

**MAKERERE**



**UNIVERSITY**

**COLLEGE OF COMPUTING AND INFORMATION  
SCIENCES**

**SOFTWARE REQUIREMENTS SPECIFICATION  
FOR  
TRAFFIC LIGHTS COMPLIANCE AND PENALTY  
SYSTEM**

**Version 1.0 approved**

**Prepared by**

<b>NAME</b>	<b>REGISTRATION NUMBER</b>	<b>STUDENT NUMBER</b>
NAKIBINGE BONNY	19/U/12552/PS	1900712552
KATEMBEKO CHRISTOPHER	19/U/24692/PS	1900724692
OTIM DERRICK MURUNGI	19/U/12613/PS	1900712613
NSUBUGA ALPHA FRANCIS	19/U/8652/EVE	1900708652

**Traffic lights Police Department.**

**5th December, 2022**

<b>Name</b>	<b>Date</b>	<b>Reason For Changes</b>	<b>Version</b>
			1.0

## Table of Contents

1. Introduction .....	4
1.1 Purpose .....	4
1.2 Document Conventions .....	4
1.3 Intended Audience and Reading Suggestions .....	5
1.4 Product Scope .....	6
1.5 References .....	7
2. Overall Description.....	8
2.1 Product Perspective .....	8
2.2 Product Functions.....	8
2.3 User Classes and Characteristics .....	9
2.4 Operating Environment .....	10
2.5 Design and Implementation Constraints .....	10
2.6 User Documentation .....	10
2.7 Assumptions and Dependencies .....	11
3. External Interface Requirements .....	11
3.1 User Interfaces .....	11
3.2 Hardware Interfaces .....	11
3.3 Software Interfaces.....	13
3.4 Communications Interfaces .....	13
4. System Features.....	14
4.1 Number Plate Capture and Scan. ....	14
4.2 Database License Match. ....	15
4.3 Driver Penalty and Notification feature.....	16
5. Other Nonfunctional Requirements .....	17
5.1 Performance Requirements .....	17
5.2 Safety Requirements .....	18
5.3 Security Requirements .....	18
5.4 Software Quality Attributes .....	18
5.5 Business Rules.....	18
6. Other Requirements.....	19
6.1 Appendix A: Glossary .....	19
6.2 Appendix B: Analysis Models.....	20

6.3 Appendix C: To Be Determined List.....	21
--	----

## **Table Of Figures**

<i>Fig 1: Simple Product Architecture.</i> .....	4
<i>Fig 2: Three-Dimensional Representation of The Traffic Lights Compliance and Penalty System</i> .....	8
<i>Fig 3: A raspberry pi camera to capture images.</i> .....	12
<i>Fig 4: Sensor embodied on its board to sense the position of the cars</i> .....	12
<i>Fig 5: Arduino UNO board.</i> .....	12
<i>Fig 6: Phone interface to control the traffic lights system.</i> .....	13
<i>Fig 7: Data flow diagram of the TLCP system.</i> .....	20
<i>Fig 8: Business Process Management Diagram for the TLCP system.</i> .....	21

