School of Computer Sciences

Universiti Sains Malaysia

CSE241 - FOUNDATIONS OF SOFTWARE ENGINEERING

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Report 1 Submission

Project Title: Heng Heng Traffic

Group 1

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Table of contents

List of Figures

List of Tables

1. Project Background

1.1 Problem Background

Sustainable Development Goal (SDG) 11 stands as a crucial objective, aiming to create cities and communities that are **inclusive, safe, resilient, and sustainable** (Our World in Data Team, 2023). Despite this aspirational goal, Penang Island grapples with persistent challenges in realizing SDG 11, predominantly rooted in **transportation issues.** The ramifications of insufficient transportation infrastructure are varied, encompassing concerns about road safety, congestion during peak hours, and the environmental impact resulting from individual commuting choices (Martyn de Kuyer, 2023).

The difficulties in Penang's transportation are highlighted by alarming statistics and expert opinions. The Penang Police Chief, Datuk Mohd Shuhaily Mohd Zain, underscores the low awareness of car-sharing among Penangites as a significant contributor to severe traffic jams. A striking revelation reveals that seven out of ten vehicles on the island are occupied by a single individual, indicating a lack of engagement in communal transportation initiatives.

Moreover, data from the Penang Institute accentuates the strain on the island's demographic. The population has surged to 1.6 million, resulting in an escalated people-to-transportation ratio from **1:1.17 in 2008 to 1:1.39 in 2014**. This surge implies that nearly every Penangite owns at least one form of transportation, exacerbating traffic challenges. Projections for 2022 suggest a concerning trend where most families will possess at least two cars, intensifying the issue. (Keoh, N. N, 2023)

An exhaustive report from the Penang Institute in 2014 delves into the **underutilization of public transportation** during peak hours. Surprisingly, only 11% of Penangites opt for public transportation from 7:00 am to 9:00 am, with a mere **3% choosing public buses**. This data underscores the overwhelming reliance on **private vehicles, reaching up to 89%**, during these crucial hours. Among private transportation users, 56% prefer cars, and 33% opt for motorcycles, amplifying the chaotic traffic situation on narrow roads (Keoh, N. N, 2023).

USM’s Transport Engineering Assoc Prof Dr Nur Sabahiah Abdul Sukor emphasizes the severity of **Penang's traffic challenges**, asserting that the state is among those with the **highest traffic rates** in the country (Imran Hilmy, 2023).

Additionally, a commentary accentuates the importance of robust road infrastructure and an efficient public transport system. Addressing traffic problems is deemed crucial for improving various aspects of individuals' lives, ranging from effective time management to enhanced psychological well-being. Studies indicate that **an efficient transport infrastructure contributes to happier workers, resulting in a significant 13% increase in productivity** (Tan Chen Tat, 2020).

In addressing the urgent transportation issues in Penang, "Heng Heng Traffic" stands out as a comprehensive and customized solution. By harnessing real-time data, the system not only optimizes traffic but also encourages carpooling while improving the efficiency of public transportation. The **Real-Time Location Service (GPS)** module ensures the safety and security of drivers through precise location tracking, identification of reckless driving, and facilitation of emergency assistance. The **Carpooling System** effectively reduces congestion with dynamic ride matching and continuous updates on traffic conditions. Managing traffic flow in real-time, the **Dynamic Toll Price** module offers personalized notifications, aiding informed decision-making for route planning. The **Smart Traffic Monitoring System** tackles traffic challenges through efficient data collection, optimization of traffic lights, and seamless integration with emergency responses. Additionally, the **Connection with Public Transportation** resolves issues by enabling notifications, special assistance requests, and live bus monitoring. Aligned with Sustainable Development Goal 11, this initiative strives to revolutionize urban transportation on Penang Island, emphasizing sustainability, efficiency, and safety.

1.2 Organization Background

Our team, Heng Heng Traffic, is eager to present our innovative system to the **Ministry of Transport of Malaysia (MOT)**. MOT oversees critical aspects of transportation, including road transport, civil aviation, road safety, among others. The mission of MOT aligns with our goal of developing a system that strengthens the transportation infrastructure through technology, serving as a catalyst for national development (official portal, 2023). We are open to a **collaborative partnership** with MOT or even considering the possibility of **selling the system** to contribute to the advancement of transportation in Malaysia.

Our system brings substantial benefits to two key stakeholders such as **residents** and **policymakers**. Residents will experience significant advantages as the system incorporates **real-time data analytics and innovative smart city solutions** to enhance traffic management. This results in reduced congestion and improved mobility (UtiliseOne, 2023). The **integration of Waze-like solutions**, known for their efficiency, enhances the urban living experience by offering residents convenient and sustainable commuting alternatives.

Policymakers, who play a pivotal role in shaping urban development, will receive a comprehensive toolkit from our proposed system. Then inclusion of **dynamic toll pricing** mechanisms and **green light optimization** empowers policymakers to implement measures that encourage sustainablen transportation choices. This aligns with broader objectives such as creating inclusive, safe, and sustainable cities, in accordance with SDG 11 (Heirul Kamel, 2022). These elements present a holistic solution that benefits both residents and policymakers alike.

Upon implementing our system, we anticipate addressing significant traffic challenges such as **road accidents and congestion**. Additionally, our system contributes to **reducing air pollution** by effectively controlling the emissions of **carbon dioxide** and **carbon monoxide**. Users also have the potential to generate side income through our system. In essence, our system provides a comprehensive alternative to address various transportation issues when implemented wisely and correctly.

In conclusion, Heng Heng Traffic is committed to presenting a **transformative solution** to MOT, contributing to the advancement of transportation in Malaysia. The cited benefits for

residents and policymakers,coupled with the potential to address traffic problems and reduce environmental impact, underscore the comprehensive nature of our system. We look forward to the **opportunity to collaborate** and make a **positive impact** on the transportation landscape in Malaysia.

Overall, The distinctive features of the proposed system rest in its advanced capabilities, with real-time data analytics as the cornerstone for informed decision-making. The integration of innovative smart city solutions, particularly leveraging Waze-like technologies, introduces efficiency, and convenience.

1.3 System overview

1.3.1 System objectives

- To enhance road safety, reducing the accident rate.
- To provide a real-time tracking system, enabling users to plan their schedules wisely.
- To create an environment where everyone will make full use of public transportation, reducing the number of vehicles.
- To provide passengers or drivers with a safe platform, ensuring they can benefit from this platform.
- To establish a system to control traffic lights, aiming to smoothen the flow of traffic.

1.3.2 System module breakdown

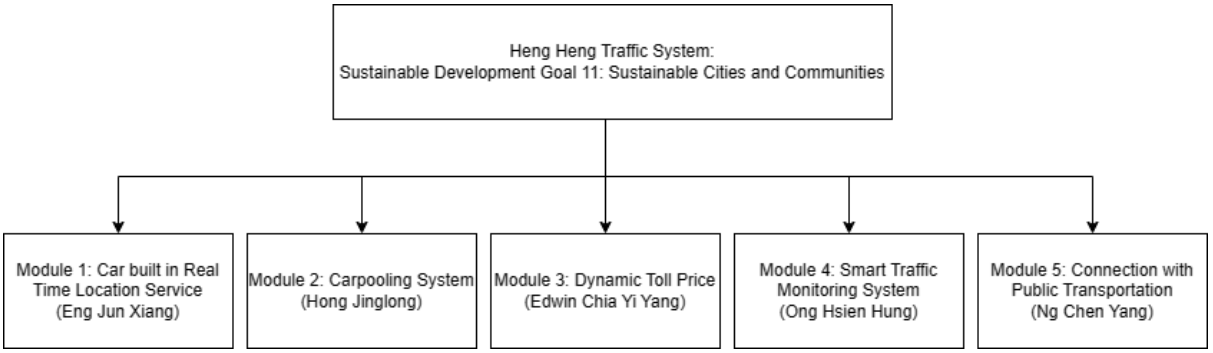

Figure 1 Figure of System Module Breakdown

1.4 Project Planning

1.4.1 Project Team Introduction

Figure 2 Group Photo

Heng Heng right here! A group of people who don't know what will happen at the end of the day but still choose to smile along the way.

Group Member	Biography
 *Figure 3 Hong Jinglong*	**Hong Jinglong** Hey there! I'm Jinglong, a seasoned project manager with a track record of leading cross-functional teams across different industries. I thrive on orchestrating complex projects and have a real knack for strategic planning, consistently delivering successful outcomes for my teams and stakeholders. How can I assist you today?
 *Figure 4 Edwin Chia Yi Yang*	**Edwin Chia Yi Yang** Hey, I'm Edwin, a business analyst hooked on Monopoly and CashFlow. These games sharpen my money skills. Not toI've handled various projects before, so hit me up with your business idea—I can help fine-tune it!
 *Figure 5 Eng Jun Xiang*	**Eng Jun Xiang** Hi, Jun Xiang here. I come from Bukit Mertajam, Penang. In this Heng Heng Traffic group , I'm a business analyst that controls all parts of the business project. My passion for solving traffic problems that happen around us. That was very disgusting to me. I hope everyone benefits through our system. Stay tuned!

 *Figure 6 Ong Hsien Hung*	**Ong Hsien Hung** Wassup, Hsien Hung here, I'm a dynamic software engineer at Heng Heng Traffic Group, and is known for my innovation and precision. With a keen analytical mind, I consistently ensure that projects align with specifications, showcasing my commitment to excellence. My passion for problem-solving and relentless pursuit of advancement highlight my visionary approach to software engineering.
 *Figure 7 Ng Chen Yang*	**Ng Chen Yang** Hi, Chen Yang here. I come from Alor Setar, Kedah. I like to be involved in sports when I am free. I am a software engineer for a team. I hope that our project will make you find it informative and amazing.

