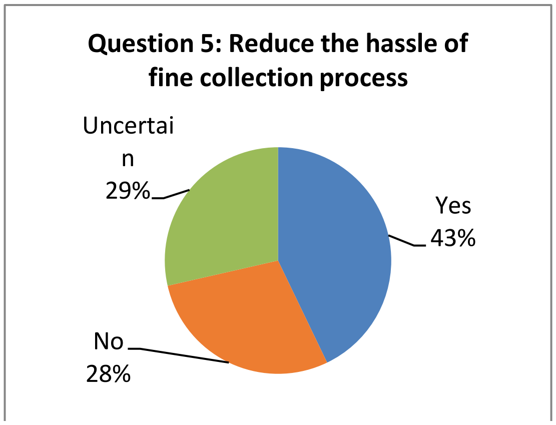


Figure 5. 10: Feedback of reduce the hassle of fine collection process

According to Figure 5.11,

- 57% of the Traffic Police Officers are certain that through the introduction of the Point Management System the discipline of the Drivers will improve drastically.
- While 43% of the Traffic Police officers think that it might improve the discipline of the driver.

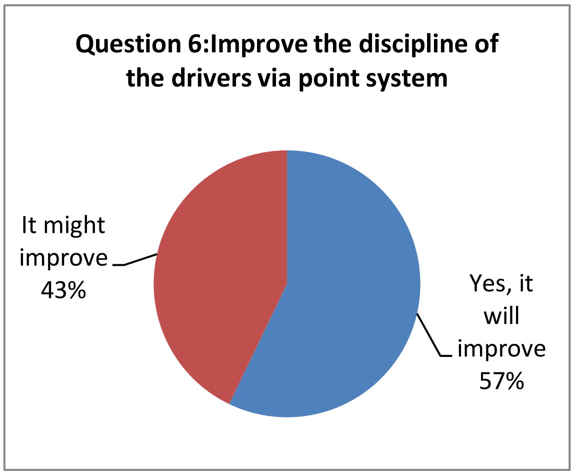
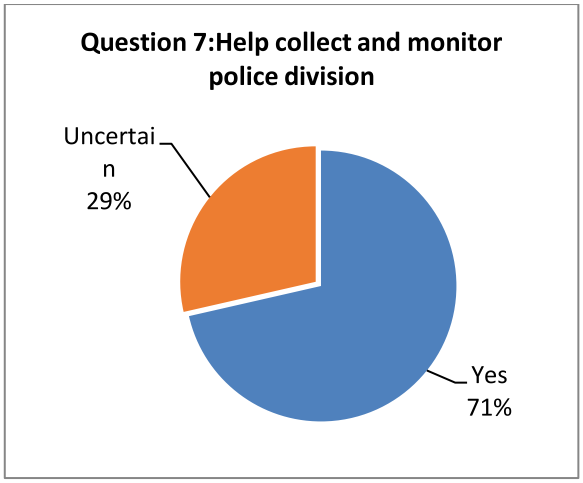


Figure 5. 11: Feedback of improving discipline of the drivers via point system

According to Figure 5.12 and 5.13,

- 71% of the Traffic Police officers feel the system will help the police division in collecting and monitoring the details of the police officers and the traffic fines issued by them. Also 71% of the Traffic Police officers feel that through the system they also can monitor the driving license holders' offenses.



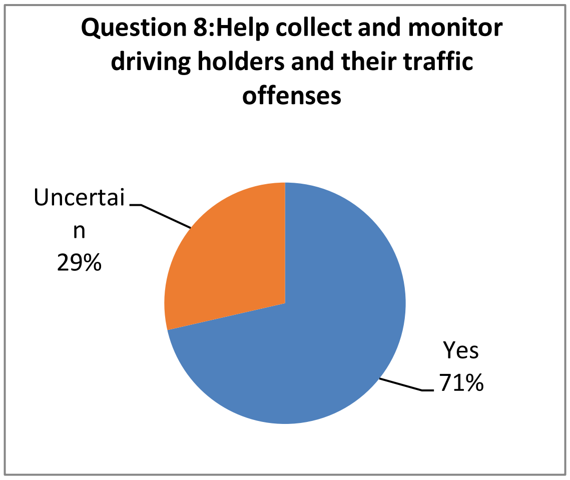


Figure 5. 13: Feedback of help collect and monitor police division

Figure 5. 12: Help collect and monitor driving holders and their traffic offenses

5.7. Summary

This chapter provided the reader with the testing aspects of the overall system, which includes the black box test strategy which was tested in levels of unit testing, integration testing, system testing and usability testing. Through questionnaire for the Driving License holders and Motor Traffic Police officers the system was evaluated.

The next chapter focuses on discussing the conclusion based on the finding of the project.

Chapter 6: Conclusion

6.1. Introduction

After the successful completion and evaluation of the project, the final task is to review the project entirely. This chapter presents a complete review of the overall project. The accomplishment of the defined objectives of the project, problems faced during the project, and benefits accrued from carrying out this project are discussed in this chapter. The chapter concludes with comments regarding the future avenues for the project.

6.2. Achievement of the project

The best approach in validating the achievements is to review whether the objectives have been properly achieved. The objectives are an illustration of steps being used to achieve the goals. This section elucidates all the objectives, how the objectives were achieved during the project.

The main objective of the proposed project is to develop an efficient motor fine management system and to improve the discipline of the drivers through the demerit point system which will lead to reducing the number of traffic violations.

The above-mentioned main objective was achieved through fulfilling objectives 1 to 4 as illustrated in Table 6.1.

Objective	Solution	Evidence
1. To speed up and reduce the hassles of the motor fine issuing process	Automating the current fine management process	To address the identified main issues and drawbacks in the manual paper-based fine issuing process explained in Section 2.3, the current system was automated via the DrivSri website. The implementation of this fine issuing process is evident with the code provided in Section 4.5 Fine Issuing Process. Further, the test results are shown in section 5.3.13 Issue Offense Ticket with the relevant screen shots of the outcome of the system. Additionally, this is validated through the user evaluation questionnaire feedback results depicted in Section 5.6.2 Analysis of feedback by Motor Traffic Police Officers.

2. Improve the discipline of drivers	Implementing the driver point management mechanism by providing reward and demerit points.	The proposed Demerit and Reward System to improve the discipline of the drivers is explained in Section 2.4 Proposed Method of Point Management Process in Sri Lanka. Also, the implementation of the system is evident with the code provided in Section 4.6 Driver Point Management Process and 4.10 Certificate of Merit. Further, the Test results are shown in section 5.3.7 Certificate of Merit and 5.3.16 Demerit System with the relevant screen shots of the outcome of the system. Additionally, this is validated through the user evaluation questionnaire feedback results depicted in Sections 5.6.1 and 5.6.2.
3. To have a convenient faster mechanism in paying the fines	Introducing the e-payment system for fine payments	To address the identified main issues and drawbacks in the current fine management process in Section 2.3-Payment Process, an online payment mechanism was implemented through the DrivSri website. The implementation of this payment process is evident with the code provided in Section 4.8 E-Payment Process. Further, the Test results are shown in section 5.3.11 Pay Offence with the relevant screen shots of the outcome of the system. Additionally, this is validated through the user evaluation questionnaire feedback results depicted in Section 5.6.1 Analysis of evaluation feedback by Driving License Holder’s.

4. To track and monitor information regarding the drivers and their traffic offenses	This was addressed through the DrivSri system where the Traffic Police Officer will be given the ability to generate and view the information regarding a particular driving license holder's details and information related to their traffic offenses.	The implementation of this process is evident with the code provided in Section 4.9 Monitor Driving License Holder and their Offenses. Further, the Test results are shown in section 5.3.3 Manage License Holder Details and 5.3.14 View issued spot fine details with the relevant screen shots of the outcome of the system. Additionally, this is validated through the user evaluation questionnaire feedback results depicted in Section 5.6.1 Analysis of evaluation feedback by Driving License Holder’s and Appendix F-MIS reports.

Table 6. 1: The achieved objective, solution, and evidence of DriSri System

6.3. Lesson Learned

Looking back at the overall project, it was an enormous learning process and numerous benefits have been accrued through the process of completion of DriSri System. The noteworthy lessons learned are highlighted below,

A. The opportunity of applying the modules learned during the course

The DriSri project provided an opportunity to apply the theoretical knowledge learned during the course. Some of the key modules which were beneficial are, System Analysis and Designing, Software Engineering, Database Management, and Agile Software development.

B. Learned a new PHP development framework and development techniques

Another major prospect and experience gained out of the project were familiarizing myself with MVC architecture, Laravel framework and getting a comprehensible knowledge about My SQL Server, jQuery, JavaScript. Also, integrating plugins, templates, and API to send an email and to make online payments was also learned during the project.

C. Learned importance of Time Management

It was indeed a balancing act where the project had to co-exist with other academic activities and work. Targets had to be set and they had to be achieved in a specified time frame despite the heavy workload due to the pandemic and other academic projects in the pipeline.

D. Accomplish with the knowledge to tackle any such future endeavors

Developing a project of this nature provided leads to critically measuring the problem and successfully gaining the final results by going through the activities of the project life cycle with well-formed knowledge. Armed with this experience, it will be very useful to face similar challenging projects in the future.

6.4. Future Work

To further enhance the DrivSri system, the following functionalities can be implemented in the future,

1. Interconnecting the system with the Department of Motor Traffic. This will enable to,
    - Registration of users to the system - DL holders need to register for the service from the DMT to get a valid user name and password. New driving license holders, can automatically receive the details with their new registration.
    - Check the authenticity of the Driving License Holders' number with the issued number from the Department of Motor Traffic to avoid fraudulent Driving license numbers
2. To verify the expiry of the Driving License and renewal status
3. Implementation of an SMS notification
4. Improve the criteria in issuing the certificate of merit
5. Implementation of a Mobile App
6. Implementing a QR code to enter the Driving License holders details
7. Usage of GEO tracking- Location tracking of the traffic offenses and taking a pic and uploading the offense/accidents to further enhance the accuracy of the traffic violation reporting.

6.5. Conclusion

This chapter brings the project documentation to a conclusion. The chapter discussed the overall accomplishments of the project, the achievements gained from endeavoring in a project of this nature, highlighting the knowledge and experience accrued. The chapter concluded with an illusion of future improvement of the project.

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Appendices

Appendix A –Spot fine offenses amounts and allocated demerit points

Table A.1 illustrates spot fine offenses amount and allocated demerit point according to the extraordinary gazette numbered 1726/12 dated 05.10.2011