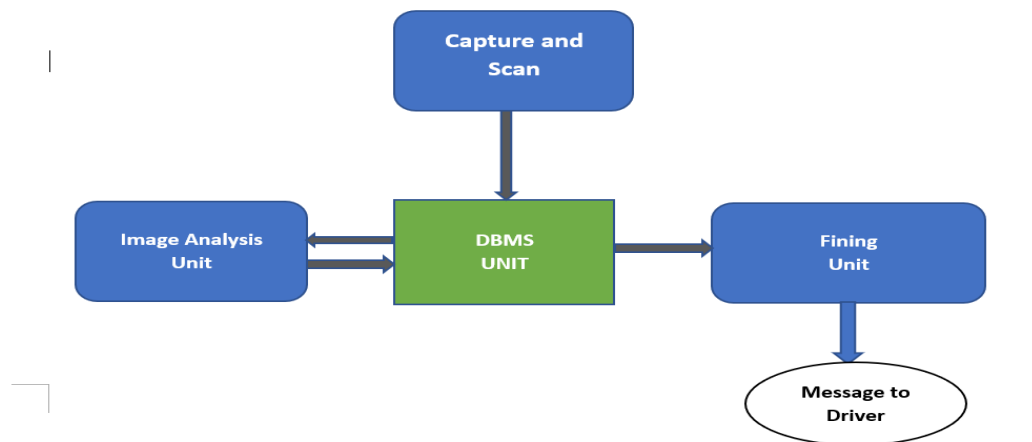
# 1.Introduction

## 1.1 Purpose

The Traffic Lights Compliance and Penalty System (TLCPS) is an automated addition system to the already existing system of traffic lights. The system is going to help traffic officers simplify their work of capturing and fining road users that are violating the traffic lights.

The SRS will be for a single subsystem that will work with the already existing traffic lights system and camera system. The main system of the Traffic lights sets the vehicles at the junctions to move or stop when lights are green and red respectively.

Therefore, the TLCPS subsystem is working hand in hand with that current system to capture and record videos and images of the vehicles to identify what drivers have violated the traffic lights then it will penalty the vehicle owners that have been identified automatically and notify them by sending the messages.



*Fig 1: Simple Product Architecture.*

## 1.2 Document Conventions

The document is compiled and typed using the following fonts and styles:

The text style used is Times New Roman, font size 12pt.

The main headings are styled in Heading 1 and in bold style, font size 22pt.

The sub-headings are styled in Heading 2 and in bold style, font size 18pt.

The line spacing is 1.5 lines.

## 1.3 Intended Audience and Reading Suggestions

The SRS is intended to be used by developers, documentation writers, project managers, traffic officers and their roles are described below:

**Documentation writers:** They monitor and maintain document management of the system and work with the developers, engineers, project managers to write the whole documentation about the system.

**Developers:** They are specialists who oversee the operations of the project by carrying out research and development plans that are tailored to the project's requirements.

**Project managers:** they are responsible for overseeing the whole project by carrying out activities which include planning, Organizing, leading the development team, implementing the project, and analyzing the project with its budget.

**Traffic officers:** The Traffic Officers are the individuals that are responsible for overseeing the way roads and traffic lights are used. They interact with the system interface to ensure that the system is functioning properly.

**Testers:** They are skilled individuals that execute and log the tests on the system to evaluate the results and document problems found for repair.

### The SRS has the following sections:

**The Overview section:** describes the whole system and what it will deliver to the users and how it will deliver its services.

**External interface requirements:** describe the system's interaction with the environment in terms of the hardware interface, software interface, user interface and the communication of the system.

**System Features:** the section basically looks at what the system contains and what it should do.

**Other non-functional requirements Section:** this section looks at the functions of the system that constrain the functional requirements. Constraints such as time are considered.

**Other requirements:** this section looks at the terms used in the SRS and what they mean to the System.

## 1.4 Product Scope

### Description

The TLCPS will contain mainly three modules and these are the Capture and Scan license plate, fining module and the Database License match module.

#### **The Capture and Scan License plate:**

This module will enable detecting cars violating the traffic light signals. The license plates are captured and scanned through optical character recognition. In such situations, the system will observe car movements, take images of the car positioning and capture their designated number plates and transform them into text.

#### **Fining and notifying:**

This module uses the output of the previous module, and gives a penalty to the corresponding number plate. It will also notify the given number plate owner about the penalty issued.

#### **Database License Match:**

This module also uses the output of the capture and scan license module, and obtains the car owner's details for example the name and telephone number to be used in the fining and notifying module.

### Goals and Objectives

1. To reduce road accidents along junctions
2. To reduce the rates of traffic along the road junctions through drivers complying with the traffic light signals.
3. To create evidence for traffic light signal violators.

### Benefits

1. The product will reduce the traffic officer burdens in chasing the drivers that have escaped the traffic lights.
2. The product is beneficial to pedestrians as well because it discourages noncompliance of the drivers to traffic lights thus bringing about more safety on the road.