Table 1.1 Table of biography of group member

1.4.2 Project Team Involvement

Project Team Involvement Agreement

1. Method of meeting:

No	Method
1	Virtual Meeting (Google Meet)
2	Messaging via smartphone
3	Physical meeting

Table 1.2 Table of meeting's method

2. Meeting Attendance:

No.	Edwin Chia Yi Yang	Hong JingLong	Eng Jun Xiang	Ong Hsien Hung	Ng Chen Yang
Meeting 1	✔	✔	✔	✔	✔
Meeting 2	✔	✔	✔	✔	✔
Meeting 3	✔	✔	✔	✔	✔
Meeting 4	✔	✔	✔	✔	✔
Meeting 5	✔	✔	✔	✔	✔

Meeting 6	✔	✔	✔	✔	✔

Table 1.3 Table of attendance

3. Running Meetings:

No	Date	Details
Meeting	18/10/2023	**Time:** 9:00pm – 10:30pm **Task:** Discus virtually of the question's structure and task allocation **Location**: Virtual (Google Meet) **Picture:** Photo
Meeting 2	20/10/2023	**Time:** 1:00pm - 3:00pm **Task:** Discuss the details of the project and check prepared module and features **Location:** DKG 31
Meeting 3	25/10/2023	**Time:** 5:00pm - 7:00pm **Task:** Final Checking of the module **Location:** Virtual (Google Meet)
Meeting 4	15/11/2023	**Time:** 9:00pm – 10:30pm **Task:** Discus virtually of the question's structure and task allocation **Location:** Virtual (Google Meet) **Picture:** Photo
Meeting 5	20/11/2023	**Time:** 6:30pm – 8:30pm **Task:** Discuss the details of the each features of every module **Location:** Subaidah at USM
Meeting 6	25/11/2023	**Time:** 6:30pm – 8:30pm **Task:** Finalize the details of the features and checking **Location:** Virtual (Google Meet) **Picture:** Photo

Table 1.4 Table of scheduled meeting

4. Division of Project Roles:

Role	Name	Job content
Project Director	Hong Jinglong	Leading the team, I define our project's vision and ensure alignment with our goals. Facilitating communication and strategic decision-making, I oversee our project's progress
Business Analyst	Edwin Chia Yi Yang	I specialize in gathering and analysing business requirements, researching information, and defining user stories for a user-friendly platform during the design phase.
	Eng Jun Xiang	With a focus on information research, I analyse business requirements, define user stories, and prioritize features for a robust and user-centric system.
Software Engineer	Ng Chen Yang	I'm one of the software engineers who analyze business requirements, define user stories, and prioritize features to ensure a robust and user-centric system.
	Ong Hsien Hung	I'm a software engineer at Heng Heng Traffic. I collaborate with Chen Yang to gather business requirements, define user stories, and contribute insights for a user-friendly platform during the design phase. He ensures the system meets all requirements, preventing any lack of essential features.

Table 1.5 Table of role of each member

4. Division of Work:

Module	**Person In Charge**
Car Built In Real Time Location Service (GPS)	Eng Jun Xiang
Carpooling System	Hong Jinglong
Dynamic Toll Price	Edwin Chia Yi Yang
Smart Traffic Monitoring	Ong Hsien Hung
Connection with Public Transportation	Ng Chen Yang

Table 1.6 Table of module for each member

2. System Requirements

2.1 Functional requirements – User Stories

2.1.1 Module 1: Car built in Real Time Location Service (GPS)

TITLE: Track Accurate Location	**PRIORITY:** 2
As a driver, **I want to** know the accurate location of my vehicle, **So that** I can know the real-time location of my car through the system for security and convenience purposes.	

ACCEPTANCE CRITERIA:
• **Given** an active GPS connection,
• **When** I request my car's location,
• **Then**
  ○ The GPS system should provide the current and accurate location of my car.
  ○ I can check the real-time location of his car for security purposes.	

Table 2.1.1 User story of tracking accurate location of vehicle (driver)

TITLE: Reckless Driving Detection	**PRIORITY:** 1
As a driver, **I want to** monitor my behaviour for signs of reckless driving(eg: Over speeding). **So that** I can prevent reckless driving behaviour to minimize road accidents.	

ACCEPTANCE CRITERIA:
• **Given** I have a reckless driving behaviour,
• **When** the GPS system detects reckless driving patterns,
• **Then**
  ○ Appropriate alerts or actions will be done to notify me.
  ○ Warning will be triggered if I still remain reckless driving.
  ○ It will remain until the driver drives safely for safety purposes.	

Table 2.1.2 User story of detection of reckless drivers and giving them signals (driver)

TITLE: Request Rescue Assistance	**PRIORITY:** 2
As a driver, **I want to** be able to request rescue assistance through the GPS system. **So that** I can quickly and accurately communicate my location in case of an emergency.	
ACCEPTANCE CRITERIA: • **Given** an emergency situation, • **When** I activate the rescue request feature in the GPS system, • **Then** ○ The system should alert emergency services. ○ The system automatically provides the rescue team with my car's exact location. ○ The recuse job will be done efficiently.	

Table 2.1.3 User story of driver can ask for rescue by providing the accurate location (driver)

TITLE: Report Traffic Incidents	**PRIORITY:** 3
As a driver, **I want to** report traffic incidents or road hazards through the GPS system. **So** that I can contribute to improving the accuracy of traffic information for myself and others.	
ACCEPTANCE CRITERIA: • **Given** I am driving on the road, • **When** traffic incidents or road hazards happen. • **Then** ○ I can report the traffic incidents about the situation through the system. ○ Other road users can know the road situation on the time. ○ Every road user can change the plan and do the action immediately.	

Table 2.1.4 User story of driver can report traffic incidents or road hazards to improve traffic information (driver)

TITLE: Law Enforcement	**PRIORITY:** 2
As the law enforcement officer, **I want to** access records from the GPS system to gather evidence for summoning reckless drivers. **So that** I can enforce traffic regulations and enhance road safety.	
ACCEPTANCE CRITERIA: • **Given** a request from law enforcement, • **When** accessing the GPS system records, • **Then** ○ The system should provide relevant information, such as historical driving behaviour and location data for the enforcement agency. ○ The record will be proof and issuance summonses for reckless driving violations.	

Table 2.1.5 User story of government agencies accessing records and giving summons for reckless drivers (law enforcement officers).

TITLE: Traffic Flow Optimization	**PRIORITY:** 2
As the traffic management officer, **I want to** use data from the GPS system to optimize traffic flow. **So that** I can adjust signal timings and implement traffic	
ACCEPTANCE CRITERIA: • **Given** access to real-time traffic data from the GPS system, • **When** analysing traffic flow, • **Then** ○ Traffic Management Center should adjust signal timings ○ The Traffic Management Center should implement strategies to improve overall traffic efficiency.	

Table 2.1.6 User story of government agencies accessing records and analysing traffic conditions (traffic management officer)

2.1.2 Module 2: Carpooling System

TITLE: Dynamic carpool matching	**PRIORITY**: 1
As a passenger or a driver, **I want** dynamically carpool matching based on route customization and preferences set before the ride. **So that** I can efficiently reach my destination while optimising for convenience and time.	
ACCEPTANCE CRITERIA: ● **Given** I am logged into the system, ● **When** I initiate a ride request and matching ● **Then** ○ The system should provide me with a list of dynamically matched rides that align to my destination and request.	

Table 2.2.1 User story of Dynamic Carpool Matching (Driver & Passenger)

TITLE: View rating	**PRIORITY**: 2
As a passenger or a driver, **I want** to view the reputation or rating of other users and drivers. **So that** I can make an informed decision on whether or not to accept this ride.	
ACCEPTANCE CRITERIA: ● **Given** I am logged into the system, ● **When** I search for ride or encounter another drivers and user's profile, ● **Then** ○ The system should display their reputation or rating prominently, indicating their reliability or performance based on past interactions.	

Table 2.2.2 User story of Viewing Rating (Driver & Passenger)

TITLE: Request for emergency assistant	**PRIORITY**: 1
As a passenger or a driver, **I want** to access emergency assistance features during my ride. **So that** I can quickly contact emergency services or notify trusted contacts if unexpected situations arise.	
ACCEPTANCE CRITERIA: ● **Given** I am on a ride using the carpool system ● **When** I encounter an emergency or feel unsafe during the ride ● **Then** ○ The system should provide a prominently accessible emergency button within the app interface.	

Table 2.2.3 User story of Request for emergency assistant (Driver & Passenger)

TITLE: Edit Route Information	**PRIORITY**: 1
As a passenger or a driver, **I want** to edit and customise my carpool details before initiating a ride within the system. **So that** I can personalize my experience and tailor the system to my needs.	
ACCEPTANCE CRITERIA: ● **Given** I am logged into the system, ● **When** I access the settings or route customization section, ● **Then** ○ The system should allow users to set route details such as route specified, desired arrival time, etc., to match them with compatible carpooling partners.	

Table 2.2.4 User story of Efit Route Information(Driver & Passenger)

TITLE: Edit Route Preference	**PRIORITY**: 3
As a passenger or a driver, **I want** to set a ride preference before initiating a carpool **So that** I can have a comfortable and personalised travel experience.	
ACCEPTANCE CRITERIA: • **Given** I am logged into the system, • **When** I set preferences such as gender, car temperature preference and music preference • **Then** ○ The system should ensure these preferences are saved and considered for ride-matching.	

Table 2.2.5 User story of Edit Route Preference (Driver & Passenger)

TITLE: Real-time traffic update	**PRIORITY**: 1
As a passenger or driver, **I want** to access real-time traffic updates and optimal route suggestions. **So that** I can efficiently navigate through traffic and save time during the carpool journey.	
ACCEPTANCE CRITERIA: • **Given** I am initiating or planning a carpool ride using the system • **When** I input the destination and set the carpool details • **Then** ○ The system should integrate with GPS navigation software's traffic data to retrieve real-time updates on traffic conditions along the route.	

Table 2.2.6 User story of Real-time Traffic Update (Driver & Passenger)

2.1.3 Module 3: Dynamic Toll Price

TITLE: Real-Time Toll Prices	**PRIORITY:** 1
As a commuter using the "Heng Heng Traffic" app, **I want to** view real-time dynamic toll prices as I approach toll roads. **So that** I can plan my route effectively and save on transportation costs.	
ACCEPTANCE CRITERIA: ● **Given** that I am using the "Heng Heng Traffic" app, ● **When** I input my starting point and destination, ● **Then** ○ The app should promptly display real-time dynamic toll prices for that specific toll road. ○ The app should suggest alternative routes considering toll prices and traffic conditions, updating this information promptly as toll prices change.	