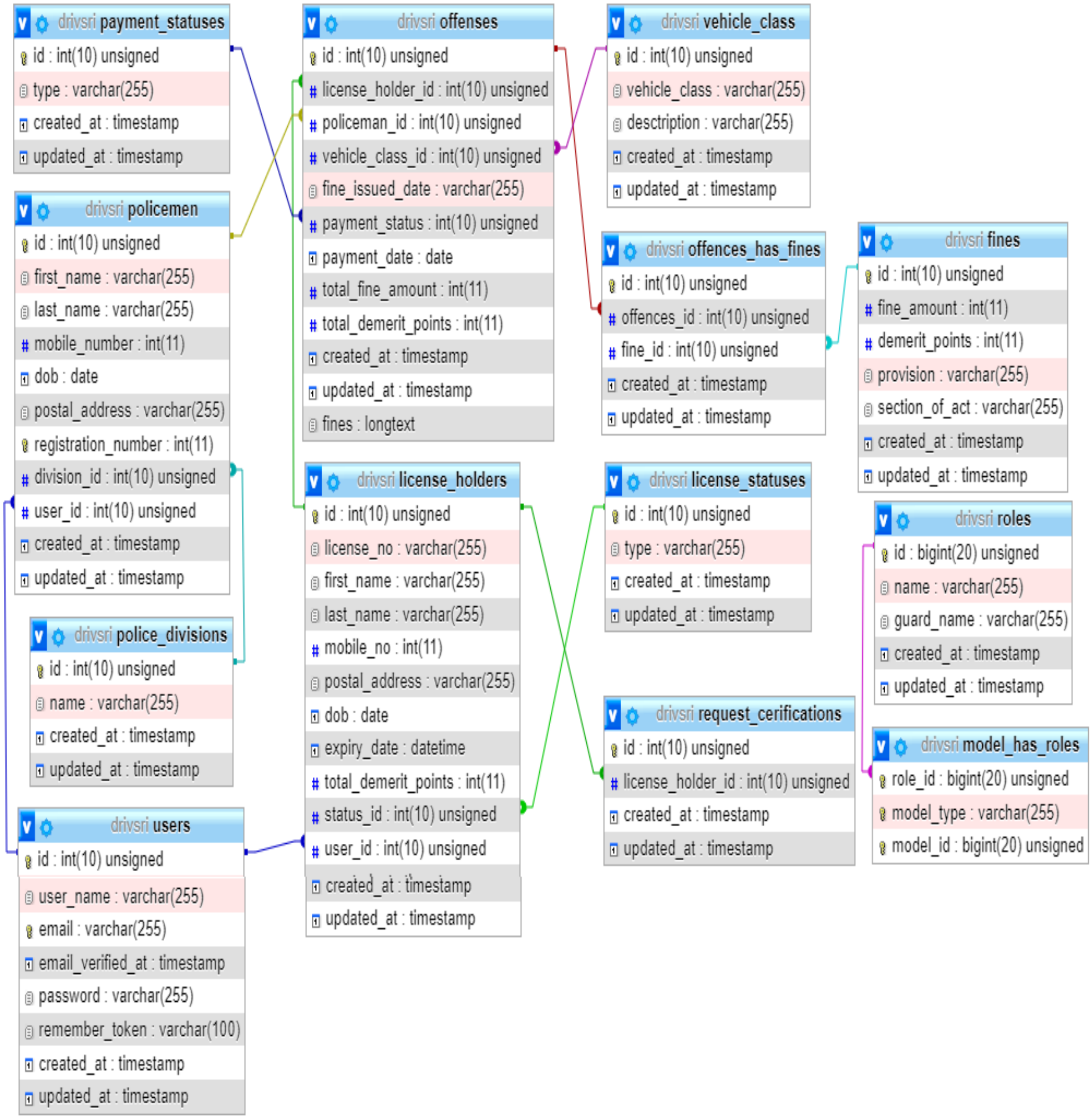
No	Section of Act	Provision	Amount of Spot Fine (Rs)	Demerit Points
1	Section 21	Identification Plates	1000.00	3
2	Section 38	Revenue Licence to be displayed on motor vehicles and produced when required	1000.00	3
3	Section 45	Prohibition on the use of the motor vehicle in contravention of the provisions of revenue license	1000.00	3
4	Section 128A	Failure to obtain authorization to drive emergency service vehicles and public service vehicles	1000.00	3
5	Section 128B	Driving a special purpose vehicle without obtaining a license	1000.00	3
6	Section 128C	Failure to obtain authorization to drive a vehicle loaded with chemicals, hazardous waste	1000.00	3
7	Section 130	Failure to have a license to drive a specific class of vehicle	1000.00	3
8	Section 135	Failure to carry a driving license when driving	2000.00	4
9	Section 139A	Instructing without an instructor license	3000.00	6
10	Section 140	Non- compliance with speed limit provisions	2000.00	6
11	Section 148	Failure to comply with road rules	1000.00	6
12	Section 152	Unobstructed control of the vehicle when driving	1000.00	
13	Section 153	Using inappropriate signals when driving and C	1000.00	6
14	Section 154	Prohibit reversing a motor vehicle for a long-distance on a road	1000.00	4
15	Section 155	Improper use of warning instruments	1000.00	3
16	Section 155A	Excessive emission of smoke and C	1000.00	6
17	Section 156	Prohibit riding or permitted to ride on running boards and C of motor vehicles	500.00	3
18	Section 157	Restriction on the number of persons in front seats of motor cards	1000.00	4
19	Section 157A	Non-use of seat belts	1000.00	3
20	Section 158	Failure to wear protective helmets when driving	1000.00	5

No	Section of Act	Provision	Amount of Spot Fine (Rs)	Demerit Points
21	Section 159	Prohibition to distribute advertisement from a vehicle in motion	1000.00	3
22	Section 160	Prohibit excessive use of noise from a vehicle	1000.00	6
23	Section 162	Failure to obey directions and signals of police officers	2000.00	6
24	Section 164	Noncompliance with traffic signs	1000.00	3
25	Section 165	Failure to take precautions when discharging fuel into the tank	1000.00	2
26	Section 166	Not halting or parking a motor vehicle on a road	1000.00	3
27	Section 167	Precautions to be taken when a motor vehicle is halted or left unattended or disabled on a road	2000.00	3
28	Section 178	Carriage of the person in excess of authorized number in private coaches and goods other than personal luggage in motor cars or private coaches	500.00	2
29	Section 179	Carriage of person or passengers excess of authorized number and goods other than personal luggage in omnibuses	500.00	2
30	Section 188	Carriage on lorry or motor tricycle van of goods in excess of maximum load or maximum axle load	500.00	2
31	Section 189	Not to exceed the number of persons carried in a lorry	500.00	2
32	Section 190	Violation of regulation	1000.00	3
33	Section 196	Failure to carry the emission certificate or the fitness certificate in the vehicle	500.00	2

Table A. 1: Spot fine offense amounts and allocated demerit points

Appendix B: Database Design

Figure B.1 show the drivsri database schema which was implemented using MySQL database.



drivsri payment_statuses
id : int(10) unsigned
type : varchar(255)
created_at : timestamp
updated_at : timestamp

drivsri policemen
id : int(10) unsigned
first_name : varchar(255)
last_name : varchar(255)
mobile_number : int(11)
dob : date
postal_address : varchar(255)
registration_number : int(11)
division_id : int(10) unsigned
user_id : int(10) unsigned
created_at : timestamp
updated_at : timestamp

drivsri police_divisions
id : int(10) unsigned
name : varchar(255)
created_at : timestamp
updated_at : timestamp

drivsri users
id : int(10) unsigned
user_name : varchar(255)
email : varchar(255)
email_verified_at : timestamp
password : varchar(255)
remember_token : varchar(100)
created_at : timestamp
updated_at : timestamp

drivsri offenses
id : int(10) unsigned
license_holder_id : int(10) unsigned
policeman_id : int(10) unsigned
vehicle_class_id : int(10) unsigned
fine_issued_date : varchar(255)
payment_status : int(10) unsigned
payment_date : date
total_fine_amount : int(11)
total_demerit_points : int(11)
created_at : timestamp
updated_at : timestamp
fines : longtext

drivsri license_holders
id : int(10) unsigned
license_no : varchar(255)
first_name : varchar(255)
last_name : varchar(255)
mobile_no : int(11)
postal_address : varchar(255)
dob : date
expiry_date : datetime
total_demerit_points : int(11)
status_id : int(10) unsigned
user_id : int(10) unsigned
created_at : timestamp
updated_at : timestamp

drivsri vehicle_class
id : int(10) unsigned
vehicle_class : varchar(255)
description : varchar(255)
created_at : timestamp
updated_at : timestamp

drivsri offences_has_fines
id : int(10) unsigned
offences_id : int(10) unsigned
fine_id : int(10) unsigned
created_at : timestamp
updated_at : timestamp

drivsri license_statuses
id : int(10) unsigned
type : varchar(255)
created_at : timestamp
updated_at : timestamp

drivsri request_cerifications
id : int(10) unsigned
license_holder_id : int(10) unsigned
created_at : timestamp
updated_at : timestamp

drivsri fines
id : int(10) unsigned
fine_amount : int(11)
demerit_points : int(11)
provision : varchar(255)
section_of_act : varchar(255)
created_at : timestamp
updated_at : timestamp

drivsri roles
id : bigint(20) unsigned
name : varchar(255)
guard_name : varchar(255)
created_at : timestamp
updated_at : timestamp

drivsri model_has_roles
role_id : bigint(20) unsigned
model_type : varchar(255)
model_id : bigint(20) unsigned

Figure B. 1: DrivSri Database Schema

Appendix C: Interesting Codes

```
class Createoffenses Table extends Migration
{
    public function up()
    {
           Schema::table('offenses', function (Blueprint $table) {
            $table->integer('license_holder_id')->unsigned()->index();
            $table->foreign('license_holder_id')->references('id')->on('license_holders')-
>onDelete('cascade')->onUpdate('cascade');

            $table->integer('policeman_id')->unsigned()->index()->nullable();
            $table->foreign('policeman_id')->references('id')->on('policemen')-
>onDelete('cascade')->onUpdate('cascade');
            $table->integer('offense_id')->unsigned()->index()->nullable();

            $table->integer('vehicle_class_id')->unsigned()->index()->nullable();
            $table->foreign('vehicle_class_id')->references('id')->on('vehicle_class')-
>onDelete('cascade')->onUpdate('cascade');
            $table->string('fine_issued_date')->nullable();
            $table->integer('payment_status')->unsigned()->index()->nullable();
            $table->foreign('payment_status')->references('id')->on('payment_statuses')-
>onDelete('cascade')->onUpdate('cascade');
            $table->date('payment_date')->nullable();
            $table->integer('total_fine_amount')->nullable();
            $table->integer('total_demerit_points')->nullable();
            $table->json('fines')->nullable();
            $table->timestamps();
        });
    }

    /**
     * Reverse the migrations.
     *
     * @return void
     */
    public function down()
    {
        Schema::dropIfExists('offenses');
    }
}
```

Figure C. 1: Offense Table Migration File

Table C.1 show the seeder uses in DriSri system. The seeders was used for creating testing data and to create the admin user credentials and to set default table data. Figure C.2 illustrate a code segment of

Seeder Name	Function
UserSeeder.php	Creates admin credentials
VehicleClassSeeder.php	Set default values for the vehicle class table including the vehicle class and description.
StatusSeeder.php	Set default values for the license holders status and payment status table.
PoliceDivisionSeeder.php	Set default values for the police division table
FineSeeder.php	Set default values for the fine table. Has added few records. New fine details can be added by system admin through the system

Table C. 1.: DriSri System Seeder Details

```
class UserSeeder extends Seeder
{
    /**
     * Run the database seeds.
     *
     * @return void
     */
    public function run()
    {
        $superUser = User::create([
            'user_name'=>'super_admin',
            'email' => 'superadmin@admin.com',
            'password' => Hash::make('1111aaaa'),
        ]);

        $superUserRole = Role::create(['name' => RoleType::SUPER_ADMIN]);
        $superUser->assignRole($superUserRole);

        $adminUser = User::create([
            'user_name'=>'admin1',
            'email' => 'admin@admin.com',
            'password' => Hash::make('1111aaaa'),
        ]);

        $adminUserRole = Role::create(['name' => RoleType::ADMIN]);
        $adminUser->assignRole($adminUserRole);
    }
}
```

Figure C. 2: UserSeeder class with admin credentials

The DrivSri system has a model for each table in the database as shown in Table C.2. Through this model all interactions with the table occur and the model allows querying for data in the table, insert, update and deleted records into the table. The model establishes a relationship among tables. Figure C.3 illustrates the code segment of the Offence Model.

Model Name	Function
User	Establish a relationship with license holder table and policemen table
LicenseHolder	Establish a relationship with license status, user, fines, request certificate, offense tables
LicenseStatus	Establish a relationship with license holder table
Policeman	Establish a relationship with user and police division table
Police_division	Establish a relationship with the policemen table
Fine	Establish a relationship with offense, license holder, and vehicle class table
Offense	Establish a relationship with fine, vehicle class, policeman, the license holder, and payment status tables.
OffenceHasFine	Establish a relationship with the fines and offense table.
PaymentStatus	Establish a relationship with the offense table
Vehicle_class	Establish a relationship with fine table
RequestCertification	Establish a relationship with license holder table

Table C. 2: Drisri System's Model Details

```
class Offense extends Model
{   use HasFactory;
    protected $table = 'offenses';
    protected $primarykey = 'id';
    protected $fillable = ['license_holder_id', 'policeman_id',
'vehicle_class_id','fine_issued_date', 'payment_status', 'payment_date',
'total_fine_amount','total_demerit_points'];

    public function paymentStatus()
    { return $this->belongsTo(PaymentStatus::class, 'payment_status');    }

    public function licensedHolder()
    {       return $this->belongsTo(LicenseHolder::class, 'license_holder_id');    }

    public function police()
    {  return $this->belongsTo(Policeman::class, 'policeman_id');    }

    public function vehicle()
    {       return $this->belongsTo(Vehicle_class::class, 'vehicle_class_id');    }

  public function fine()
  { return $this->belongsToMany(Fine::class, 'offences_has_fines','offences_id','fine_id');
  }
}
```

Figure C. 3: Implementation of Offense Model

The DrivSri system has 4 controls as shown in Table C.3. Controllers use to group related request handling logic into a single class. Figure C.3 illustrates the code segment of the license holder model.

Controller Name	Function
AdminController	The functions related to system administrator are handled through this controller.
PoliceController	The functions related to Police Officer are handled through this controller.
LicenseHolderController	The functions related to License Holder are handled through this controller.
LoginController	The function related to login is handled through this controller

Table C. 3: DriSri System Controller Details

```
 class LicenseHolderController extends Controller
{
   public function index()
   {  $user_id = Auth::user()->id;
      $license_holder = LicenseHolder::where('user_id', $user_id)->first();
      $offences = Offense::where('license_holder_id', $license_holder->id)->get();
      $total_fine_amount = 0;
      // calculating the accumulated total fine amount
      foreach ($offences as $offence)
      { $total_fine_amount = $total_fine_amount + $offence->total_fine_amount;    }
     return view('license_holder.license_holder', ['user' => $license_holder, 'fine_amount'
=> $total_fine_amount]);
   }

 public function updateLicenseHolder(Request $request)
   {
      $user = User::findOrFail(Auth::user()->id);
      $mobile_number= str_replace(' ','',$request->input('mobile_number'));
      $license_holder = LicenseHolder::where('user_id', Auth::user()->id)->first();
      $user->email = $request->input('email');
      $license_holder->first_name = $request->input('first_name');
      $license_holder->last_name = $request->input('last_name');
      $license_holder->mobile_no = $mobile_number;
      $license_holder->dob = $request->input('dob');
      $license_holder->postal_address = $request->input('address');
      $license_holder->license_no = $request->input('license_no');
      $user->save();
      $license_holder->save();
      return   redirect('licensed_holder/update_profile')->with('status',   'Profile   Updated
Successfully'); }    }
```

Table C. 4: Implantation of LicenseHolder Controller with updateLicenseHolder()

Appendix D: Test Plan

Table D.1 illustrates the DrivSri Traffic Fine and Point Management System Test Plan.