3. Due to the fact that the product issues penalties to the violating drivers, it can be beneficial to the government since the penalties are used to run the activities of the government such as road repairs and maintaining the system function.

## 1.5 References

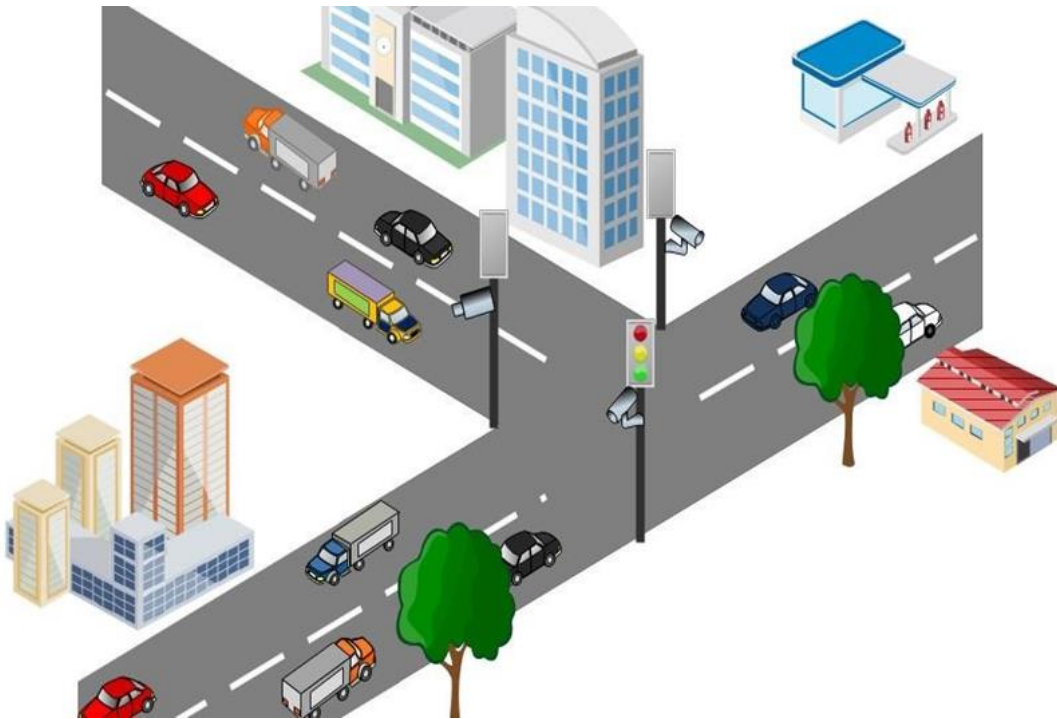
- [1] H. Singh and A. Kathuria, " "Analyzing driver behavior under naturalistic driving conditions: A review," *Accident Analysis & Prevention*,," 2021. [Online]. [Accessed 07 12 2022].
- [2] R. S. a. A. S. A. Rakotonirainy, ""Three social car visions to improve driver behavior," in *Pervasive and mobile computing*, vol. 14,, 2014., pp. 147-160.
- [3] M. A.-A. J. Y. Z. C. a. J. L. Y. Li, "Analyzing traffic violation behavior at urban intersections," in *Accident Analysis & Prevention*,,, 2020, p. 141.
- [4] S. Gaur and S. Singh, "Automatic Car License Plate Detection System for Odd and Even Series,," in *International Journal of Computer Applications*, 2016, pp. vol. 150,.
- [5] H. Saghaei, "Proposal for automatic license and number plate recognition system for vehicle identification,," 2016..
- [6] R. Fu, "The research and design of vehicle license plate recognition system in traffic management system,," in *International Journal of Signal Processing, Image Processing and Pattern Recognition*,, 2016, pp. pp. 445-456,.
- [7] O. A. a. A. F. D. Amusan, "Nigerian Vehicle License Plate Recognition System using Artificial Neural Network," in *International Journal of Advanced Research in Computer and Communication Engineering*,, 2015, pp. pages1-5..
- [8] N. D. Agrawal and A. Sahu, "Intelligent Real-Time Traffic Controller Using Image Processing—A Survey,," in *International Journal of Science and Research (IJSR) ISSN (Online)*,, 2015, pp. pages. 2319-7064,.
- [9] D. P. C. a. V. G. G. P. Arya, "Design and implementation of traffic violation monitoring system,," in *Int J Comput Sci Inf Technol*,, , "" vol. 6, no. 3, 2015. , 2015, pp. pages. 2384-2386,.