Table 2.3.1 User story of real-time toll prices (commuter)

TITLE: Dynamic Toll Pricing Adjustment	**PRIORITY:** 1
As a local government officer using "Heng Heng Traffic," **I want to** modify dynamic toll pricing parameters. **So that** I can efficiently manage traffic flow by setting criteria based on factors like traffic volume or time of day.	
ACCEPTANCE CRITERIA: ● **Given** administrative access within the "Heng Heng Traffic" system, ● **When** I access the toll pricing settings, ● **Then** ○ I should be able to set criteria for dynamic toll pricing based on factors such as traffic volume, time of day, or other relevant parameters. ○ The system should facilitate real-time modifications, offering flexibility to adapt to changing traffic conditions.	

Table 2.3.2 User story of dynamic toll pricing adjustment (local government officer)

TITLE: Historical Toll Price Data	**PRIORITY:** 2
As a toll analyst, **I want to** access historical toll price data. **So that** I can analyse trends and make informed decisions regarding future toll adjustments or infrastructure planning.	
ACCEPTANCE CRITERIA: ● **Given** a database within the system, ● **When** I request historical toll price data for specific time frames, ● **Then** ○ The system should provide comprehensive data records for analysis and decision-making purposes.	

Table 2.3.3 User story of historical toll price data (city planner)

TITLE: Toll Price Prediction	**PRIORITY:** 3
As a commuter, **I want to** know predicted toll prices for specific times and days. **So that** I can plan my journeys in advance and anticipate potential cost fluctuations.	
ACCEPTANCE CRITERIA: ● **Given** that I use the app and it has access to historical toll price data and traffic patterns, ● **When** I input date and time information for a future journey, ● **Then** ○ The system should provide estimated toll prices based on historical data and traffic patterns.	

Table 2.3.4 User story of toll price prediction (commuter)

TITLE: Customised Toll Notifications	**PRIORITY:** 3
As a commuter, **I want to** receive personalised notifications regarding toll price changes on my preferred routes. **So that** I can make informed decisions and plan my travels efficiently.	
ACCEPTANCE CRITERIA: ● **Given** user preferences stored in the system, ● **When** toll prices change on frequently used routes, ● **Then** ○ I receive notifications via the mobile app or email, allowing them to stay informed and adjust their plans accordingly.	

Table 2.3.5 User story of customised toll notifications (commuter)

2.1.4 Module 4: Smart Traffic Monitoring

TITLE: Real-time Traffic Data Collection	**PRIORITY:** 1
As a traffic officer, **I want to** effortlessly gather up-to-the-minute traffic data, **So that** I can swiftly adjust traffic signals based on current conditions.	
ACCEPTANCE CRITERIA: ● **Given** that the smart traffic system is operational, ● **When** I trigger data collection in the Smart Traffic system, ● **Then** ○ I should be able to view real-time traffic data on a user-friendly interface. ○ The system should capture and update traffic information every minute seamlessly.	

Table 2.4.1 User story of real-time traffic data collection (traffic officer)

TITLE: Traffic Light Optimization	**PRIORITY:** 1
As a traffic officer, **I want to** easily fine-tune traffic light timings using real-time data, **So that** I can enhance traffic flow and minimize congestion.	
ACCEPTANCE CRITERIA: ● **Given** the real-time traffic data is available, ● **When** I input current traffic data into the Smart Traffic system, ● **Then** ○ The system should provide clear, actionable recommendations for optimal traffic light durations. ○ Recommendations should align effectively with the actual traffic conditions.	

Table 2.4.2 User story of traffic light optimization (traffic officer)

TITLE: Emergency Response Integration	**PRIORITY:** 2
As an emergency response coordinator, **I want to** prioritize emergency vehicles during emergencies by using Smart Traffic system, **So that** I can ensure swift and secure passage for emergency services.	
ACCEPTANCE CRITERIA: ● **Given** an emergency situation is detected, ● **When** emergency vehicles are approaching an intersection, ● **Then** ○ The system should promptly adjust traffic lights to prioritize the passage of emergency vehicles. ○ Traffic lights should adapt quickly, ensuring a smooth passage for emergency vehicles.	

Table 2.4.3 User story of emergency response integration (emergency response coordinators)

TITLE: Historical Data Analysis	**PRIORITY:** 2
As a traffic analyst, **I want to** effortlessly analyze historical traffic data, **So that** I can identify patterns and trends for informed future planning.	
ACCEPTANCE CRITERIA: ● **Given** the Smart Traffic system has collected historical data, ● **When** I request a historical data analysis, ● **Then** ○ The system should present visualizations and insights into traffic patterns over specified time periods. ○ Generated insights should contribute effectively to decision-making.	

Table 2.4.4 User story of historical data analysis (traffic analyst)

TITLE: User Alerts and Notifications	**PRIORITY:** 3
As a traffic officer, **I want to** receive alerts and notifications for critical traffic events, **So that** I can proactively address potential issues.	
ACCEPTANCE CRITERIA: ● **Given** the Smart Traffic system is monitoring real-time data, ● **When** the system identifies a critical traffic event (e.g., accidents, road closures), ● **Then** ○ The system should immediately send user-friendly alerts and notifications to relevant authorities. ○ Alerts should be timely and easy to understand.	

Table 2.4.5 User story of alerts and notifications (user)

TITLE: On-the-Go Traffic Monitoring Adjustments	**PRIORITY:** 3
As a traffic officer, **I want to** access the Smart Traffic system effortlessly on my mobile device, **So that** I can quickly monitor traffic and make informed decisions on the field.	
ACCEPTANCE CRITERIA: ● **Given** the Smart Traffic system is operational, ● **When** accessed through a mobile device, ● **Then** ○ The system should provide an intuitive interface with real-time traffic updates. ○ Mobile access should allow for quick and effective decision-making on the field with minimal effort.	

Table 2.4.6 User story of mobile access for on-the-go monitoring (traffic officer)

2.1.5 Module 5: Connection with public transportation

TITLE: Sending notification to driver	**PRIORITY:** 2
As a public bus user, **I want to** send a notification to the driver when I'm waiting at a specific bus stop **So that** the driver is aware of my presence.	
ACCEPTANCE CRITERIA: ● **Given** that I am at a bus stop, ● **When** I press a button in order to send a notification via the app ● **Then** o The electronic dashboard in the bus will pop out a message for the driver	

Table 2.5.1 User story of sending notification to driver (user)

TITLE: Request Special Assistance	**PRIORITY:** 2
As a passenger with specific needs, **I want to** request special assistance, such as wheelchair accessibility or priority seating **So tha**t I can have a comfortable and accessible journey.	
ACCEPTANCE CRITERIA: ● **Given** that the driver is aware of special requirement from users ● **When** I request it through the app ● **Then** n o The driver acknowledges and accommodates my request once he arrive at the bus stop	

Table 2.5.2 User story of Request Special Assistance (user)

TITLE: Enable Real-Time Monitoring of Bus Location	**PRIORITY:** 3
As a bus user, **I want to** have access to real-time updates on the location of my bus **So that** I can plan my journey more effectively.	
ACCEPTANCE CRITERIA: ● **Given that** I have opened the app, ● **When** I key in certain location or bus, ● **Then** o I receive accurate and timely information about the current location of the bus I am waiting for.	

Table 2.5.3 User story of Enable Real-Time Monitoring of Bus Location (user)

TITLE: Purchased Digital Tickets	**PRIORITY:** 1
As a bus user, **I want to** purchase and display digital tickets directly within the app **So that** I can make full use of the e-wallet and make the process of boarding the bus faster.	
ACCEPTANCE CRITERIA: ● **Given** that I want to board the bus ● **When** I purchase a ticket through the app ● **Then** o A digital ticket is generated and displayed for later use.	

Table 2.5.4 User story of Purchase and Display Digital Tickets (user)

TITLE: Access Offline Bus Information	**PRIORITY:** 2
As a bus user with intermittent internet connectivity, **I want to** access essential features such as bus schedules and route information when I loss my connection **So that** I can plan my schedule even in areas with poor connectivity.	
ACCEPTANCE CRITERIA: ● **Given** that I am in an area with poor connectivity ● **When** I access the app, ● **Then** o I can view essential bus information offline	

Table 2.5.5 User story of Access Offline Bus Informations (driver)

TITLE: Receive Passenger Notifications	**PRIORITY:** 1
As a bus driver, **I want to** receive notifications when passengers are waiting at a specific bus stop **So that** I can efficiently plan stops and I will not miss any of my passengers, which will cause any dissatisfaction.	
ACCEPTANCE CRITERIA: ● **Given** that I am driving a bus, ● **When** a passenger sends a notification through the app ● **Then** o I receive a notification indicating their presence at a specific bus stop	

Table 2.5.6 User story of Receive Passenger Notifications (driver)

2.2 Functional requirements – Use Cases

2.2.1 Use Case list

Module 1: Car built in real time location service (GPS)

Module	Use Case ID	Use Case Name	Description
Car built in Real Time Location Service(GPS)	GPS001	Know Accurate Location	**Driver** knows the accurate location of my car by keeping track of its whereabouts for security purposes.
	GPS002	Reckless Driving Detection	**Drivers** receive appropriate alerts for reckless driving behaviour detected.
	GPS003	Request Rescue Assistance	**Driver** request rescue assistance through the system communicate my location quickly and accurately
	GPS004	Report Traffic Incidents	**Drivers** report traffic incidents or road hazards through the GPS system to improve the accuracy of traffic information.
	GPS005	Law Enforcement by Summoning Reckless Drivers	**Government agencies** access records from the GPS system to gather evidence for summoning reckless drivers.
	GPS006	Traffic flow Optimization.	**Government agencies** can use the system system to analyse traffic flow.