Test Case ID	**Test Case**
User Login Module	
1	Login Validation for empty
2	Login with invalid credentials
3	Insert invalid email address
4	User click on Forgot password link
5	Try to access the dashboard without logging in
6	Logout from the screen
7	Login with valid credentials for the admin
8	Login with valid credentials for police officer
9	Login with valid credentials for a license holder
10	Validation of empty fields submission
Add License Holder	
10	Validation of empty fields submission
11	Validate the password length
12	Validate password and confirm password match
13	Validate Mobile number
14	Validate Driving License ID
15	Validating click on submit button with all valid data
Manage License Holder Details	
16	Display all the license holder details
17	Update license holder details
18	Delete License holder details
19	Validation of the Add Police Officer form
Manage Police Officers	
19	Validation of the Add Police Officer form
20	Submit the completed add police officer form
21	Update the police officer details
22	Delete a particular police officer
Manage Fine	
23	Validation the Add Fine Details
24	Submit the completed add fine details
25	Update the fine details
26	View traffic offense details
27	Issue certificate of merit
30	View Spot fine details
31	Update license holder profile
Request Certificate of Merit	
32	Request certificate of merit when demerit points >5
33	Request certificate of merit when demerit points <5
34	Request certificate of merit more than once.

Pay Offence	
35	Validating online payment through sandbox of Payhere
36	Payment status update and total due amount reduce.
37	Display license holder details
Issue Offense Ticket	
38	Validation of License Holder details
39	Validation of spot fine issue date, due payment date
40	Validation on multiple fines and calculate the total fine amount for the ticket
41	Issuing spot fine for Active License holder
42	Issuing spot fine for Suspended license holder
43	View issued offense of a valid police officer
43	Update police officer profile
Demerit Point System	
43	Demerit point between 0 to 23
44	Demerit point between 24 to 27
45	Demerit point greater than 28

Table D. 1:DriSri Test Plan

Appendix E: Evaluation Questionnaires

DrivSri Traffic Fine and Point Management System

Usability Questionnaire

Name:………………………………………………….

Type of users : □ System Administrator
□ Motor Traffic Police
❑ Driving License Holder

Instructions: Select the following in order of preference.

1. Your opinion on the developed web application’s navigation,

   ❑Excellent □ Good ❑ Average □ Poor

2. Your opinion on the developed web application’s web layout,

   ❑Excellent □ Good ❑ Average □ Poor

3. Your opinion on the developed web application’s performance speed,

   ❑Excellent □ Good ❑ Average □ Poor

4. Your opinion on the understandability of the error and success messages and ease of use

   ❑Excellent □ Good ❑ Average □ Poor

5. Your opinion on the micro-content displayed

   ❑Excellent □ Good ❑ Average □ Poor

6. Any suggestions to improve the usability?

………………………………………………………………………………
……………………………………...
......
………………………………………………………………………………
……………………………………...
......

Table E. 1: Usability Questionnaire

DrivSri Traffic Fine and Point Management System
Evaluation Questionnaire for Motor Traffic Police

Name:……………………………………………….
Police Division:………………………

Instructions: Select the following in order of preference.

1. Your opinion on the comprehensiveness of the web application to the Department of Motor Traffic?
   ❑Sufficient level of functionality
   ❑Minimum level of functionality
   ❑Need more functionality

2. How useful is this application to the Motor Traffic Department?
   □Very useful ❑Partially useful □Not useful

3. How convenient is this application compared to the manual fine issuing process?
   ❑ Very convenient □ Convenient ❑ Not convenient

4. Do you think this application will save time in the process of issuing of the spot fines?
   □Save Time ❑Might save time □ It will not save time

5. Does the application helps in speeding up and reducing the hassle of the fine collection process?
   □Yes ❑No □Uncertain

6. Do you think this application will improve the discipline of the drivers through the introduction of point management system?
   □ Yes, it will improve the discipline of the driver
   ❑ It might improve the discipline of the driver
   □ No, it will not improve the discipline of the driver

7. Do you think this system will help to collect and monitor the information regarding the police division?
   □Yes ❑No □Uncertain

8. Do you think the system will help to collect and monitor information regarding driving license holders and their traffic offenses?
   □Yes ❑No □Uncertain

9. Any suggestions to improve the application?

…………………………………………………………………………………
…………………………………...……………………………………………
…………………………………...………………………………………….
……………………………………………………………………………...

Table E. 2: Evaluation Questionnaire for Motor Traffic Police

DrivSri Traffic Fine and Point Management System
Evaluation Questionnaire for Driving License Holder

Name:……………………………………………………….

Instructions: Select the following in order of preference.

1. How useful is this application to the Driving License holder?
   □Very useful ❑Partially useful □Not useful

2. Do you think this application will save time in the process of paying fines through e-payment?
   □Yes, it will save time
   ❑ It might save time
   □ No, it will not save time

3. Do you think the point management system will reduce the traffic offenses?
   □Yes ❑ It might □ No

4. Does the system help to monitor your demerit points, license status and payment status?
   □Yes ❑ It might □ No

5. Are you satisfied with the rewarding system?
   □Yes ❑ No □ Need Improvement

6. Any suggestions to improve the application?

………………………………………………………………………………………
………………………………………...……………………………………………
………………………………………………………………………………………
……...
………………………………………………………………………………………
..

Table E. 3: Evaluation Questionnaire for Driving License Holder

Appendix E: MIS Report

DrivSri Traffic Fine and Point Management System generate 5 types of reports as shown in Figure E.1

1. License Holders Report
   This report provides details about the demerit points, license status of the driving license holders. The System Administrator can obtain a list of suspended driving license holders as shown in Figure F.2.

2. Police Division Report
   This report provides information about each police division, the number of police officers and no of issued offenses from the division, and total fine amounts as shown in Figure F.3

3. Fine Type Report
   This report provides the number of offenses issued for each spot fines as shown in Figure F.4. This provides allow the motor traffic police to identify the most common fine and the motor traffic department can take measures to discipline the drivers.

4. Vehicle Class Report
   This report provides the number of offenses issued for each vehicle class as shown in Figure F.5. This allows the Motor Traffic Department to decide what type of vehicle drivers to impose more rules and regulations.

5. Payment Report
   This report provides the total revue from traffic offense that the Motor Traffic Department has generated to the government as Figure 5.5

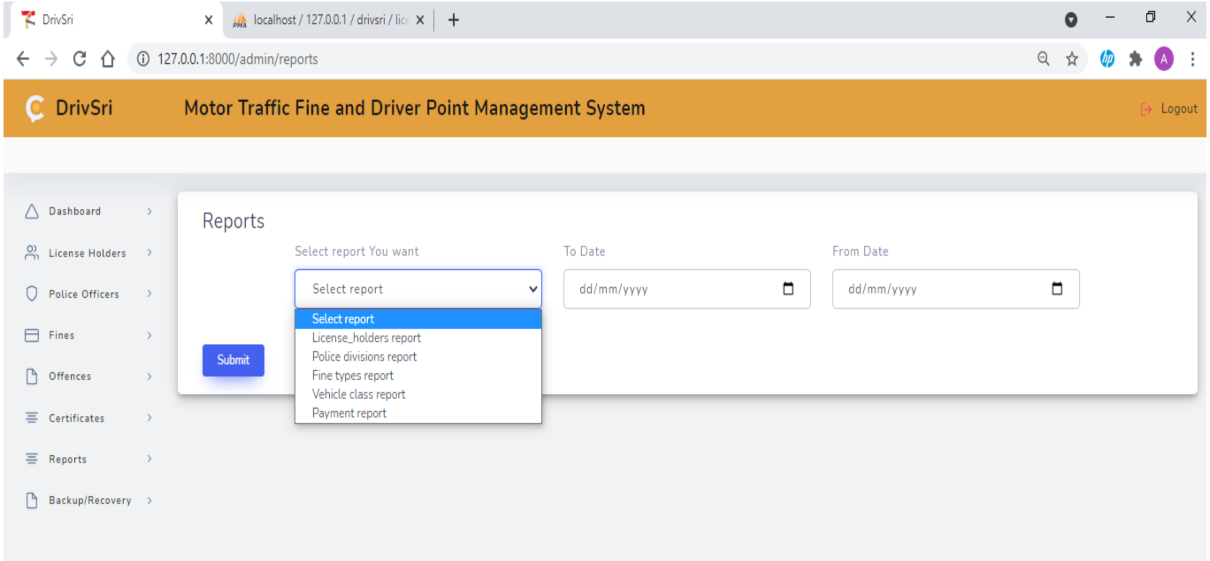
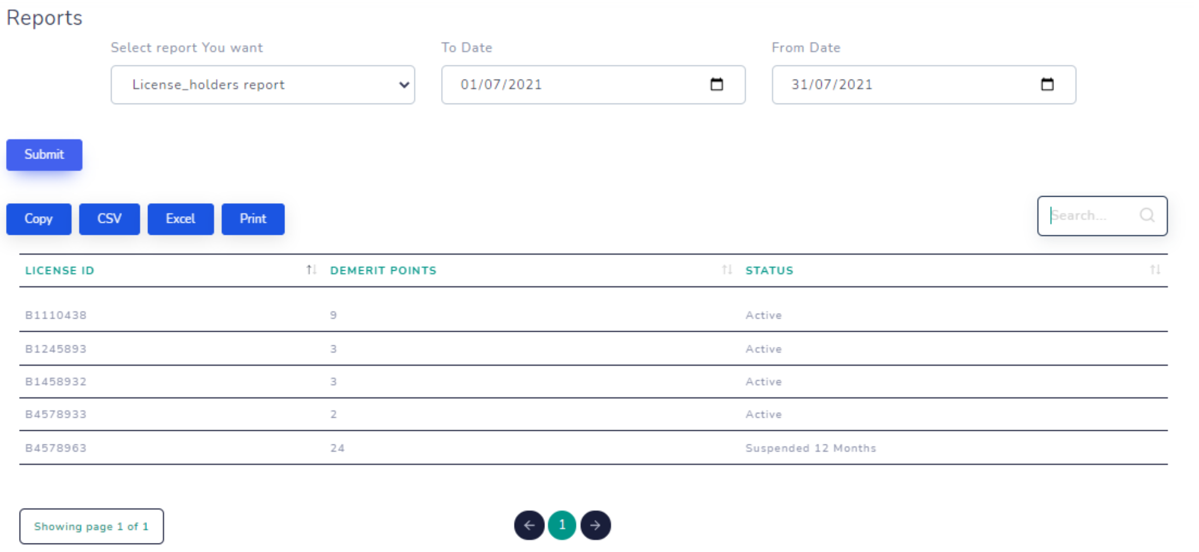


Figure E. 1:DrivSri Reports



Reports

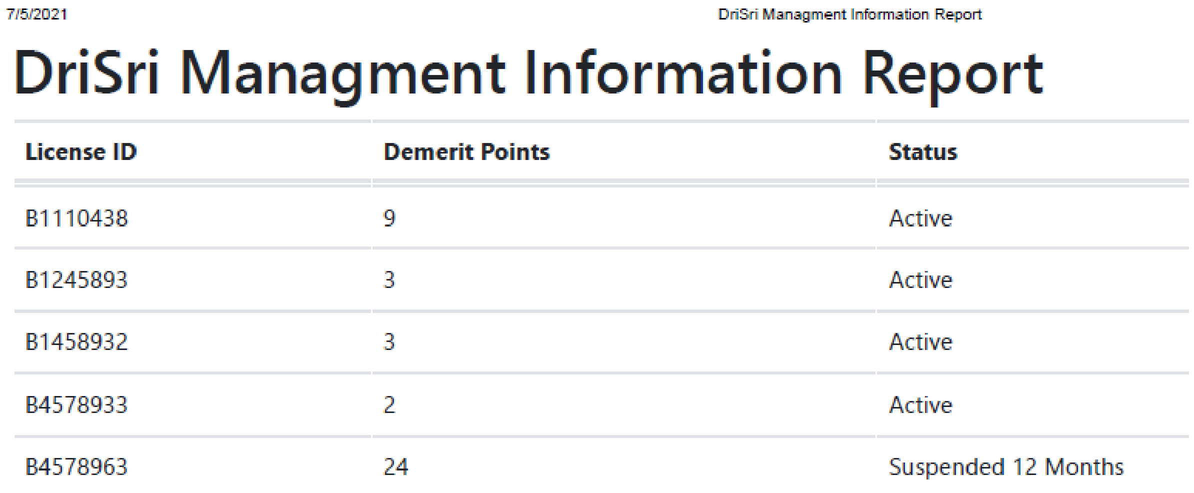
Select report You want: License_holders report