[10] H. M. C. K. a. W. H. S. Wong, ""Developing advanced traffic violation detection system with RFID technology for smart city,"" IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), 2017. [Online]. [Accessed 09 12 2022].

## 2. Overall Description

### 2.1 Product Perspective

This system is not much of a groundbreaking innovation as it is a complement to the already existing traffic lights system that is already being used in various parts of the country. Hence it is a new self-contained product that is meant to enhance law enforcement in the area of traffic through capturing and fining drivers and riders that violate the traffic rules and regulations.



*Fig 2: Three-Dimensional Representation of The Traffic Lights Compliance and Penalty System*

### 2.2 Product Functions

The users of this system will be Traffic Officers on the ground and the Traffic Coordinator in the control room. The stated users have different functions they require from the system and these are listed below;

**Traffic Officers**



The traffic officer shall be able to login to the system therefore the system shall facilitate the login.

The traffic officers shall be able to request for deactivation or reactivation of the system depending on the suitability of the current traffic situation implying the system shall facilitate state for the officer to control the traffic.

The traffic officers shall be able to view the details of a traffic offender therefore the system shall have an interface to display the details from the database.

### **Traffic Coordinator**

The traffic coordinator shall be able to deactivate or reactivate the system at the behest of the Traffic Officers on the ground therefore the system shall possess a hardware component for turning the system off.

The traffic coordinator shall be able to view footage at the traffic lights therefore the system shall collect all the video recordings from the camera for the traffic coordinator's review.

## **2.3 User Classes and Characteristics**

User	Characteristics
Traffic Officers	<ul style="list-style-type: none"><li>• The traffic officers enforce the fining functionality of the system.</li><li>• Basic level knowledge on how to use a smartphone.</li><li>• No experience or technical expertise is required.</li></ul>
Traffic Coordinator	<ul style="list-style-type: none"><li>• The traffic coordinator overlooks the general functioning of the system.</li><li>• He/she requires technical expertise.</li></ul>

## 2.4 Operating Environment

The system shall operate in the free world environment regardless the weather conditions such as Rain, sunshine, dust etc that are available.

**The hardware platforms that are intended for the system include:**

- Arduino board.
- Raspberry pi board.
- Sensor boards.

**The software platform where the system shall be operating include:**

- Python
- Html, Css, Js
- C or C++ for the Arduino board.

Other software that will be used is the Optical Character Recognition (**OCR**) to identify the characters from the license plates.

## 2.5 Design and Implementation Constraints

**The driver involvement:**

However much the system is about the traffic lights used by the drivers, drivers' interface is not included in the system. They just have to be aware of the system.

**Working time of the system.**

The system must operate only if the traffic officers are not on ground. Therefore the designers will have to consider turning off the system incase an officer is controlling the junction.

**Character Recognition**

The system must be able to accurately recognize the characters from the license plate image captures.

## 2.6 User Documentation

**User manual:** A comprehensive guide that provides detailed instructions for using all features and functions of the device.

**Training facilities:** Materials, such as video tutorials on the YouTube to assist the developers on how the system was designed and for the users to provide knowledge on how the system works.

**On-line help:** a feature that provides guidance on the system function to the user incase the fail to operate the system.

## 2.7 Assumptions and Dependencies

The sub system depends on the traffic lights system that controls the traffic lights colours. (Red, green, yellow).