Table 2.6.1 Table of use case list for Module 1

Module 2: Carpooling System

Module	Use Case ID	Use Case Name	Description
Carpooling System	CS001	Dynamic carpool matching	**Passengers and drivers** can choose the ride that best suits their needs.
	CS002	View rating	**Passengers and drivers** are allowed to view others passengers or driver's ratings before they accept the ride offer.
	CS003	Request for emergency assistant	**Passengers and drivers** can access emergency assistance features during a ride through the application interface in case of an emergency such as accidents, robbery, etc..
	CS004	Edit Route Information	**Passengers and drivers** can enter and edit the route information such as the destination, the route, desired time of arrival, etc.
	CS005	Edit Route Preference	**Passengers and drivers** are allowed to choose their preference of various aspects such as driver or passenger's gender and number.
	CS006	Real-time traffic update	**Passengers and drivers** can view the real-time traffic updates along the journey.

Table 2.6.2 Table of use case list for Module 2

Module 3: Dynamic Toll Price

Module	Use Case ID	Use Case Name	Description
Dynamic Toll Prices	DTP001	Adjust Dynamic Toll Pricing	**Local government officers** adjust toll prices in real-time based on traffic conditions like volume and time of day.
	DTP002	Access Historical Toll Data	**Toll analysts** analyse past toll prices from the system for future decisions on toll changes or infrastructure plans.
	DTP003	View Real-Time Toll Prices	**Commuters** see live toll prices on the app as they approach toll roads, suggesting alternative routes based on tolls and traffic.
	DTP004	View Predicted Toll Prices	**Commuters** get estimated future toll prices by entering date and time in the app using past toll data and traffic patterns.

	DTP005	Receive Customised Toll Notifications	**Commuters** receive personalised alerts via the app/email when toll prices change on their preferred routes.

Table 2.6.3 Table of use case list for Module 3

Module 4: Smart Traffic Monitoring

Module	**Use Case ID**	**Use Case Name**	**Description**
Smart Traffic Monitoring System	SMU001	Real-time Traffic Data Collection	**Traffic officers** initiate real-time data collection, allowing the Smart Traffic system to capture and update traffic information every minute for informed decision-making.
	SMU002	Traffic Light Optimization	**Traffic Officers** input current traffic data, and the system calculates and recommends optimal traffic light durations, enhancing traffic flow and reducing congestion.
	SMU003	Emergency Response Integration	During emergencies, the **Emergency Response Coordinator** triggers automatic adjustments in traffic lights,

			prioritizing the passage of emergency vehicles.
	SMU004	Historical Data Analysis	The **Traffic Analyst** requests and receives visualizations and insights from the system regarding historical traffic data, aiding in identifying patterns and trends.
	SMU005	User Alerts and Notifications	The system monitors real-time data and sends immediate alerts and notifications to relevant authorities, including **Traffic Officers**, in the event of critical traffic events.
	SMU006	On-the-Go Traffic Monitoring Adjustments	**Traffic officers** access the Smart Traffic system on their mobile devices for on-the-go monitoring, allowing quick decision-making and adjustments based on real-time traffic conditions.

Table 2.6.4 Table of use case list for Module 4

Module 5: Connection with public transportation

Module	Use Case ID	Use Case Name	Description
Connection with public transportation	CPD001	Sending notification to driver	**Passengers** send notifications to the driver for real-time communication during the journey. The notification will be facilitated by the system.
	CPD002	Request Special Assistance	**Passengers** request special assistance. The system processes requests to ensure a comfortable and tailored journey.
	CPD003	Enable Real-Time Monitoring	**Passengers** gain access to real-time monitoring features, allowing them to track and view live updates and status information during their journey.
	CPD004	Purchase Digital Tickets	**Passengers** digitally purchase and display

			tickets. The system processes transactions for a seamless journey experience.
	CPD005	Access Offline Bus Information	**Passengers** access essential bus details offline, ensuring availability without the internet. The system guarantees a reliable offline experience.
	CPD006	Receive Passenger Notifications	**Driver** gets notification from the passenger. The system will update the notification in the electrical dashboard of the bus.

Table 2.6.5 Table of use case list for Module 5

2.2.2 Use case diagram

Module 1:Real time location service system (GPS)

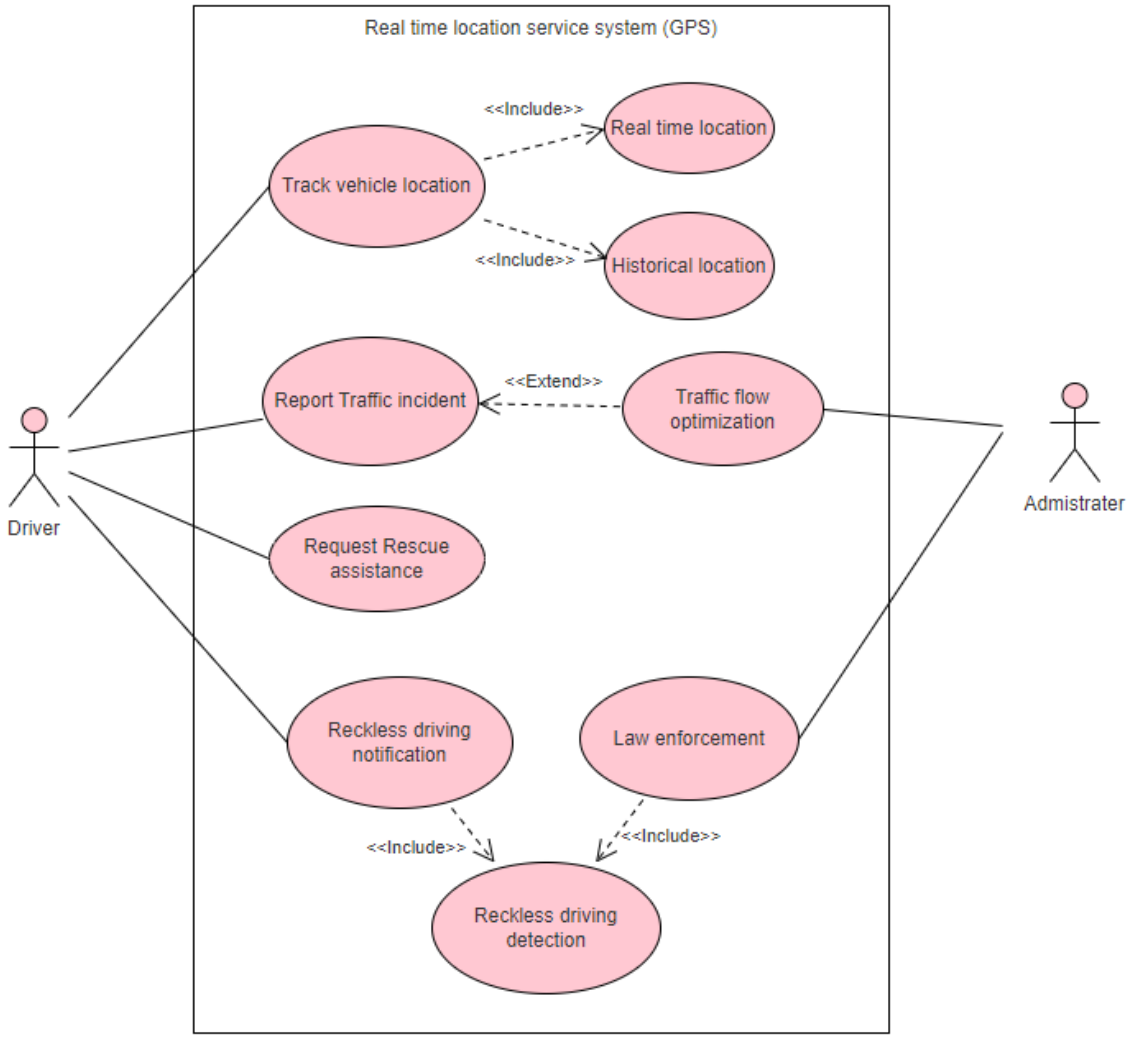

Figure 8: Use Case Diagram of Module 1- Real time location service system (GPS)