To Date: 01/07/2021

From Date: 31/07/2021

LICENSE ID	DEMERIT POINTS	STATUS
B1110438	9	Active
B1245893	3	Active
B1458932	3	Active
B4578933	2	Active
B4578963	24	Suspended 12 Months

The PDF Output:

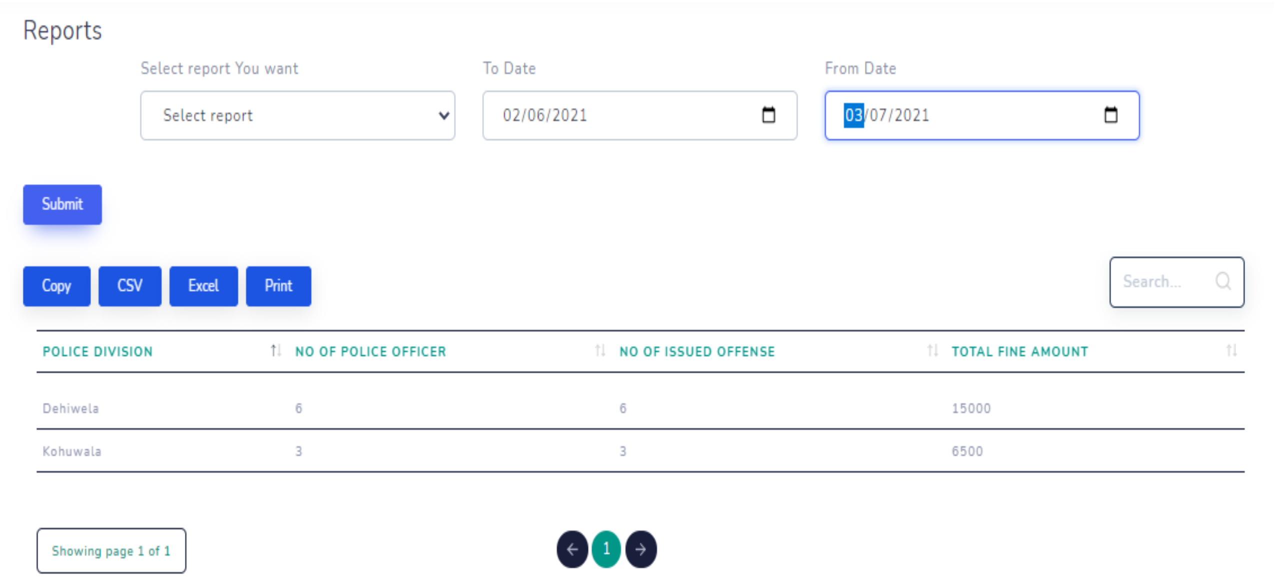


7/5/2021 DriSri Managment Information Report

DriSri Managment Information Report

License ID	Demerit Points	Status
B1110438	9	Active
B1245893	3	Active
B1458932	3	Active
B4578933	2	Active
B4578963	24	Suspended 12 Months

Figure E. 2: License Holders Report

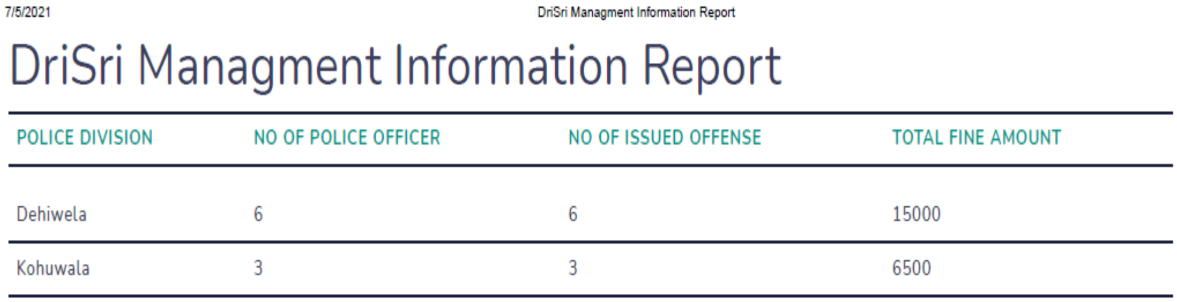


To Date: 02/06/2021

From Date: 03/07/2021

POLICE DIVISION	NO OF POLICE OFFICER	NO OF ISSUED OFFENSE	TOTAL FINE AMOUNT
Dehiwela	6	6	15000
Kohuwala	3	3	6500

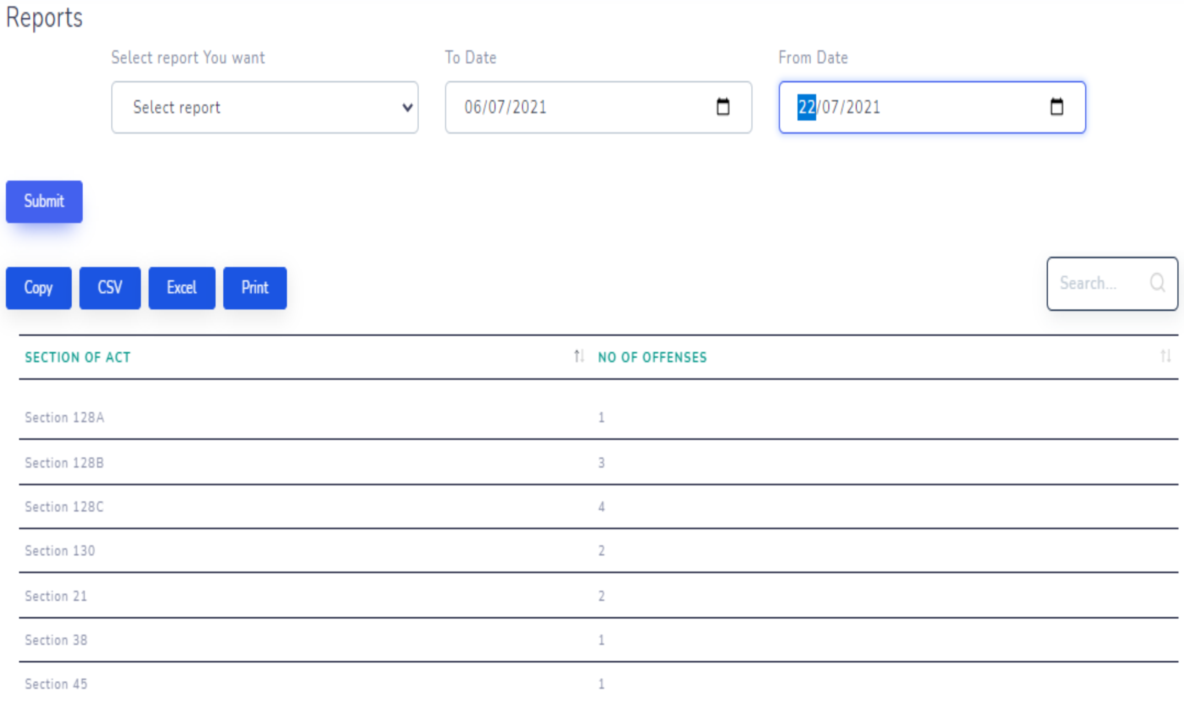
The PDF Output:



DriSri Managment Information Report

POLICE DIVISION	NO OF POLICE OFFICER	NO OF ISSUED OFFENSE	TOTAL FINE AMOUNT
Dehiwela	6	6	15000
Kohuwala	3	3	6500

Figure E. 3: Police Division Reports

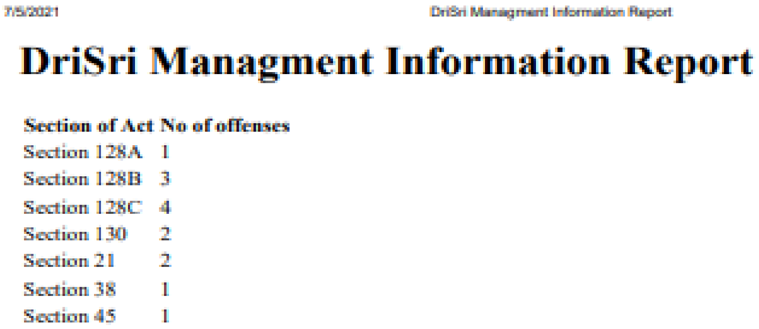


To Date: 06/07/2021

From Date: 22/07/2021

SECTION OF ACT	NO OF OFFENSES
Section 128A	1
Section 128B	3
Section 128C	4
Section 130	2
Section 21	2
Section 38	1
Section 45	1

The PDF Output:

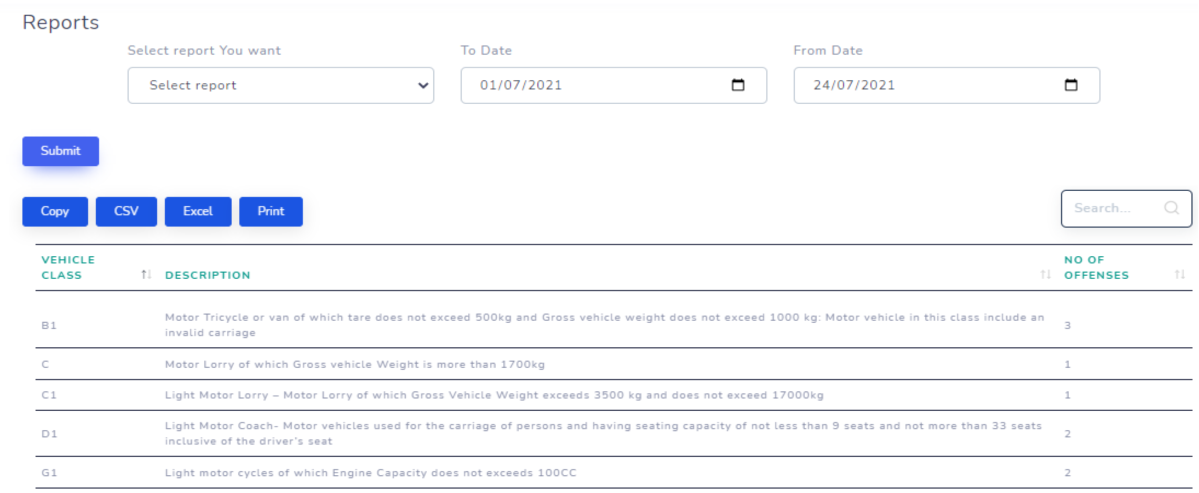


7/5/2021 DriSri Managment Information Report

DriSri Managment Information Report

Section of Act	No of offenses
Section 128A	1
Section 128B	3
Section 128C	4
Section 130	2
Section 21	2
Section 38	1
Section 45	1

Figure E. 4: Fine Reports



Reports

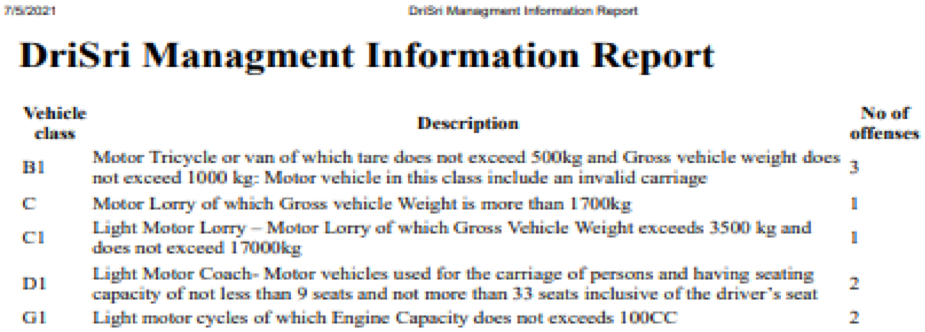
Select report You want: Select report

To Date: 01/07/2021

From Date: 24/07/2021

VEHICLE CLASS	DESCRIPTION	NO OF OFFENSES
B1	Motor Tricycle or van of which tare does not exceed 500kg and Gross vehicle weight does not exceed 1000 kg: Motor vehicle in this class include an invalid carriage	3
C	Motor Lorry of which Gross vehicle Weight is more than 1700kg	1
C1	Light Motor Lorry – Motor Lorry of which Gross Vehicle Weight exceeds 3500 kg and does not exceed 17000kg	1
D1	Light Motor Coach- Motor vehicles used for the carriage of persons and having seating capacity of not less than 9 seats and not more than 33 seats inclusive of the driver's seat	2
G1	Light motor cycles of which Engine Capacity does not exceeds 100CC	2

The PDF Output:

