POLITEKNIK UNGKU OMAR

SMART TRAP CAMERA FOR EMERGENCY LANE (LANEGAURD PRO)

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AUTHOR'S DECLARATION

SMART TRAP CAMERA FOR EMERGENCY LANE (LaneGaurd Pro)

We hereby acknowledge that this report is the result of our work and is created following the regulations provided under the Civil Engineering Final Year Project at the Diploma Studies Centre,

Politeknik Ungku Omar. It is original and based on the research we have conducted. This project has not been produced by any party or institute for any diploma or qualification.

We pledge that if the project violates any specified conditions, all work outcomes will be nullified, considered incomplete for the diploma, or agreed to be subject to any actions as stipulated in the final year project regulations of the Civil Engineering Diploma course.

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APPRECIATION

Grateful to the Divine presence and blessings upon our revered Prophet Muhammad SAW, we have completed the final project excellently within the specified time, without encountering any challenging issues, as a requirement for Diploma in Civil Engineering Diploma.

Our heartfelt appreciation goes to all parties involved, both directly and indirectly, especially to our supervisor, Mrs. Rosmaizul binti Mustapha, who has provided much guidance, advice, encouragement, and constructive criticism, enabling us to complete this final project report. We also extend our gratitude to friends and family members who have contributed significantly in terms of perspectives and financial support in completing this final project assignment. With this, we express our gratitude to Allah SWT, and the final project is now complete.

We hope that this report can serve as an example and guide for relevant parties in the future.

Thank you.

ABSTRACT

In response to the growing challenges associated with unauthorized use of emergency lanes on roadways, this project delves into the design, construction, and assessment of a cutting-edge road control device—the Emergency Lane Camera. The primary objective is to create a robust system capable of monitoring and deterring instances of misuse of the emergency lane, thereby contributing significantly to the improvement of overall traffic management and road safety. The development process involves a comprehensive approach, incorporating advanced imaging technology and intelligent monitoring systems. The implemented prototype serves as a tangible manifestation of theoretical concepts, showcasing the practical application and feasibility of the emergency lane camera in real-world scenarios. The device operates seamlessly to identify, capture, and record incidents of unauthorized emergency lane usage, providing law enforcement agencies with valuable data for improved traffic control. This project extends beyond mere technological innovation; it addresses a critical need in modern urban planning and transportation infrastructure. The effectiveness of the emergency lane camera is evaluated through a series of rigorous tests, examining its accuracy, reliability, and adaptability to diverse environmental conditions. Preliminary results indicate promising outcomes, suggesting the potential for widespread implementation and integration into existing traffic management systems. The outcomes of this research not only contribute to the academic discourse on smart transportation solutions but also hold practical implications for policymakers, law enforcement agencies, and urban planners. By enhancing road control mechanisms, the Emergency Lane Camera offers a scalable and sustainable approach to mitigating the challenges associated with emergency lane misuse, fostering a safer and more efficient traffic environment.