Module 2: Carpooling System

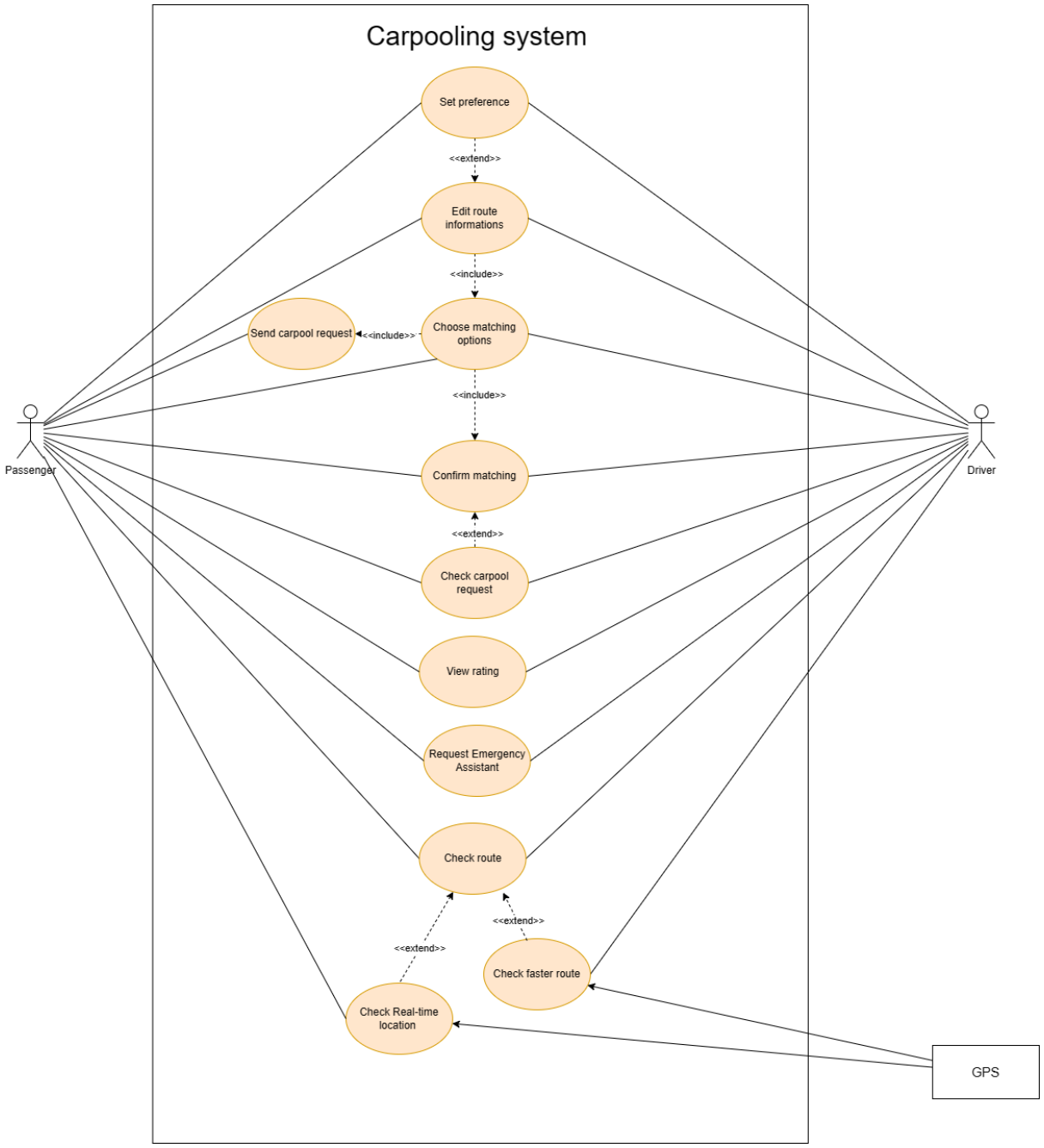

Figure 9: Use Case Diagram of Module 2- Carpooling System

Module 3: Dynamic Toll Price

Figure 10: Use Case Diagram of Module 3- Dynamic Toll Price System

Module 4: Smart Traffic Monitoring

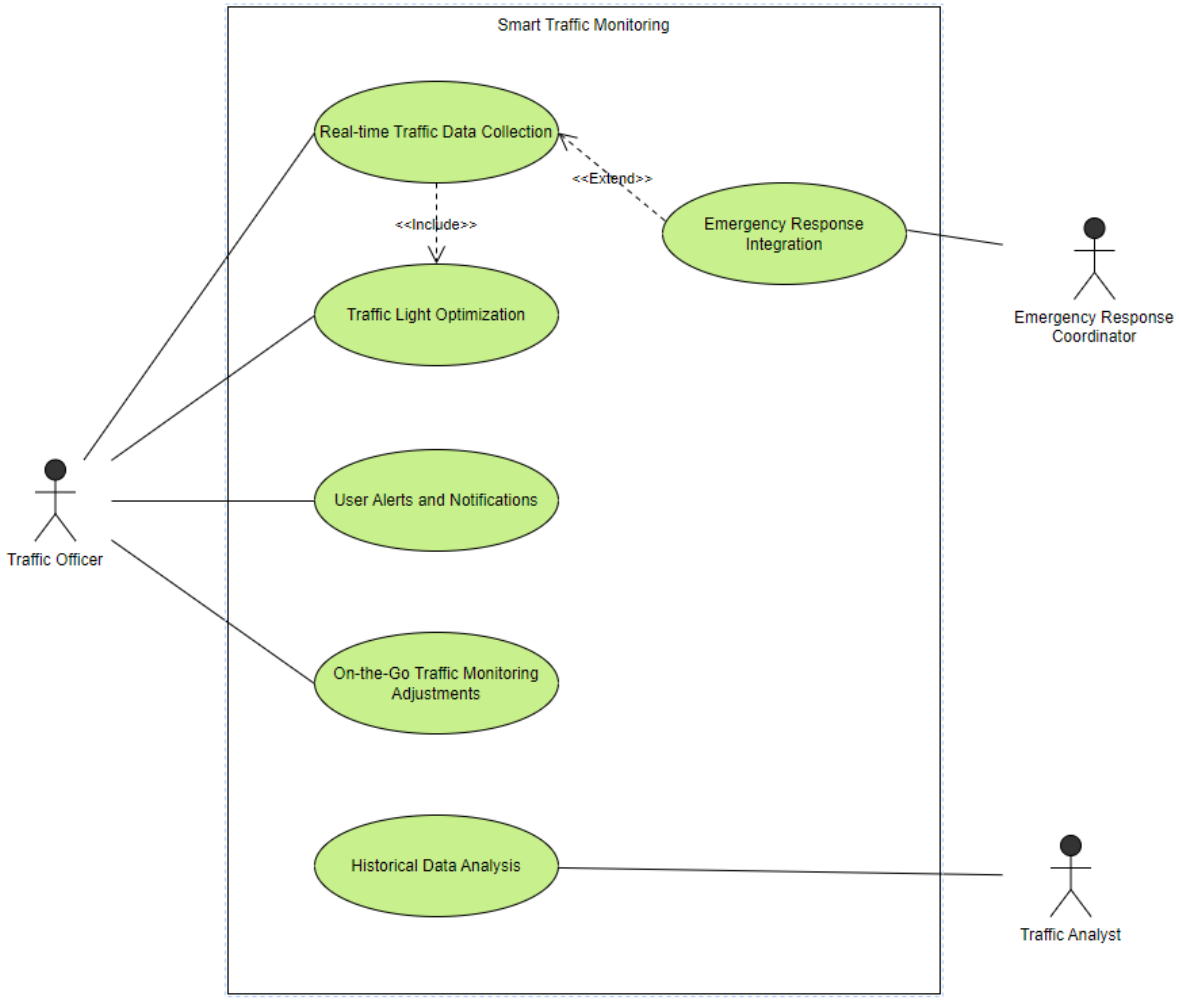

Figure 11: Use Case Diagram of Module 4: Smart Traffic Monitoring

Module 5: Connection with public transportation

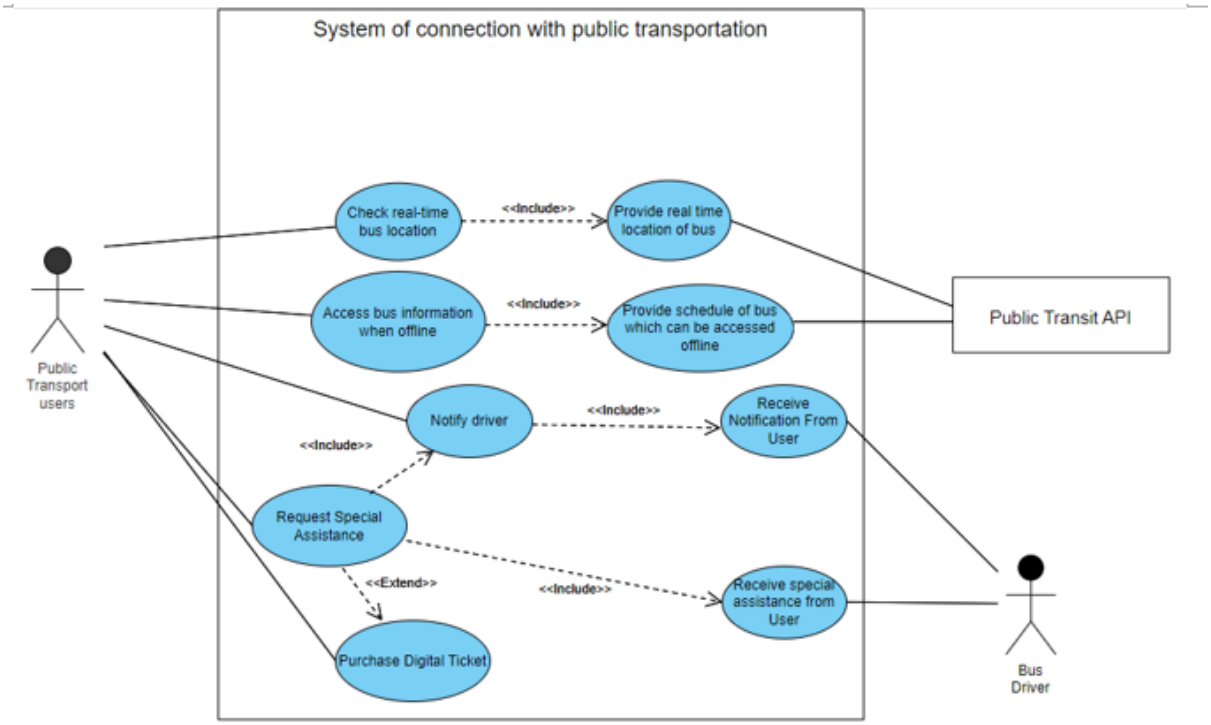

Figure 12: Use Case Diagram of Module 5: System of Connection with Public Transportation

2.3 Non-functional requirements

1. Performance:

The system must ensure low latency and high responsiveness across all its components. Real-time location services need to provide near-instantaneous updates on vehicle positions to support carpooling and traffic management. The carpooling system should offer quick matching of ride-sharing partners. Dynamic toll pricing should calculate and apply fees swiftly based on traffic conditions. Smart traffic monitoring requires fast data processing to provide up-to-the-minute insights. Integration with public transportation must facilitate seamless transfers and real-time information updates. Additionally, the system should scale efficiently to handle increased user load during peak traffic times. Performance benchmarks and response time thresholds need to be defined and consistently met to ensure a smooth user experience.

2. Reliability:

The system must be highly available and resilient. Downtime in any of its components, such as real-time location services or traffic monitoring, could have severe consequences. Redundancy and failover mechanisms should be in place to minimise service interruptions. Data integrity and consistency are paramount, particularly in the dynamic toll pricing component, where financial transactions occur. Moreover, the system must be robust in handling unexpected situations, such as network disruptions or system failures, to avoid compromising user safety and the efficiency of traffic management. Regular testing and monitoring, along with backup systems, should ensure the reliability and availability of the entire ecosystem.

3.Security:

The system must prioritize the safeguarding of data integrity, confidentiality, and availability. This involves implementing robust measures such as encryption for data protection during transmission and storage. Access controls should be stringent, ensuring only authorized users can access sensitive functionalities and information. Authentication mechanisms must be strong, employing multi-factor authentication where applicable to fortify user verification.