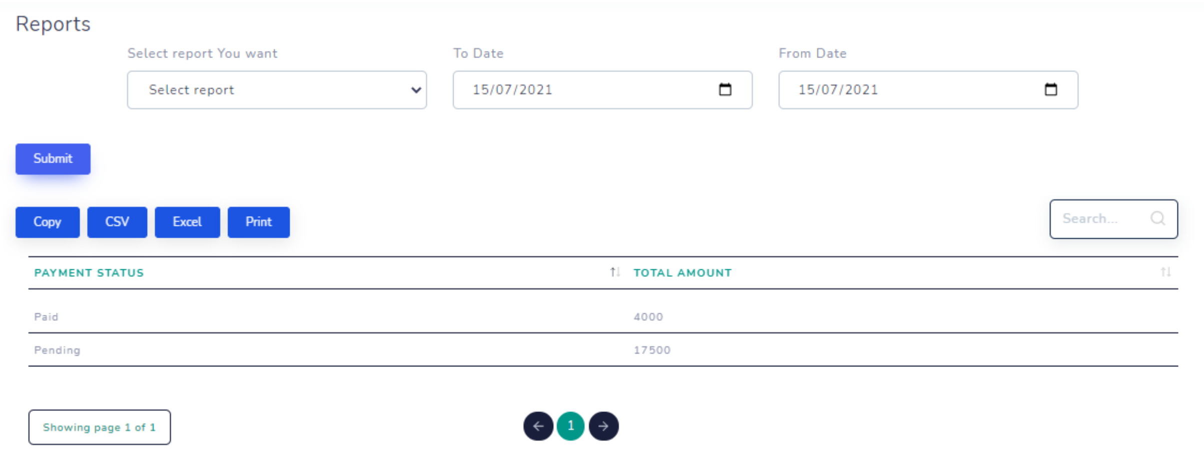


7/5/2021 DriSri Managment Information Report

DriSri Managment Information Report

Vehicle class	Description	No of offenses
B1	Motor Tricycle or van of which tare does not exceed 500kg and Gross vehicle weight does not exceed 1000 kg: Motor vehicle in this class include an invalid carriage	3
C	Motor Lorry of which Gross vehicle Weight is more than 1700kg	1
C1	Light Motor Lorry – Motor Lorry of which Gross Vehicle Weight exceeds 3500 kg and does not exceed 17000kg	1
D1	Light Motor Coach- Motor vehicles used for the carriage of persons and having seating capacity of not less than 9 seats and not more than 33 seats inclusive of the driver's seat	2
G1	Light motor cycles of which Engine Capacity does not exceeds 100CC	2

Figure E. 5: Vehicle Class Report



Reports

Select report You want: Select report

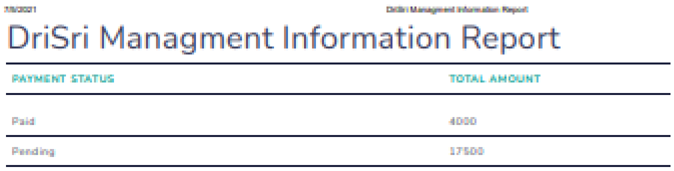
To Date: 15/07/2021

From Date: 15/07/2021

PAYMENT STATUS	TOTAL AMOUNT
Paid	4000
Pending	17500

Showing page 1 of 1

The PDF Output:



7/8/2021 DriSri Managment Information Report

DriSri Managment Information Report

PAYMENT STATUS	TOTAL AMOUNT
Paid	4000
Pending	17500

Figure E. 6: Payment Report

Appendix F: System Manual

Title: Web Based Motor Traffic Fine and Driver Point Management System

Date: 19th July 2021

Version: 1.0

System: Web Application

This documentation provides information for the system administrators, developers and who involve in the system to develop further. Those who would like get the technical information in order to configure and use the system successfully.

Hardware Configuration

- Intel Core i5 Processor
- 8GB RAM
- 250GB Hard Disk Drive
- Monitor 1366 X 768
- Internet connection

Software Configuration

- 64-bit Windows Operating System
- Visual Studio Code
- Laravel 8 with PHP 7.3 and composer
- XAMPP
- Web browser - Internet Explorer/Mozilla Firefox/Google Chrome

Configuration of the pre-requisites

Information related to installation, compilation, and execution details of the system is as below.

Install XAMPP Server 7.4 or higher, Visual Studio Code, Composer

XAMPP Server is an open-source freely available software bundle that contains Apache, MySQL, and PHP. Using XAMPP can configure the system locally with the webserver and database. XAMPP can install on Windows, Linux, or Mac Operating systems.

Steps to configure the system:

1. Download and install XAMPP software
2. Start the XAMPP server
3. Type “localhost/PHPMyAdmin” in a web browser and create database name drivsri
4. Open the project in Visual Studio Code and type the below command to migrate the database all tables
   PHP artisan migrate:fresh –seed

5. Go to the terminal of the Visual Stuido Code and type
   ```
   php artisan serve
   ```
6. Open a web browser and type the following URL http://127.0.0.1:8000/ to view the DriSri Website

Appendix G: User Manual

Login to the System

The user login to the DriSri System by entering the username and password as show in figure G.1.

Login credentials for the System Administator

Email address: admin@admin.com

Password :1111aaaa

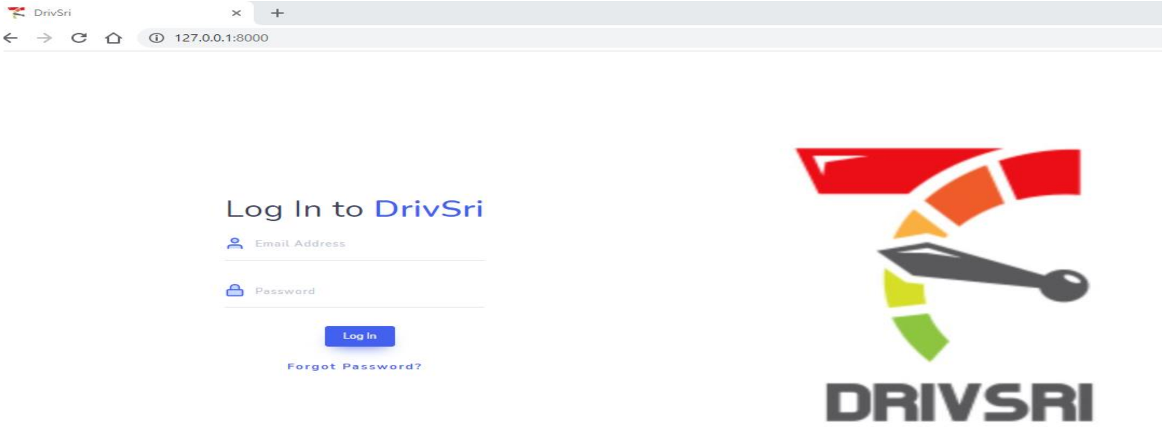


Figure G. 1: Login of DrivSri Website

The system administrator can create the police officer by fill the form in Figure G.2 by entering the details of the police officer including police registration number, police division, email address and personal contact details. All fields need to be filled and cannot be empty.

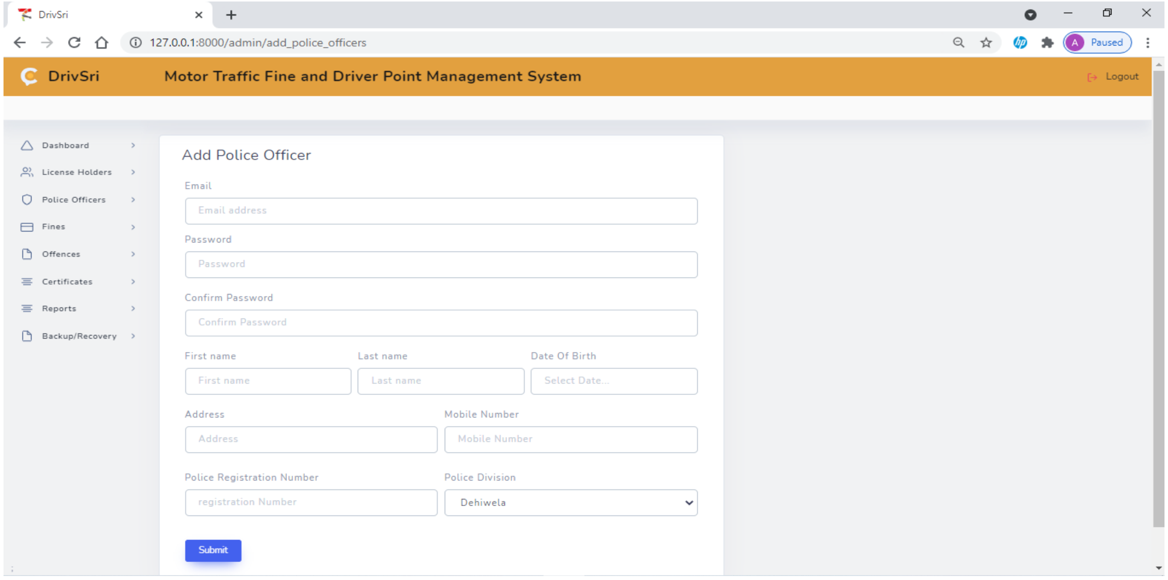
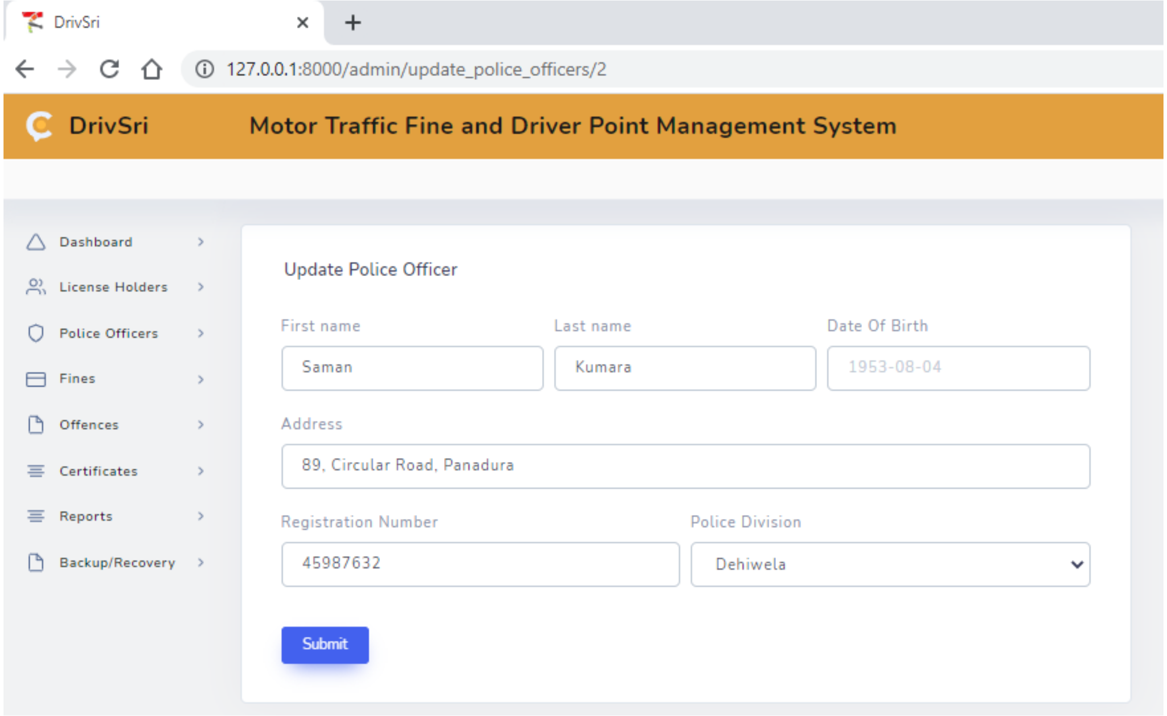


Figure G. 2: Add Policeman Holder Details

The administrator can view, update and delete license holder details by selecting on the left menu police officer/ view. Once the user clicks the update button as show in Figure G.3.



Update Police Officer

First name: Saman
Last name: Kumara
Date Of Birth: 1953-08-04
Address: 89, Circular Road, Panadura
Registration Number: 45987632
Police Division: Dehiwela

Figure G. 3: Update Police Officer

The system administrator can create the license holder accounts by fill the form in Figure G.3 by entering the details of the license holder including license number, email address and personal contact details. All fields need to be filled and cannot be empty.