The system assumes that the roads contain a line that a car shouldn't exceed at a red light.

The system is assumed to be non-functional in case a traffic officer is on ground therefore it should not capture anyone.

The system assumes that car owners are all registered with their corresponding contact details.

## 3.External Interface Requirements

### 3.1 User Interfaces

A login interface that contains a form containing fields like name, officer number, password for the traffic officers to login.

A form dialog displaying the details of the person that violated the traffic lights offence.

A button containing **OFF** that will turn off the system in case a traffic officer is on ground.

An **ON** that will turn the system back on when the system is needed to run and capture those violating the rules.

A Log out button that will help the traffic officer to navigate out of the system after accomplishing the tasks.

### 3.2 Hardware Interfaces

This software product will consist of a system that will be hosted on a Personal Computer. Hence the user will need to have a Personal Computer with a good keyboard and mouse that will enable him/her to navigate the system's interface and thus properly use the system itself.





*Fig 6: Phone interface to control the traffic lights system.*

## 3.3 Software Interfaces

### Software interfaces:

Python

Arduino software IDE. Ie C/C++

Html, CSS, JS

### Database:

SQL queries.

### Operating System:

Windows

### Libraries and tools

Tensor flow

JDBC manager.

## 3.4 Communications Interfaces

The system shall communicate to the violating drivers through a network called C which is used for texting. It performs by sending text-only messages of up to 160 characters to violating driver phones.

## 4.System Features

### 4.1 Number Plate Capture and Scan.

#### 4.1.1 Description and Priority

Capture number plate is a feature in which the camera will operate in case the sensor has identified that there is a violating vehicle at red lights. The camera is positioned in a position to capture the license plate of the vehicle and store it partially for scanning in order to obtain the digits on it. This feature is of high priority because it provides the image of the license plate where the number is scanned.

#### 4.1.2 Stimulus/Response Sequences

<b>Use case:</b>	Capture and scan the number plate.
<b>ID:</b>	<b>001</b>
<b>Brief Description:</b>	The capture and scan license plate are to take a photo of the number plate and save it as an image such that it can be scanned to obtain its number.
<b>Primary Actors</b>	Camera
<b>Secondary Actors</b>	Vehicle Drivers.
<b>Preconditions</b>	The vehicle should must have exceeded the specified dimensions after the traffic lights turn red
<b>Main Flow</b>	<ol style="list-style-type: none"><li>1. The vehicle in motion is sensed by the sensor to obtain its position.</li><li>2. If the light is red and the vehicle is in motion, the license plate is captured by the camera.</li><li>3. The captured image is saved in the system and by use of optical character recognition, the number is scanned from the plate and saved as a sequence of figures and letters.</li></ol>
<b>Post conditions</b>	The system saves the sequence of letters and digits in the database.
<b>Alternative Flow</b>	If the vehicle remains in its position at red light, the system (camera ) doesn't take the shot of the license plate.

<b>Business rules</b>	They capture image should be very clear for scanning in order to obtain the right digits on the photo
-----------------------	---

### 4.1.3 Functional Requirements

NPCS 1: The system shall capture the number plate of the violating vehicle with the help of the camera.

NPCS 2: The system shall scan the image captured in order to obtain the figures on the license plate.

NPCS 3: The system shall be able to detect the motion of the vehicle at red lights using the sensors.

## 4.2 Database License Match.

### 4.2.1 Description and Priority

The Database license match is a module of the system that will make use of the scanned number from the image of the violating car's plate and match it with the corresponding details that are stored in the database in order to identify the owner of the vehicle and their corresponding details. The Database license match module is of a high priority to the system because it will help us identify the individuals that are related to the license plate number captured such that we get to know who to penalty.