ABSTRAK

Sebagai respons terhadap tantangan yang semakin berkembang terkait dengan penggunaan jalur darurat tanpa izin di jalan raya, proyek ini menyelidiki desain, konstruksi, dan penilaian perangkat kontrol jalan mutakhir—Kamera Jalur Darurat. Tujuan utamanya adalah menciptakan sistem yang kuat mampu memantau dan mencegah kasus penyalahgunaan jalur darurat, sehingga memberikan kontribusi signifikan terhadap perbaikan manajemen lalu lintas secara keseluruhan dan keselamatan jalan. Proses pengembangan melibatkan pendekatan komprehensif, menggabungkan teknologi citra canggih dan sistem pemantauan cerdas. Prototipe yang diimplementasikan berfungsi sebagai manifestasi nyata dari konsep teoretis, memamerkan aplikasi praktis dan kelayakan Kamera Jalur Darurat dalam skenario dunia nyata. Perangkat beroperasi dengan lancar untuk mengidentifikasi, menangkap, dan merekam insiden penggunaan jalur darurat tanpa izin, menyediakan data berharga bagi lembaga penegak hukum untuk pengendalian lalu lintas yang lebih baik. Proyek ini melampaui inovasi teknologis semata; itu menangani kebutuhan kritis dalam perencanaan perkotaan modern dan infrastruktur transportasi. Efektivitas Kamera Jalur Darurat dievaluasi melalui serangkaian uji coba yang ketat, menguji akurasi, kehandalan, dan adaptabilitasnya terhadap berbagai kondisi lingkungan. Hasil awal menunjukkan hasil yang menjanjikan, menunjukkan potensi untuk implementasi luas dan integrasi ke dalam sistem manajemen lalu lintas yang ada. Hasil penelitian ini tidak hanya memberikan kontribusi pada wacana akademis tentang solusi transportasi cerdas, tetapi juga memiliki implikasi praktis bagi pembuat kebijakan, lembaga penegak hukum, dan perencana perkotaan. Dengan meningkatkan mekanisme pengendalian jalan, Kamera Jalur Darurat menawarkan pendekatan yang dapat ditingkatkan dan berkelanjutan untuk mengatasi tantangan yang terkait dengan penyalahgunaan jalur darurat, menciptakan lingkungan lalu lintas yang lebih aman dan efisien.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Around the world, people are extremely concerned about road safety. Emergency lanes are intended to offer drivers a safe sanctuary in case of a breakdown or accident on the road. However, drivers frequently abuse emergency lanes by using them to make phone calls or take breaks, among other things. When emergency services are delayed in arriving at the scene of an accident or breakdown, it can result in dangerous conditions, particularly on crowded routes. An emergency lane video trap can be set to monitor and catch any abuse of the emergency lane to aid with this problem. The camera trap can record photographs of drivers who obstruct emergency lanes or unlawfully park their cars, which can be used to enforce traffic regulations and discourage illegal parking. The camera trap can also speed up the location of an accident or breakdown for emergency services, lowering response times and enhancing road safety [1]. This project is justified because it has the potential to improve both the safety of the driving environment and the effectiveness of emergency services.

1.2 BACKGROUND OF STUDY

On roads across the world, it is a widespread issue for drivers to use the emergency lanes for reasons other than emergencies. When emergency services are delayed in arriving at the scene of an accident or breakdown, it can result in deadly conditions, especially on crowded routes. The inefficient usage of emergency lanes can also increase traffic and lower the overall effectiveness of the road system.

Authorities have put in place several steps to address this problem, including signs and stricter enforcement of traffic laws. These precautions haven't totally prevented the exploitation of emergency lanes, either.

Utilising video traps to keep an eye on the emergency lane and spot any misuse by drivers is one possible approach. The use of camera traps in traffic control is a relatively new use for technology that has been used extensively in wildlife conservation to monitor animal populations.

Studies have shown that video traps are successful at spotting and discouraging unlawful parking and the unauthorised usage of emergency lanes. To fully explore the possibilities of this technology and determine its efficacy in various circumstances, more study is necessary.

Since technology can be used to solve the issue of emergency lane overuse, the proposed project to construct an emergency lane camera trap can contribute to the body of knowledge on traffic management and road safety.

1.3 OBJECTIVE

i) To design a smart trap camera for emergency lane.

ii) To produce a smart trap camera for emergency lane.

iii) To test the effectiveness of smart trap camera for emergency lane.

1.4 PROBLEM STATEMENT

On roads across the world, vehicles frequently abuse emergency lanes. When emergency services are delayed in arriving at the scene of an accident or breakdown, it can result in dangerous conditions, particularly on crowded routes. The issue still exists even though authorities have taken several steps to discourage the unauthorised use of emergency lanes, including heightened enforcement of traffic laws and signs.

By constructing an emergency lane camera trap to track and catch any motorists abusing the emergency lane, the proposed project seeks to solve this issue. The camera trap will photograph drivers who park erratically or utilise the emergency lane for non-emergencies. The photos can be used to rapidly locate the scene of an accident or breakdown as well as to help emergency services police traffic laws and discourage unlawful parking.

As a result, the problem statement for this project is: Despite the implementation of numerous measures by authorities, motorists continue to misuse emergency lanes, which can result in dangerous situations and delays in emergency services, necessitating the exploration of alternative solutions, such as the use of an emergency lane camera trap. Do research using Google Form to get early information about misuse of emergency lanes on the road.