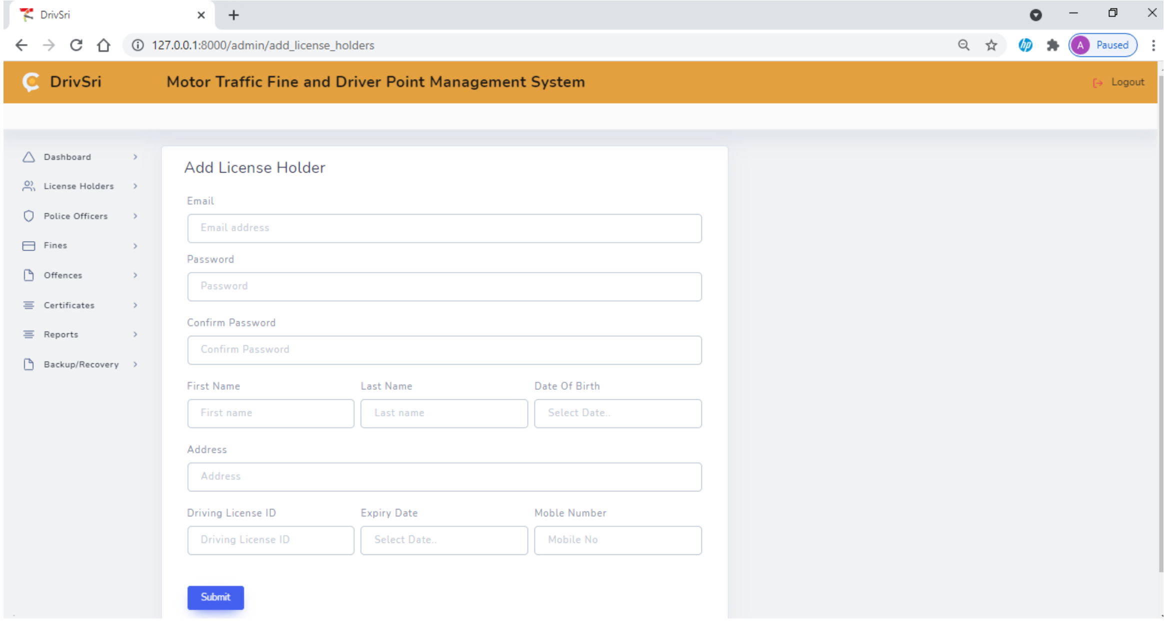
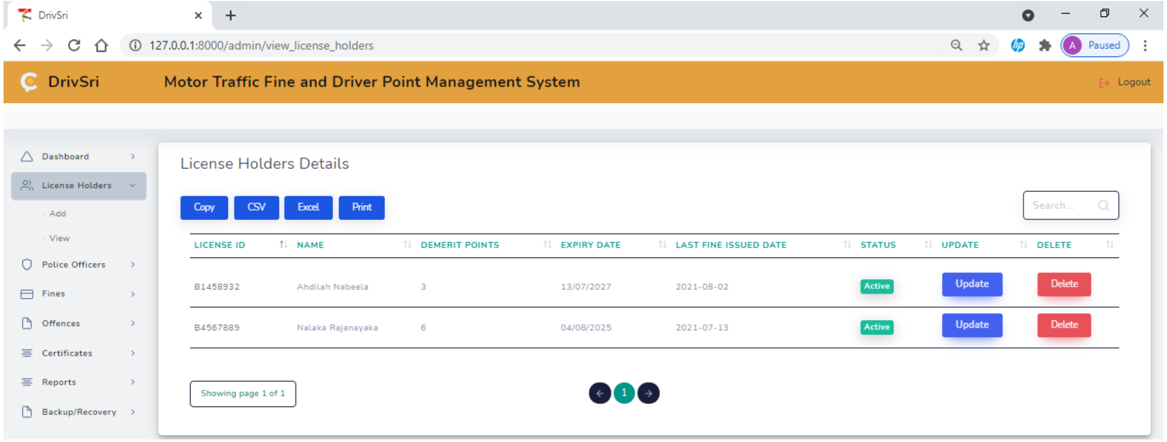


Figure G. 4: Add license holder details

The administrator can view, update and delete license holder details by selecting on the left menu license holder / view

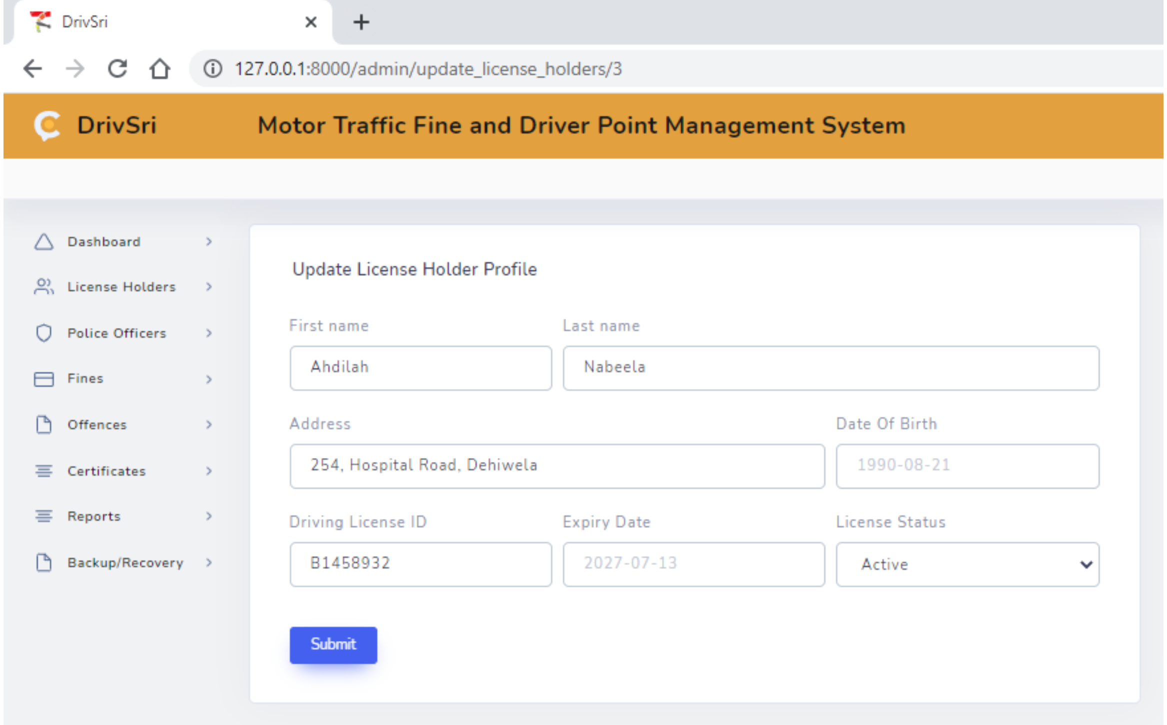


License Holders Details

LICENSE ID	NAME	DEMERIT POINTS	EXPIRY DATE	LAST FINE ISSUED DATE	STATUS	UPDATE	DELETE
B1458932	Ahdilah Nabeela	3	13/07/2027	2021-08-02	Active	Update	Delete
B4567889	Nalaka Rajanayaka	6	04/08/2025	2021-07-13	Active	Update	Delete

Figure G. 5: License Holder Details

When the update button is click the Figure G.6 appears. The system administrator can update name, address, date of birth and driving license ID, expiry date and license holder status.



Update License Holder Profile

First name: Ahdilah

Last name: Nabeela

Address: 254, Hospital Road, Dehiwela

Date Of Birth: 1990-08-21

Driving License ID: B1458932

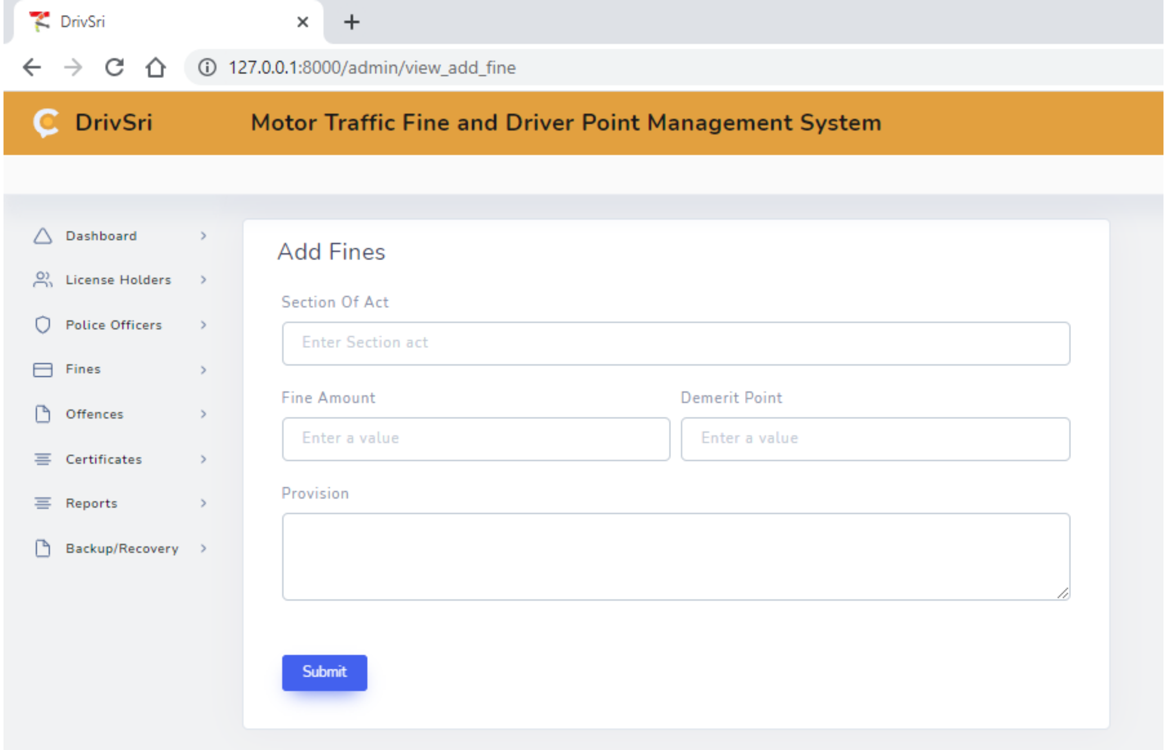
Expiry Date: 2027-07-13

License Status: Active

Figure G. 6: Update License Holder Profile

When the user click on the Delete button of a particular driving license holder in Figure G.6 the details will be deleted.

The System Administrator can add fines to the system by selecting Fine/Add in the Menu as show in Figure G.7 . The administrator need to complete all the fields by fill the section of act, fine amount, demerit points and description/provision to the system and select submit button.



Add Fines

Section Of Act

Enter Section act

Fine Amount

Enter a value

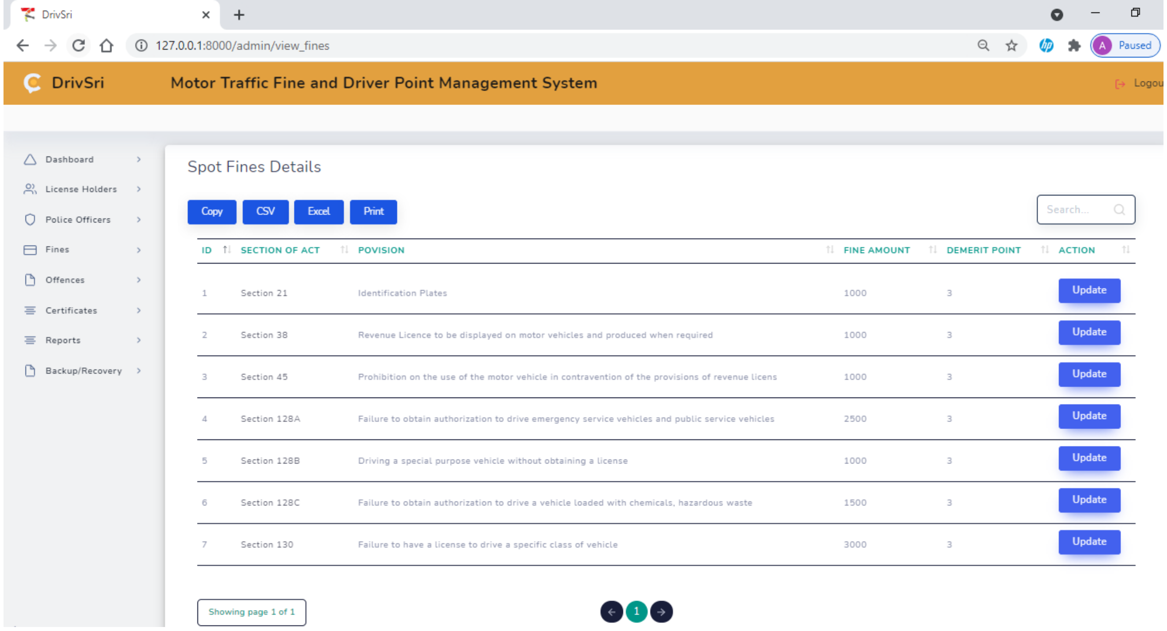
Demerit Point

Enter a value

Provision

Figure G. 7: Add Fines

By selecting Fines/View the system administrator can view the fines and update the fine details as show in Figure G.8