### 4.2.2 Stimulus/Response Sequences.

<b>Use case:</b>	Match number.
<b>ID:</b>	<b>002</b>
<b>Brief Description:</b>	The number match is a purpose of the system that helps the system to match the scanned number to similar details in the database to identify who the violating owner is.
<b>Primary Actors</b>	Sql query match
<b>Secondary Actors</b>	Scanner using OCR technology.
<b>Preconditions</b>	The license number to be matched must have been scanned form the image.
<b>Main Flow</b>	1. After the license number has been scanned and saved.

	<p>2. The database collects the pattern for matching using the SQL query that helps to match the scanned number to the corresponding details of the owners in the same database.</p> <p>3. The details are then displayed.</p>
<b>Alternative Flow</b>	If the number is not identified in the database. The system assumes that the number is forwarded to the inspector for review.

#### 4.2.3 Functional Requirements

DLM 1: The system shall match the scanned number from the image with the equivalent details in order to identify the offending driver's details.

DLM 2: the system shall send notification of the penalty that has been attached to the violating driver.

### 4.3 Driver Penalty and Notification feature.

The Driver fining and notification feature is the last part of the system which is responsible for obtaining the details of the captured violating driver and assigning a fee to them. It not only assigns a fee but also notifies the driver of the vehicle of the assigned fee through the messaging system. The feature is of high priority because it accomplishes the main purpose of the product.

#### 4.3.2 Stimulus/Response Sequences

<b>Use case:</b>	Fining and notification.
<b>ID:</b>	<b>003</b>
<b>Brief Description:</b>	<p>The fining and notification are the feature on the system that has the main function of the system. It obtains the details and assigns a fee to the obtained number.</p> <p>The vehicle owner receives a message for violation of traffic lights</p>
<b>Primary Actors</b>	Sql query
<b>Secondary Actors</b>	Driver



<b>Preconditions</b>	The license number must have corresponding details to clearly know the driver.
<b>Main Flow</b>	<ol style="list-style-type: none"> <li>1. The details that have been matched are identified.</li> <li>2. The system allocates the penalty of 100,000.</li> <li>3. The system then sends a notification to the driver via sms about the penalty that has been charged.</li> </ol>
<b>Post conditions</b>	The system must notify the driver that the penalty has been issued.
<b>Business rule</b>	The system should immediately forward a message to the violating driver after the penalty has been issue

#### 4.3.3 Functional Requirements

DF 1: The system shall assign a fee to the violating driver based on the results captured from the database match license number.

DF 2: The system shall notify the driver of the fee that has been attached to his/ her license plate by sending an sms.

## 5. Other Nonfunctional Requirements

### 5.1 Performance Requirements

The system shall capture the number plate of the violating vehicle with the help of the camera only if the sensor has sensed the vehicle position is wrong.

The system shall be able to capture all images per 1 sec.

The system shall match the scanned number from the image with the equivalent details only if the digits provided are valid and have matching details.

The system shall send notification of the penalty that has been attached to the violating driver only if the details have been validated.

## 5.2 Safety Requirements

Due to bad weather condition, the system hardware like camera and sensor lens should be enclosed in weather guard protection tools.

After implementation, the system should be tested on the roads using the outdoor CCTV cameras to ensure that the other cameras that will be used in the field work very well.

Sensor and camera position shall be tested on roads to ensure that the number plates are captured very well and they position is identified clearly.

## 5.3 Security Requirements

Due to the fact the system is only made for Traffic officers, each traffic officer has a unique number them. The system shall only accept those unique number for the traffic officers for the login.

## 5.4 Software Quality Attributes

**Reliability:** The system should be able to operate continuously and accurately, with minimal downtime or errors.

**Usability:** The system should have a user-friendly interface basically a GUI for easy understandability of the system by the traffic officers.

**Efficiency:** The system should be able to capture all the images of every vehicle at junctions that have a two-way path since there are many vehicles per second.

**Flexibility:** The system cameras should be able to adjust position to capture the license plates of the different sizes of the cars.

**Scalability:** sometimes there are many vehicles at the junction, therefore the system cameras should be able to capture all of them at once per second.

**Maintainability:** The system hardware and database should have access to regular maintenance and support services to ensure its accuracy and reliability.