4. Scalability:

The system should exhibit the capability to efficiently handle increased loads and user demands without compromising performance or functionality. This includes the ability to seamlessly accommodate growing data volumes, traffic data, and transactional throughput. The system's architecture should be designed in a manner that allows for easy expansion of resources, such as processing power, memory, or storage, to meet evolving needs without significant disruptions or degradation in performance.

5. Acceptability:

The software must prioritise understandability and usability, aiming to create a system that ensures ease of use and minimises user errors. Upon registration, users should undergo a straightforward tutorial session to familiarize themselves with the system's functions. This training should equip them with proficiency in utilizing the system's features, promoting efficient and error-free usage thereafter.

3. System Architecture and Design

3.1 Architectural design

3.1.1 Conceptual view

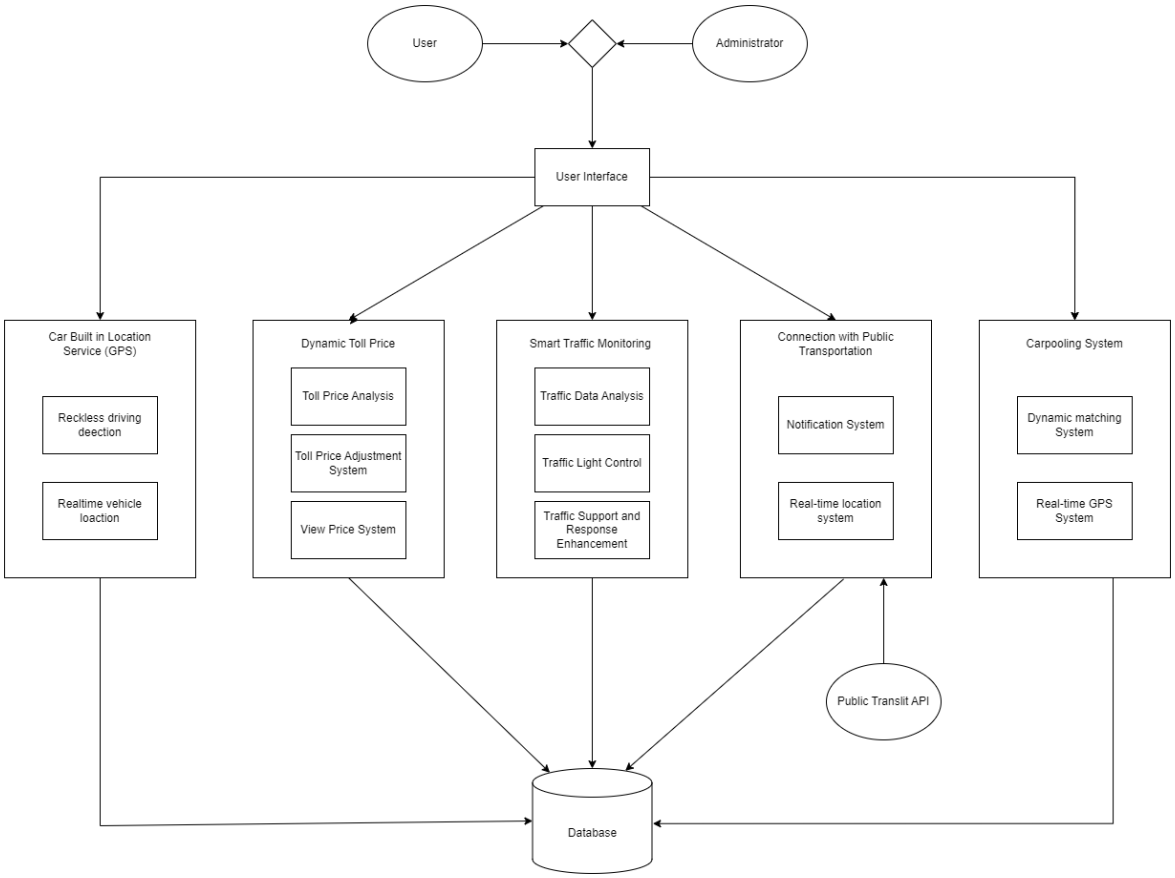

Figure 13: Conceptual View of The System

The Heng Heng System harmonizes five key modules: GPS for real-time navigation, carpooling for sustainable ride-sharing, toll pricing for optimized cost-effective travel, traffic monitoring for congestion analysis, and public transport integration for enhanced transit services. Designed for both drivers and administrators, this conceptual framework strives to create a seamless urban transportation experience by improving efficiency, reducing congestion, and promoting sustainable travel practices.

3.1.2 Process view

Module 1: Real time location service (GPS)

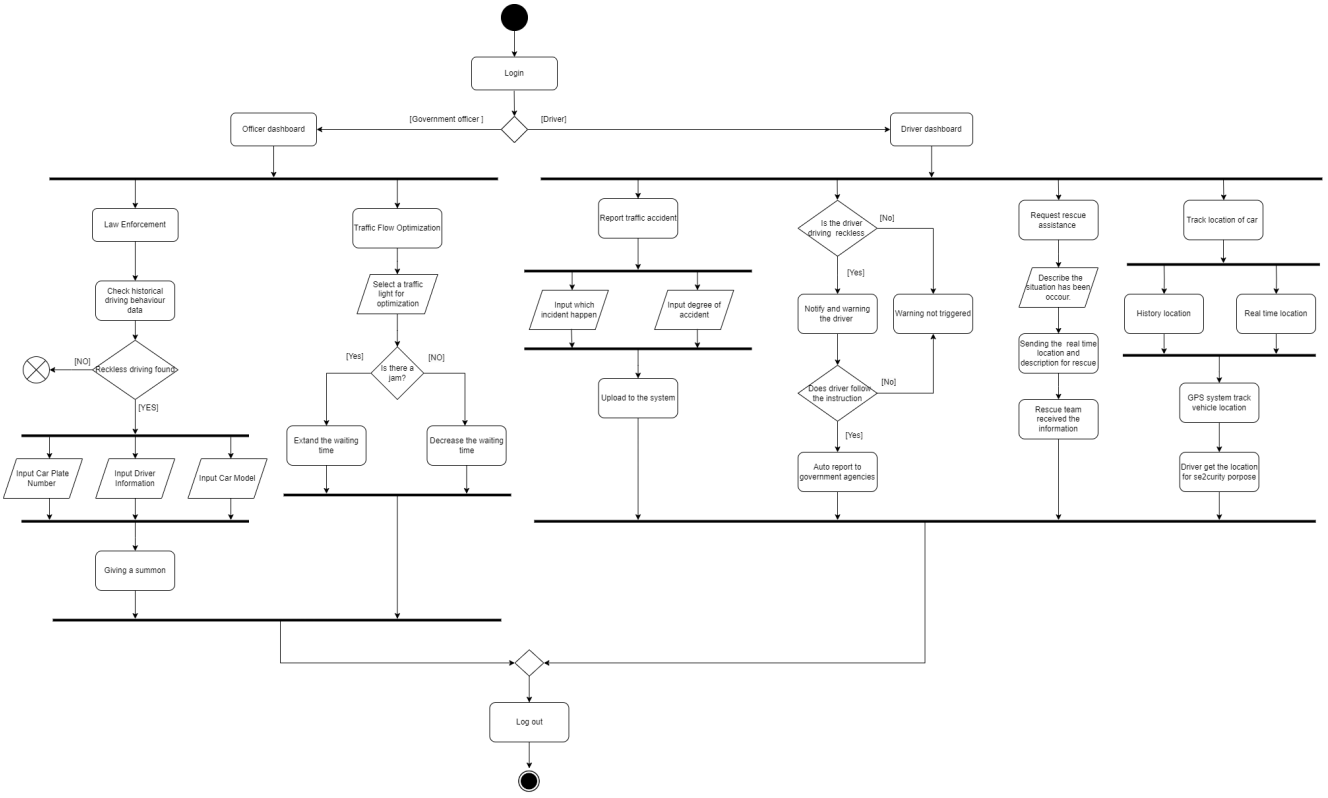

Figure 14: Process View of Real time Location Service Module (GPS)

Driver

As a driver, when I was logged into the dashboard, there were 4 features for me to select. Firstly I can get a notice when I was driving recklessly without obeying the rules such as over speeding. When the system detects I was driving recklessly, it will pop up a warning for me. Once I received the warning, I must change my driving behaviour. If not, the system will report to the government agencies for further action.

Secondly , as a driver I can report traffic accidents that happen on the road by key in all the information that occurs such as which type of accident happened and what is the degree of accident. Then, the system will upload to the database and every user will know what

happened on the road. The data will also be sent to adminstaters for further adjustment for the traffic.

Thirdly, I can ask for rescue when I am faced with an emergency situation. By pressing an emergency button. The system will auto send an accurate location to the rescue team, then they will know the exact location to increase rescue efficiency.

Lastly, I can track the location of my own car. In the dashboard , I can choose whether I want to know the historical location or the real time location. By knowing the location of my own vehicle, it will increase car security.

Officer

As an officer, I can optimise the traffic conditions using the system. When I log in into the system, I can choose which traffic light that I can optimise. By monitoring the road condition, I can adjust the timing of traffic lights by increasing the timing when there is a jam.

Otherwise, I can use the system to have law enforcement. When I login to the account, I can check whether the driver does not have good driving behaviour,a compound or summon can be given to the driver.