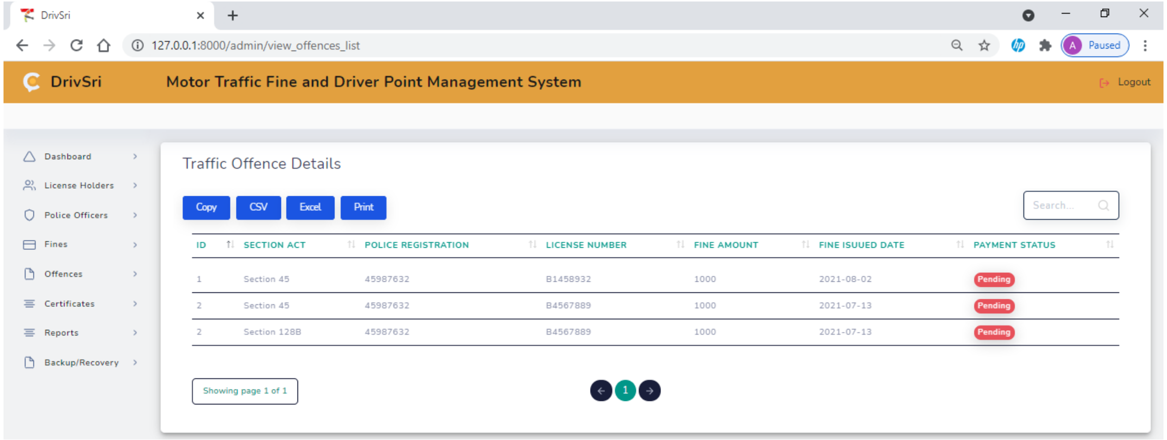
Spot Fines Details

ID	SECTION OF ACT	POVISION	FINE AMOUNT	DEMERIT POINT	ACTION
1	Section 21	Identification Plates	1000	3	Update
2	Section 38	Revenue Licence to be displayed on motor vehicles and produced when required	1000	3	Update
3	Section 45	Prohibition on the use of the motor vehicle in contravention of the provisions of revenue licens	1000	3	Update
4	Section 128A	Failure to obtain authorization to drive emergency service vehicles and public service vehicles	2500	3	Update
5	Section 128B	Driving a special purpose vehicle without obtaining a license	1000	3	Update
6	Section 128C	Failure to obtain authorization to drive a vehicle loaded with chemicals, hazardous waste	1500	3	Update
7	Section 130	Failure to have a license to drive a specific class of vehicle	3000	3	Update

Showing page 1 of 1

Figure G. 8: View/Update Fine details

System Administrator can view offence details as show in Figure G.9. This window provides information about the section of act, registration of police officer, license holder number and fine amount, fine issued date and payment status.

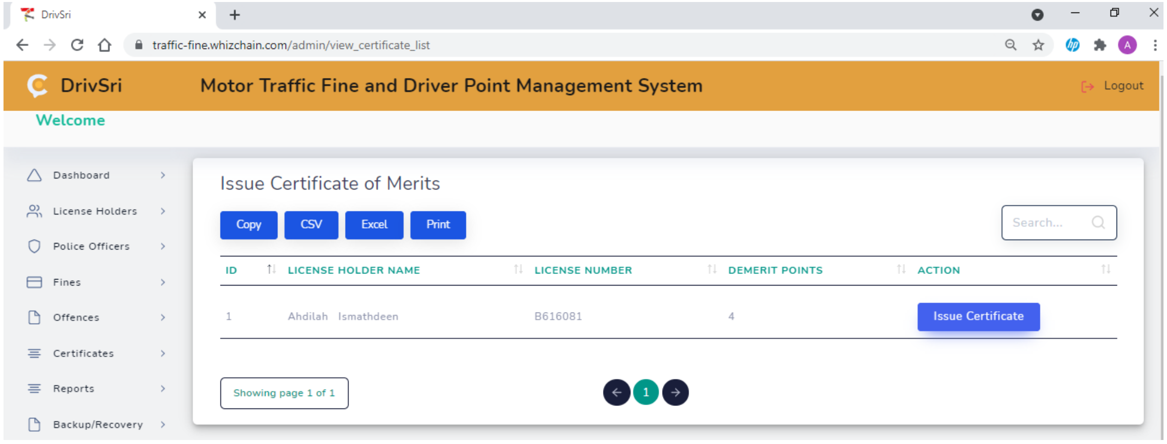


Traffic Offence Details

ID	SECTION ACT	POLICE REGISTRATION	LICENSE NUMBER	FINE AMOUNT	FINE ISUUED DATE	PAYMENT STATUS
1	Section 45	45987632	B1458932	1000	2021-08-02	Pending
2	Section 45	45987632	B4567889	1000	2021-07-13	Pending
2	Section 128B	45987632	B4567889	1000	2021-07-13	Pending

Figure G. 9: Traffic Offence Details

To issue certificate of merit, system administrator click on certificate menu as show in Figure G.10. Once the admin click on "issue certificate" the certificate will be emailed to the license holder's email address.



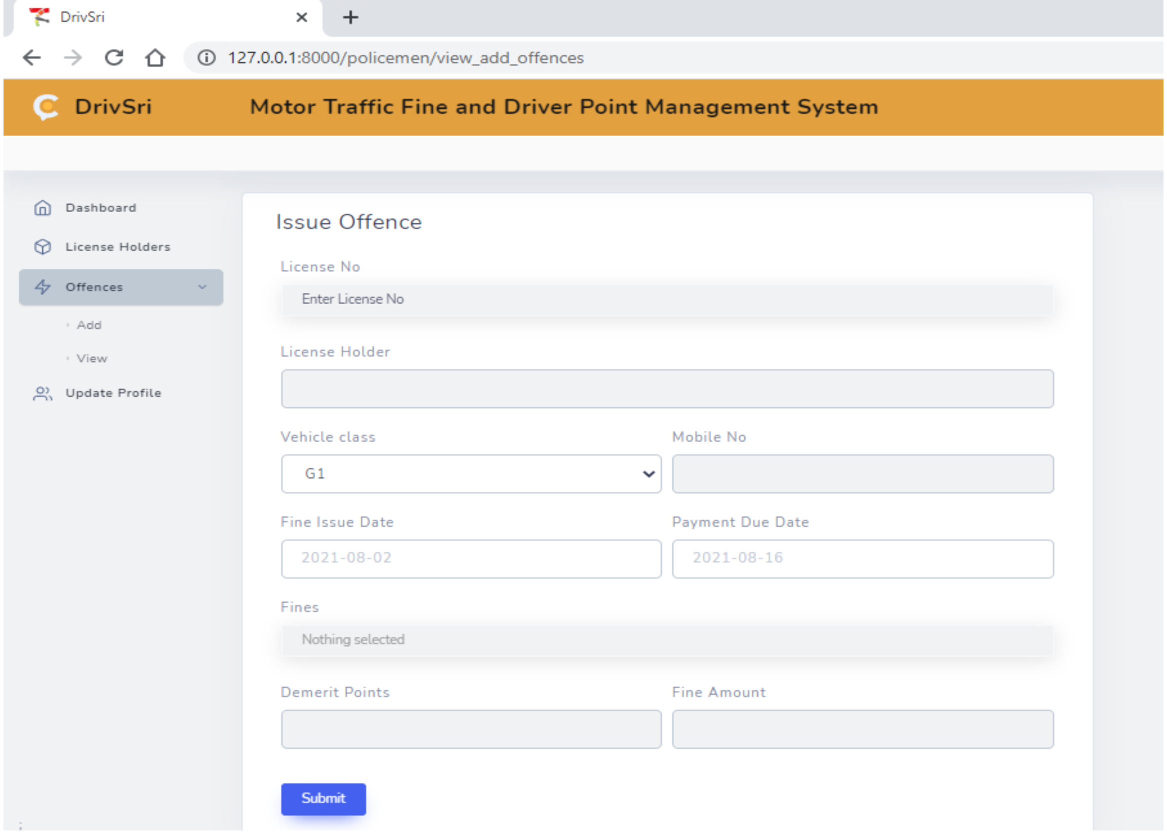
Issue Certificate of Merits

ID	LICENSE HOLDER NAME	LICENSE NUMBER	DEMERIT POINTS	ACTION
1	Ahdilah Ismathdeen	B616081	4	Issue Certificate

Figure G. 10: Issue Certificate of Merit

The police officer login the system using his credentials and issue offence by filling the form in Figure G.11 The police officer selects offences/add menu to issue the offence.

Police officer enters the license No and select the number from the drop down list and enter the vehicle class, and select the fines from the dropdown. The user can select multiple fines. Once the form is completed click on submit.


DrivSri
127.0.0.1:8000/policemen/view_add_offences
DrivSri
Motor Traffic Fine and Driver Point Management System
Dashboard
License Holders
Offences
Add
View
Update Profile
Submit

Issue Offence

License No: Enter License No

License Holder:

Vehicle class: G1

Mobile No:

Fine Issue Date: 2021-08-02

Payment Due Date: 2021-08-16

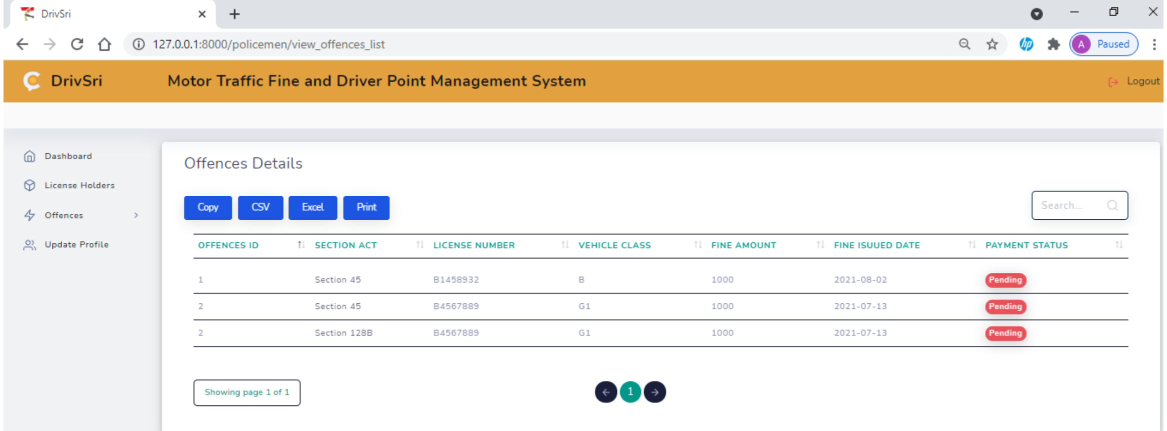
Fines: Nothing selected

Demerit Points:

Fine Amount:

Figure G. 11: Issue Offence

By selecting Offences/View in Figure G.12, police officer can view the details of offence he/she issued.



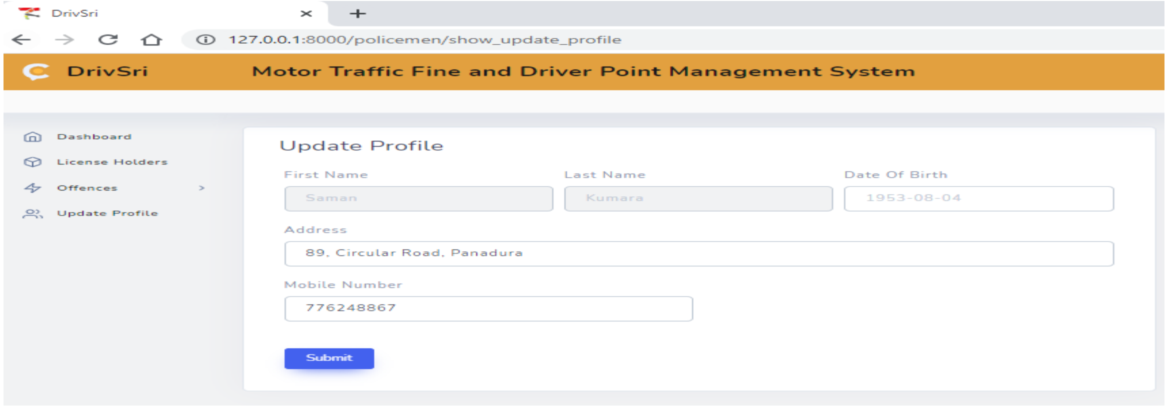
Offences Details

OFFENCES ID	SECTION ACT	LICENSE NUMBER	VEHICLE CLASS	FINE AMOUNT	FINE ISUUED DATE	PAYMENT STATUS
1	Section 45	B1458932	B	1000	2021-08-02	Pending
2	Section 45	B4567889	G1	1000	2021-07-13	Pending
2	Section 128B	B4567889	G1	1000	2021-07-13	Pending

Showing page 1 of 1

Figure G. 12: Offence Details

When the police officer select the Update Profile Menu Figure G.13 will appear and the allowed to update personal details only.