## 5.5 Business Rules

**Penalties:** the system shall issue a penalty that is specified the traffic rules and regulations of Ug shs 100,000.

# 6. Other Requirements

## 6.1 Appendix A: Glossary

**Traffic light compliance and penalty system:** this is the system that is developed to capture license plates and scan the numbers on them for the violating drivers and it automatically issues a penalty of shs.100,000

**User interface:** The interface on the TLCPS that allows the traffic officer and operator to input monitor the control of the system.

**Operating environment:** the real world / conditions in which the TLCPS is operating.

**Hardware interface:** These are the physical or components of the system that one can touch on which the system is operating.

**Communications interface:** The connection between the software system and external communication devices or networks. Such as the way the system notifies the drivers about the penalties issued to them.

**Performance requirements:** The specific performance criteria that the system must meet in order to be considered successful.

**Safety requirements:** The measures that must be taken to ensure the safety of users and operation of the system.

**Security requirements:** The measures that must be taken to protect the system from unauthorized access or tampering.

### Abbreviations:

TLCPS: Traffic Lights Compliance and Penalty System.

SRS: Software Requirements Specification.

CCTV: Closed-circuit Television.

GUI: Graphical User Interface.

OCR: Optical Character Recognition.

SQL: Structured Query Language

SMS: Short Message System.

CSS: Cascading Style Sheets.