Module 2: Carpooling System

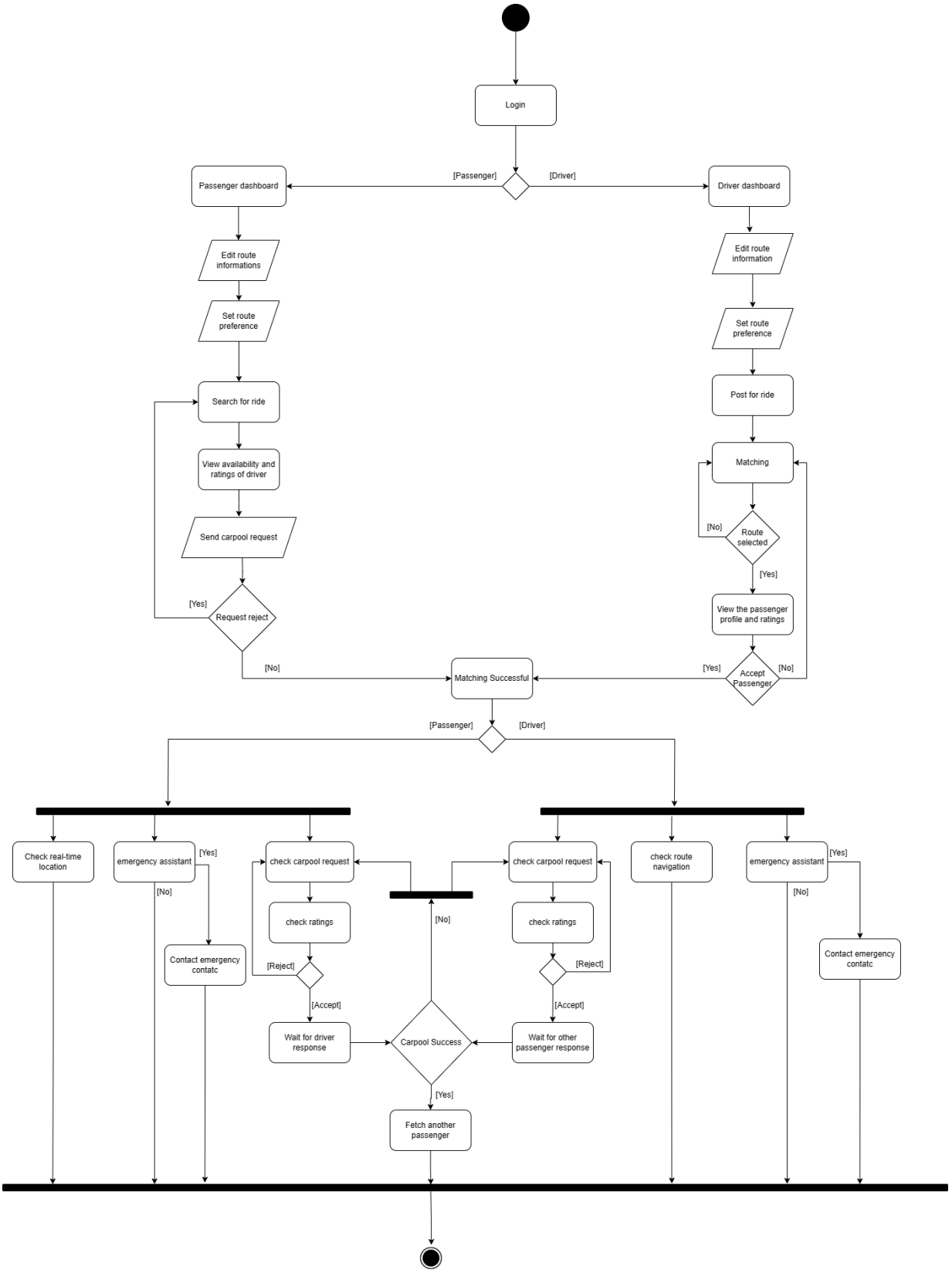

Figure 15: Process View of Carpooling System

Passenger

When logged in as a passenger, the passenger can access the passenger dashboard and modify the route information such as the pickup location, desired time of arrival, etc. After this, passengers can also choose to modify the preference for the ride such as gender of driver, vehicle type and so on. The search results to be displayed. The passenger may view the ratings and basic information of the driver or other passengers in a particular carpool to choose the desired carpool to join. After a particular carpool is selected, a carpool request will be sent to the driver and other passengers in the car. If all members in the carpool agree to the request, then matching is a success. If not, the user needs to search for another ride.

After a successful matching, as a passenger, they can choose to view the real time location of the driver in map view when waiting and also check the real time location of the car after the passengers are being fetched. The passengers can also request the emergency assistant such as access the emergency contact set before the ride by clicking a button on the screen in the case of emergency or danger. The passenger can also check for the carpool request and view the ratings of the other passenger before they decide to accept or reject the request.

Driver

When logged in as a driver, the driver will have to edit the driver route information such as the initial and final destination, followed by the preference edit like gender requirements, number of seats available and car model. When the required and optional information is entered, the route will be posted. After the route is posted, if the route is selected by a passenger, the driver will be notified to respond to the match, which is to accept or reject. If the matching is mutual on both sides, then the matching process is successful.

As a driver, he can choose to check for the efficient route suggested by the GPS navigation software during the trip. The driver can also request the emergency assistant such as access the emergency contact set before the ride by clicking a button on the screen in the case of

emergency or danger. The driver can also check for the carpool request and view the ratings of the other passenger before he decides to accept or reject the request.

Module 3: Dynamic Toll Price

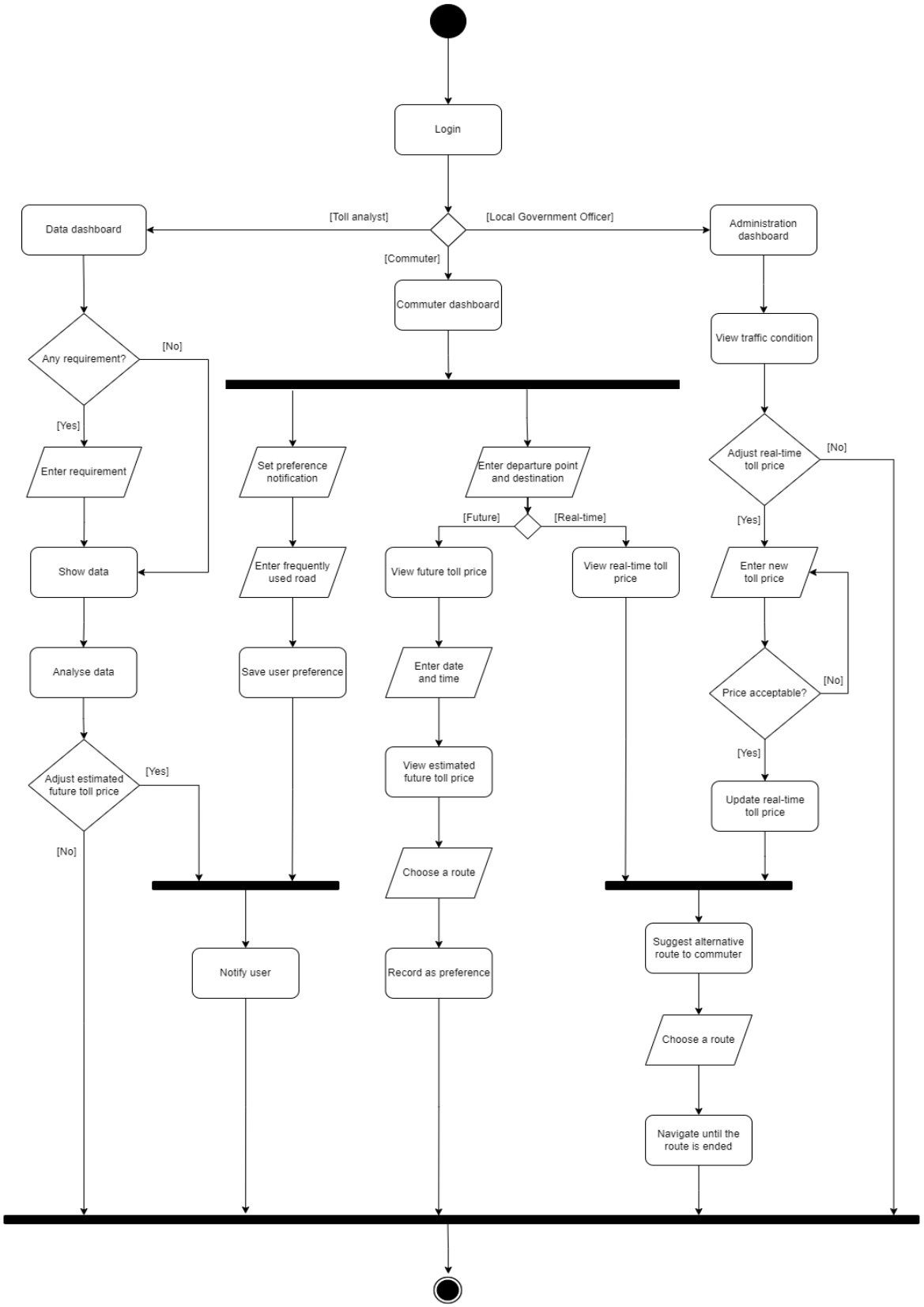

Figure 16: Process View of Dynamic Toll Price Module

Commuter

View Real-Time Toll Prices or Future Toll Price:

Commuters input their trip details to access real-time toll prices and future toll estimates based on specified dates and times. The system promptly displays toll rates for intended routes, continuously updating these prices and suggesting alternative routes based on toll prices and traffic conditions. This empowers commuters to make cost-efficient and well-informed route decisions.

Preference Notification System:

Commuters personalise notification preferences by specifying preferred routes. They receive timely updates on toll rate changes along these routes. This feature aids commuters in making informed route selections, enhancing their travel planning strategies.

Toll Analyst

Request Historical Toll Data:

The Toll Analyst interacts with the system, seeking precise historical toll price data within defined time frames.

Analyse Historical Data:

Upon acquisition of the historical toll price data, the analyst scrutinises trends, patterns, and fluctuations in toll rates. This analysis forms the basis for informed decisions on future toll adjustments or infrastructure planning.

Local Government Officer

Access Toll Pricing Setting:

The Local Government Officer utilises administrative controls to access and modify dynamic toll pricing settings within the system.

Modify Dynamic Toll Parameters:

Using the toll pricing settings, the officer adeptly adjusts factors such as traffic volume, time of day, and other pertinent parameters. These modifications enable real-time adaptability to changing traffic conditions, facilitating efficient traffic flow management within the transportation network.