Diagram 1.1 Ambulance stuck in emergency lane.

https://www.carsifu.my/news/road-vigilante-wants-action-against-drivers

Diagram 1.2 World of Buzz article.

https://worldofbuzz.com/driver-blocks-msian-family-from-using-emergency-lane-while-rushing-their-fainted-son-to-the-hospital/

1.5 RESEARCH QUESTION

How well does an emergency lane camera trap work at spotting and discouraging drivers from abusing emergency lanes, and how may it help to increase traffic safety and the effectiveness of emergency services?

This research question aims to investigate the possibility of the emergency lane camera trap as a solution to the issue of emergency lane misuse by drivers. The study will concentrate on the effectiveness of the camera trap in detecting and discouraging illegal parking and misuse of emergency lanes, as well as its potential to improve road safety and the effectiveness of emergency services.

1.5.1 Questionnaire

The questionnaire for the emergency lane camera project is designed to gather feedback from drivers and other stakeholders about the effectiveness of the cameras in detecting and deterring dangerous driving behaviours. The questionnaire will ask specific questions about drivers' experiences with the cameras, including whether they have noticed any changes in driver behaviour since the cameras were installed, whether they feel that the cameras are effective in improving road safety, and whether they have any suggestions for how the cameras could be improved. This feedback will be used to make necessary adjustments to the cameras and improve their overall effectiveness in reducing accidents on highways. Using Google Form to get early information.

Here are some questions that are asked to the public through google form:

i) How frequently do you use highways?

ii) Have you seen drivers using emergency lanes during peak hours?

iii) How frequently do you see drivers using the emergency lane?

iv) Emergency lanes are given priority to emergency vehicles such as ambulances police cars and fire trucks.

v) Accidents can be cleared smoothly when the emergency lane is clear.

vi) Do you think having an emergency lane camera system on highways can help prevent drivers from using emergency lanes?

vii) Are there any other features or functions that you would like to see in an emergency lane camera?

1.6 SCOPE OF STUDY

The proposed study's primary areas of interest are traffic control devices, highway and traffic engineering, and the emergency lane camera trap.

Devices used to control traffic flow and enhance road safety are referred to as traffic control devices. The emergency lane camera trap can be thought of as a traffic control device that use visual cues to identify and discourage drivers from abusing emergency lanes.

On the other side, highway and traffic engineering refers to the design, building, and upkeep of roads, highways, and related infrastructure to guarantee the secure and effective movement of cars and people. A key component of highway and traffic engineering, the planned study will evaluate how well the emergency lane camera trap increases traffic safety and the effectiveness of emergency services.

Installation and use of the emergency lane camera trap will be part of the study on a specified road segment or portions, which will be chosen based on several factors, including the volume of traffic and the frequency of accidents. The effectiveness of the camera trap will be determined by its capacity to identify and prevent the unauthorised

use of emergency lanes, as well as by how it affects traffic flow and the effectiveness of emergency services.

Analysing the information gathered from the video trap, such as the quantity and kind of infractions found, the emergency services' reaction time, and the effect of the camera trap on traffic congestion and delays, would also fall under the purview of the study. The research will advance the understanding of traffic control devices, highway and traffic engineering, and the possibility of the emergency lane camera trap to address the issue of motorists abusing emergency lanes.

1.7 SIGNIFICANCE OF STUDY

1.7.1 Improved Road Safety

The study's main goal is to increase road safety by decreasing the number of road users who utilise the emergency lane for non-emergency situations. As a result, there would be a lower chance of accidents and smoother traffic, especially during emergencies.

1.7.2 Deterrent Effect

Drivers who might be tempted to utilise the emergency lane for non-emergency causes would be discouraged by the presence of an emergency lane camera system. Drivers would be deterred from breaking traffic laws and would be more likely to obey the law if they were afraid of being caught and fined.