JS: Java Script

## 6.2 Appendix B: Analysis Models

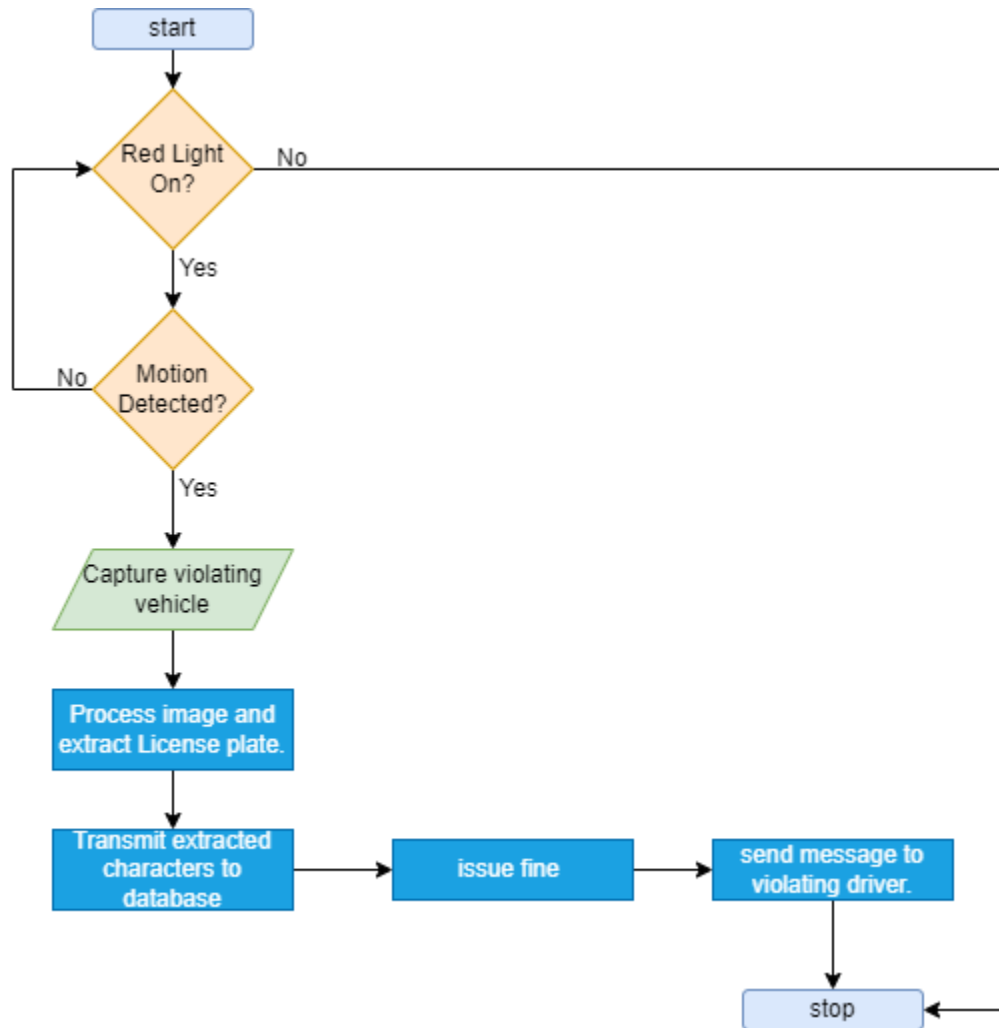


Fig 7: Data flow diagram of the TLCP system.

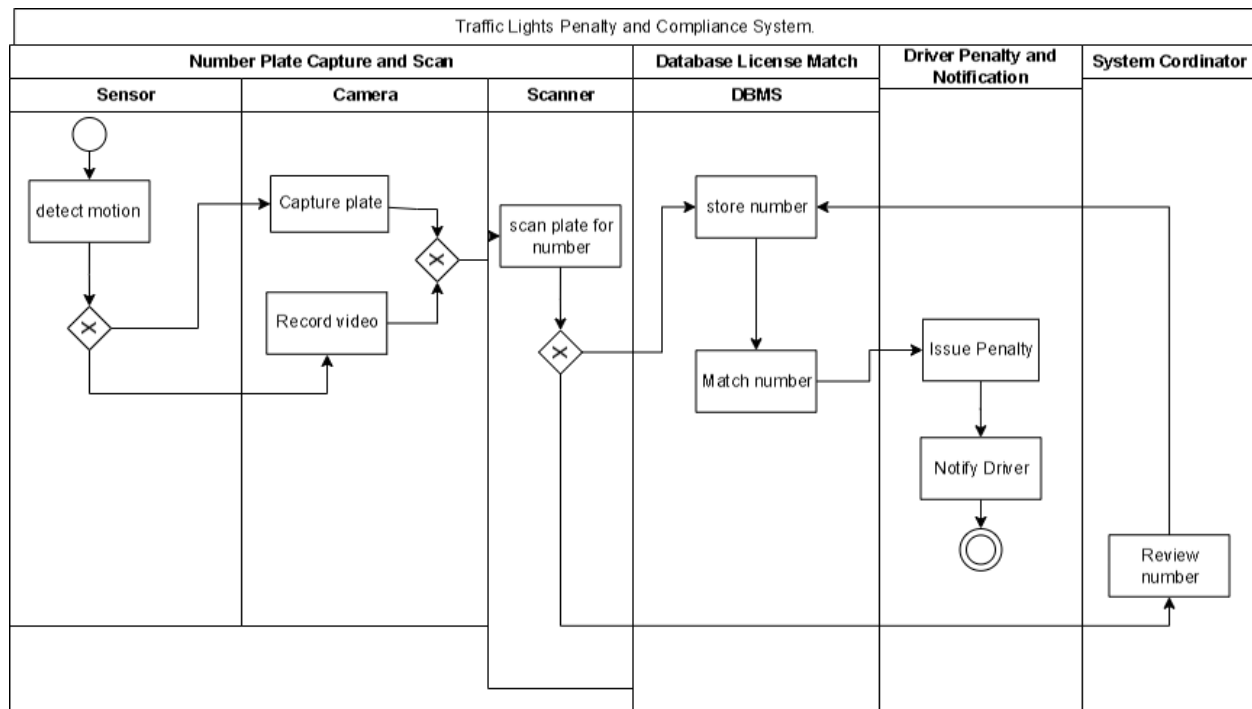


Fig 8: Business Process Management Diagram for the TLCP system.

## 6.3 Appendix C: To Be Determined List