Module 4: Smart Traffic Monitoring System

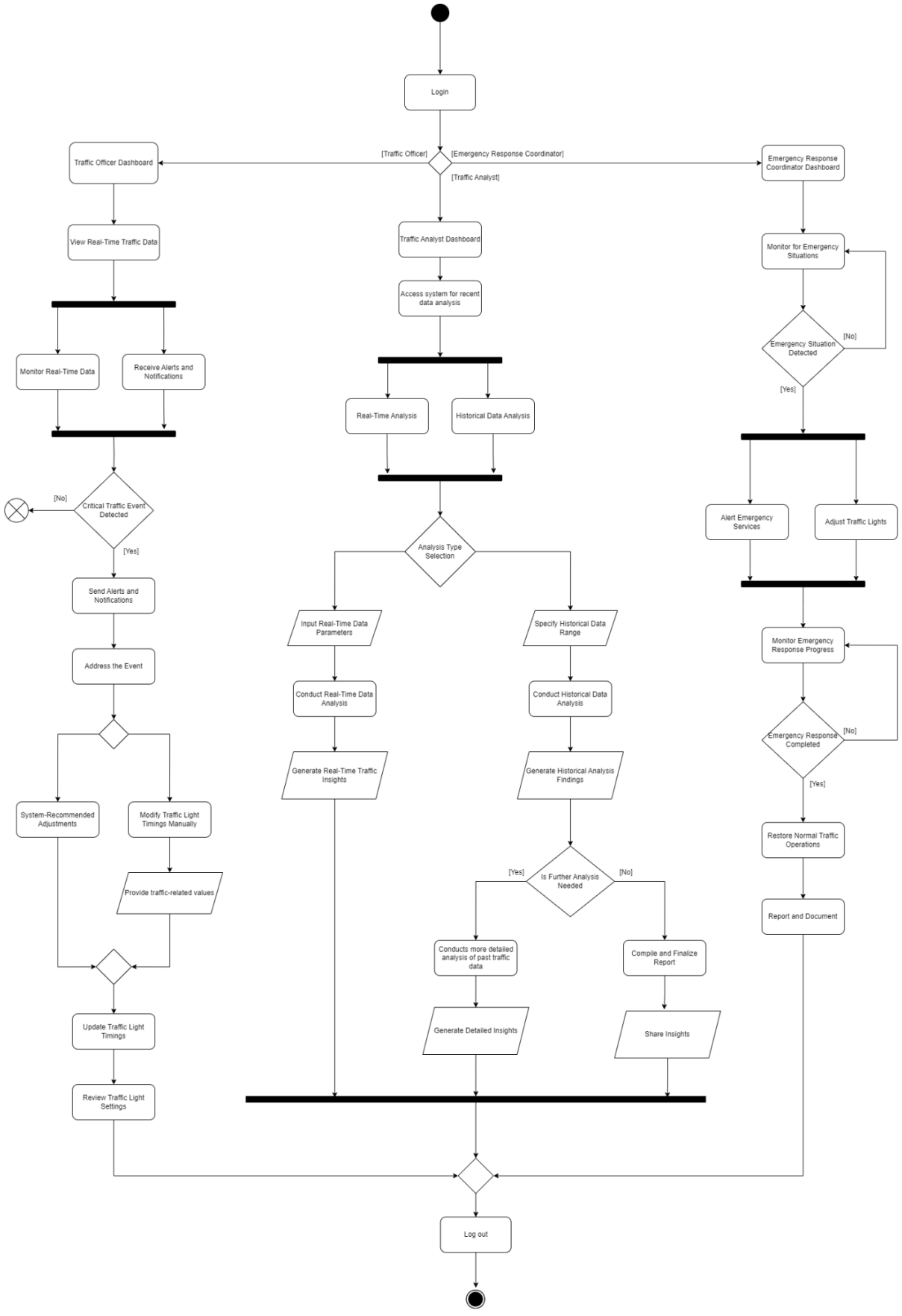

Figure 17: Process View of Smart Traffic Monitoring System

Traffic Officer

During the traffic, the Traffic Officer initiates their tasks by logging into the Traffic Management System. They can choose between two primary tasks: Real-Time Traffic Data Analysis or User Alerts and Notifications. In the Real-Time Traffic Data Analysis path, they input current traffic data, receive recommendations or perform manual analysis, and make decisions to adjust traffic light timings accordingly. Alternatively, if they opt for User Alerts and Notifications, they continuously monitor real-time alerts and respond as needed. After completing their tasks, the officer logs out and documents the actions taken.

Traffic Analyst

The Traffic Analyst, upon logging into the system, decides between two analysis types: Real-Time Traffic Data Analysis or Historical Data Analysis. In the Real-Time Analysis path, they input parameters, analyze data, review recommendations or conduct manual analysis, and make decisions based on insights. In the Historical Data Analysis path, they specify the time range, analyze data, and review insights. If further exploration is needed, detailed insights can be generated. The analyst finalizes the analysis and shares insights with relevant stakeholders.

Emergency Response Coordinator

The Emergency Response Coordinator continuously monitors for emergency situations. Upon detecting an emergency, they initiate multiple actions, including alerting emergency services and promptly adjusting traffic lights to prioritize emergency vehicle passage. Depending on the situation, they may coordinate with law enforcement and clear traffic routes for emergency vehicles. The coordinator closely monitors the progress of emergency response actions. Once the emergency is resolved, they restore normal traffic operations and document the actions taken during the response.

Module 5: Connection with Public Transportation

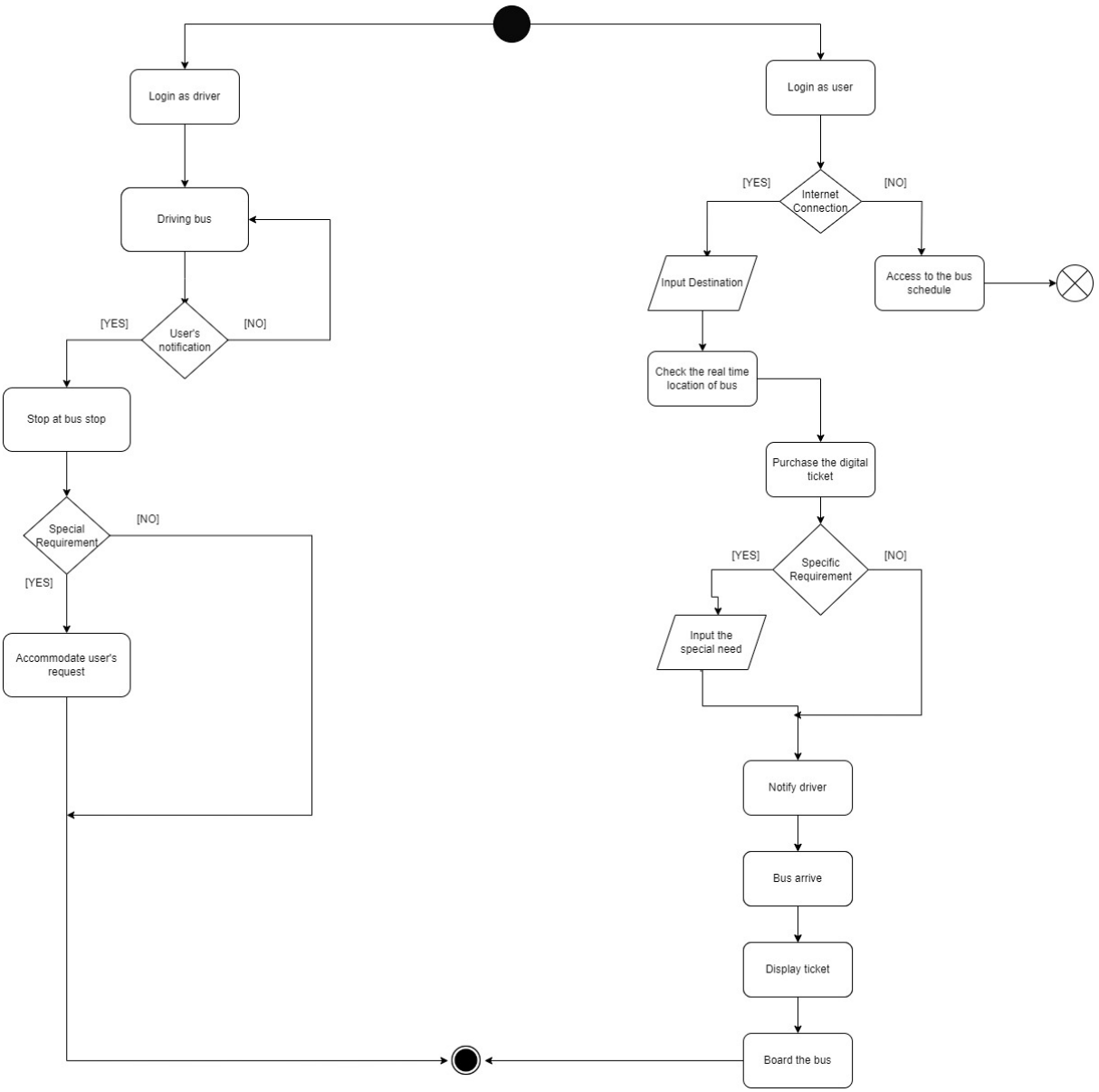

Figure 18: Process View of Connection with Public Transportation Module

Passenger

When logged in as a passenger, users have two options based on their internet connection. If there is no internet connection, they can access the bus schedule. Otherwise, they can input their desired destination to check the real-time bus location. Following that, they can purchase a digital ticket and input any special requirements they may have. After completing all the processes, passengers can notify the driver to ensure they are not missed. Upon the bus's arrival, passengers need only to show the purchased digital ticket, saving a significant amount of time compared to purchasing a ticket directly from the bus driver. Eventually, users can successfully board the bus.

Driver

When logged in as a driver, drivers operate the bus as usual. An electrical dashboard in the bus displays any notifications sent by passengers. When a notification appears, the driver pays more attention to the upcoming bus stop. If not, the driver will continue driving. Upon reaching the bus stop, the electrical dashboard indicates if any special assistance is required by the passenger, prompting the driver to take any necessary steps to assist them. This ensures that passengers are picked up successfully.

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