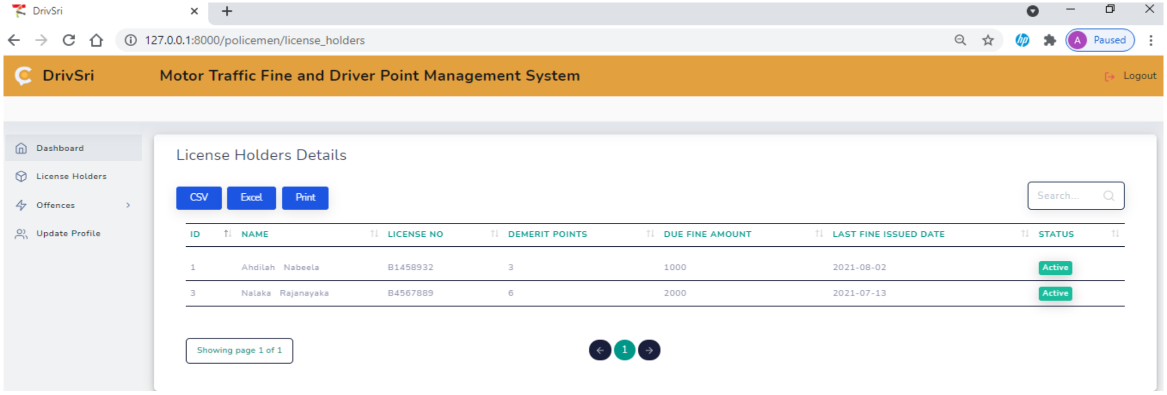

DrivSri
127.0.0.1:8000/policemen/show_update_profile
DrivSri
Motor Traffic Fine and Driver Point Management System
Dashboard
License Holders
Offences
Update Profile
Submit

Update Profile

First Name: Saman
Last Name: Kumara
Date Of Birth: 1953-08-04
Address: 89, Circular Road, Panadura
Mobile Number: 776248867

Figure G. 13: Update Profile

The police officer can view license holders' details as show Figure G.14 before issuing an offence. It provides information about the license holders last fine issue date, license holder status, due fine amount, demerit points.

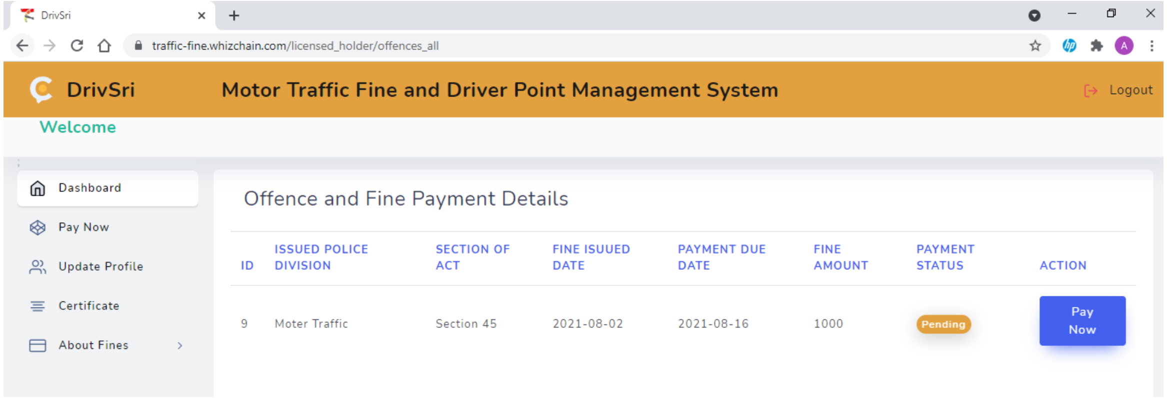


License Holders Details

ID	NAME	LICENSE NO	DEMERIT POINTS	DUE FINE AMOUNT	LAST FINE ISSUED DATE	STATUS
1	Ahdilah Nabeela	B1458932	3	1000	2021-08-02	Active
3	Nalaka Rajanayaka	B4567889	6	2000	2021-07-13	Active

Figure G. 14: License Holders' Details

The license holder login the system using his credentials and click on "Pay Now" Menu. The users offence history will appear. To make the payment the user need to click on the pay now button on the form as show in Figure G.15

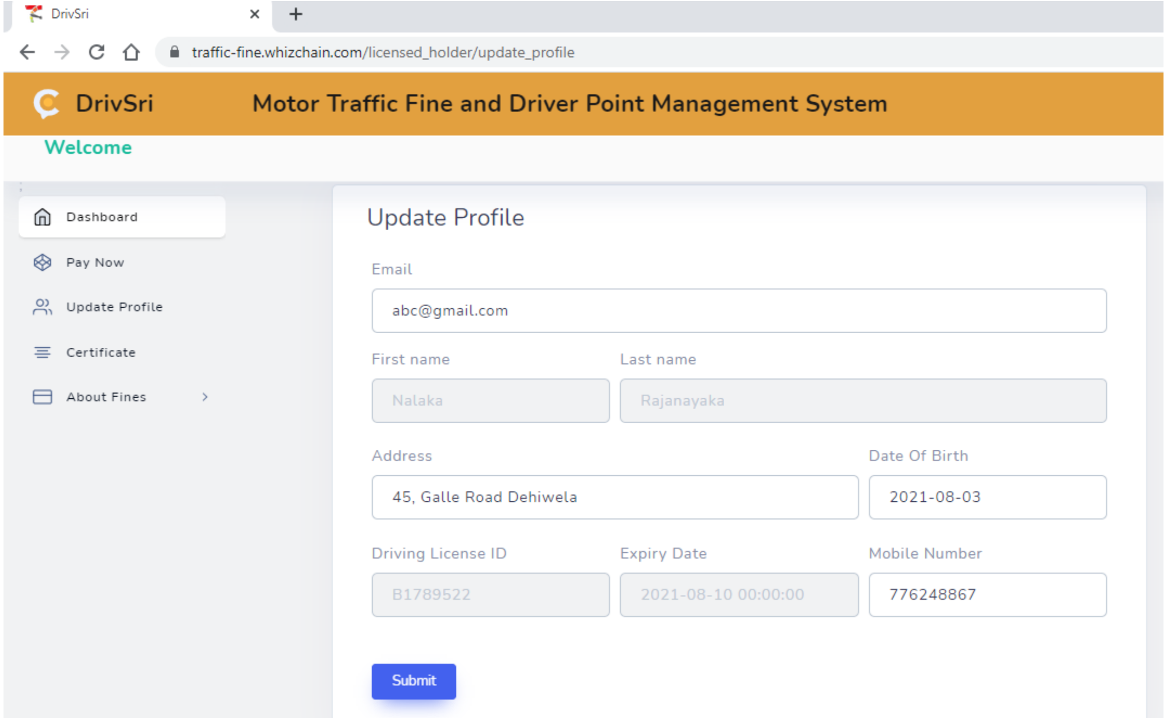

DrivSri
traffic-fine.whizchain.com/licensed_holder/offences_all
DrivSri
Motor Traffic Fine and Driver Point Management System
Logout
Welcome
Dashboard
Pay Now
Update Profile
Certificate
About Fines

Offence and Fine Payment Details

ID	ISSUED POLICE DIVISION	SECTION OF ACT	FINE ISUUED DATE	PAYMENT DUE DATE	FINE AMOUNT	PAYMENT STATUS	ACTION
9	Moter Traffic	Section 45	2021-08-02	2021-08-16	1000	Pending	Pay Now

Figure G. 15: Offence and Fine Payment Details

License holder can update the personal details by selection “Update Profile” on the Menu as show in Figure G.16.


DrivSri
traffic-fine.whizchain.com/licensed_holder/update_profile
DrivSri
Motor Traffic Fine and Driver Point Management System
Welcome
Dashboard
Pay Now
Update Profile
Certificate
About Fines
Submit

Update Profile

Email: abc@gmail.com

First name: Nalaka

Last name: Rajanayaka

Address: 45, Galle Road Dehiwela

Date Of Birth: 2021-08-03

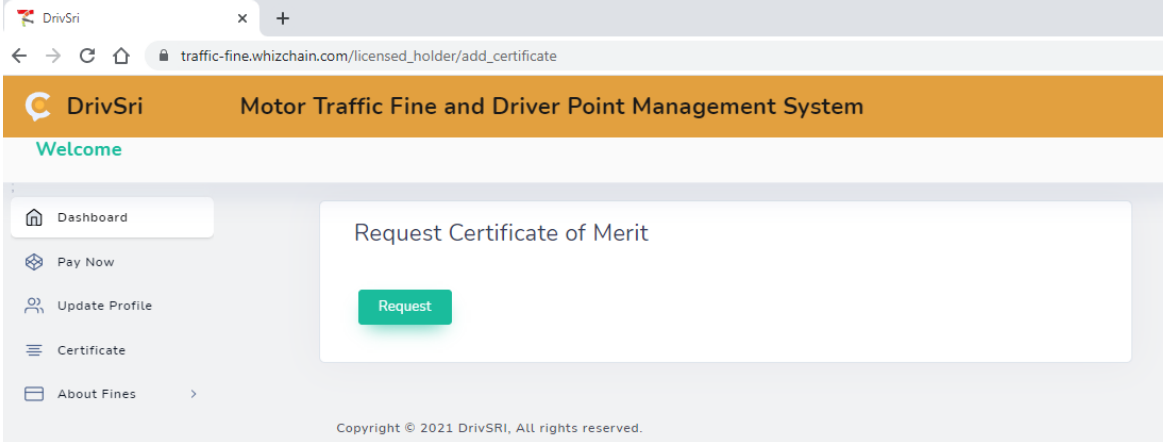
Driving License ID: B1789522

Expiry Date: 2021-08-10 00:00:00

Mobile Number: 776248867

Figure G. 16: Update Profile

The license holder “Certificate” to request a certificate of Merit as show in Figure G.17.


DrivSri
traffic-fine.whizchain.com/licensed_holder/add_certificate
DrivSri
Motor Traffic Fine and Driver Point Management System
Welcome
Dashboard
Pay Now
Update Profile
Certificate
About Fines
Request

Request Certificate of Merit

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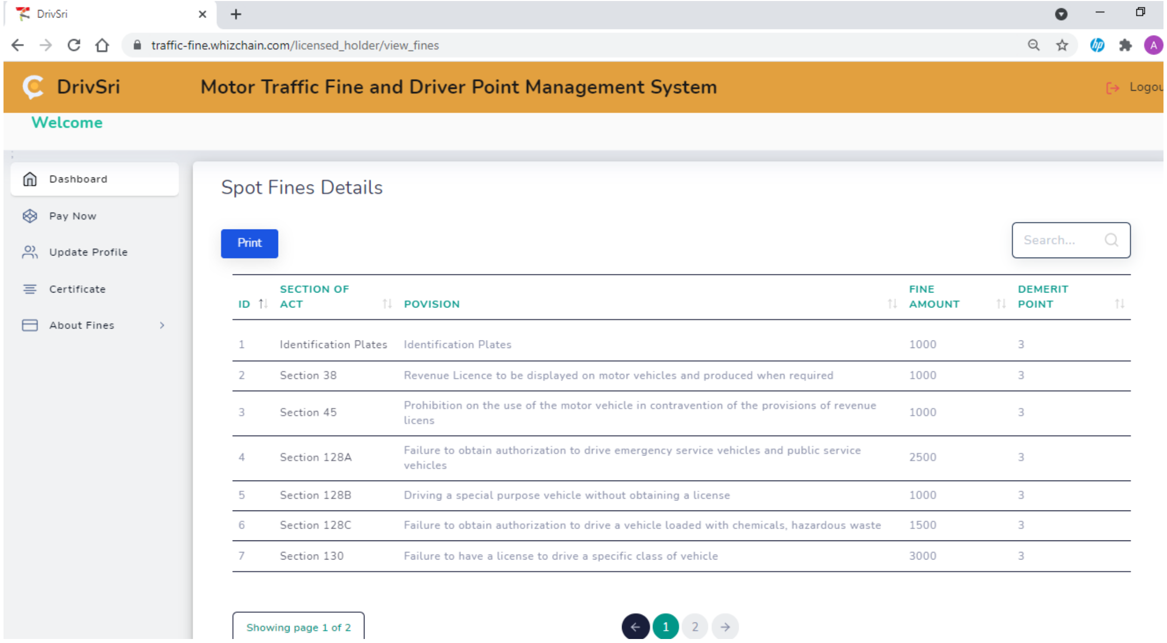
Figure G. 17: Request Certificate of Merit

Also can view the fine details by click on “About Fine” as show in Figure G.18.



Spot Fines Details

ID	SECTION OF ACT	POVISION	FINE AMOUNT	DEMERIT POINT
1	Identification Plates	Identification Plates	1000	3
2	Section 38	Revenue Licence to be displayed on motor vehicles and produced when required	1000	3
3	Section 45	Prohibition on the use of the motor vehicle in contravention of the provisions of revenue licens	1000	3
4	Section 128A	Failure to obtain authorization to drive emergency service vehicles and public service vehicles	2500	3
5	Section 128B	Driving a special purpose vehicle without obtaining a license	1000	3
6	Section 128C	Failure to obtain authorization to drive a vehicle loaded with chemicals, hazardous waste	1500	3
7	Section 130	Failure to have a license to drive a specific class of vehicle	3000	3

Figure G. 18: Fine Details