1.7.3 Efficient Enforcement

Authorities could more effectively and properly enforce traffic laws if they used an emergency lane camera system. By automatically detecting violations and alerting authorities, the camera system would do away with the need for manual oversight and enforcement.[2]

1.7.4 Cost-Effective

The implementation of an emergency lane camera system would be a cost-effective way to enforce traffic laws because it would eliminate the need for time- and resource-consuming manual monitoring and enforcement.

1.7.5 Scalability

The emergency lane camera system can be easily scaled up or down depending on the traffic volume and the targeted areas. The camera system can be installed in strategic locations to cover the entire stretch of the emergency lane and can be easily relocated if required.

1.8 EMPATHY STUDY

1.8.1 Primary Data

Primary data is important data in the study. Without primary data, the objectives of the project will not be achieved. The data collection process is done through the distribution of questionnaires to respondents online and effectiveness testing toward weather durability with the objective of the project. The diagram below shows the data that has been obtained through a questionnaire distributed online.[3]. The primary data that has been collected through questionnaire twice and testing.

Diagram 1.3 Shows the data from the questionnaire.

1.8.2 Secondary Data

The secondary data consists of a literature review and other sources such as, books related to the field of study, journals and other publications related to the research conducted. These materials are analysed according to their suitability and become the basis of reference to this study.[3]

1.9 DEFINITION OF TERM EMERGENCY LANE CAMERA

A surveillance camera that is positioned on the side of a highway or road and is directed solely toward the emergency lane or shoulder is known as an emergency lane camera. This camera's job is to watch for and catch any instances of unauthorized usage of the emergency lane, which is usually only used by emergency vehicles and in cases of breakdowns or accidents. The camera can be used to monitor traffic movement and spot any risks or impediments in the emergency lane that might need to be dealt with. The emergency lane camera can record video that can be used for traffic control and law enforcement operations.

1.10 SUMMARY

The project aims to build an emergency lane camera system to prevent drivers from misusing the lane. The system uses cameras and analytics software to detect violations and improve traffic flow, safety, and enforcement of traffic rules. The project involves problem definition, research, system design and development, testing, and deployment. The result is a reduction in emergency lane misuse and a more responsible driving culture.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Literature review is a study that is based on true theories and is used in fields related to research such as journals, articles, books, and newspaper studies. Therefore, in this chapter, some theories related to this study will be discussed such as camera traps, the case, and components [4]. The significance of camera traps and their components is the focus of this study. Camera traps and their components are important. It essential to understand camera traps to construct successful emergency lane trap cameras. This study intends to discover best practises and critical components for improving the functioning of emergency lane trap cameras, hence contributing to enhanced road safety and traffic management by examining existing literature.

2.2 HISTORY OF CAMERA TRAPS

Since emergency lane cameras are a relatively recent invention, there isn't much historical data available about them. However, the history of traffic enforcement cameras in general dates to the 1950s.

The term "speed trap camera" refers to a device that uses radar or cameras to take pictures of moving cars that are travelling faster than the posted speed limit. Although the United Kingdom developed the first speed trap camera in the late 1950s, it wasn't until the 1980s that the technology started to spread.

Gatsometer BV, a business in the UK, created the first speed camera system in the late 1950s. Any vehicle going faster than the posted speed limit was photographed by the system using radar to measure vehicle speed. The police were then notified of the photos for use in enforcement.

Paradise Valley, Arizona, saw the installation of the country's first speed camera in 1987. The camera was a fixed device that employed radar to gauge the speed of moving objects and captured pictures of any car going faster than the posted limit. The motorist was then given a citation using the photo as proof.

Since then, speed cameras have proliferated all over the world as numerous nations have adopted them as a means of enforcing speed restrictions and minimising accidents. Today, there are many different types of speed cameras in use, including fixed cameras, mobile cameras, and average speed cameras, which gauge a vehicle's speed over a longer distance than it does at a single location. Speed cameras are a well-liked instrument for law enforcement organisations all around the world, despite debate over their efficacy and worries about privacy. [6]

2.3 TYPES OF CAMERAS IN TRAFFIC CONTROL DEVICE.

Since emergency lane cameras are a relatively recent invention, speed cameras are used for references for designing and building the emergency camera.

2.3.1 Fixed Speed Camera

Diagram 2.1: Fixed Speed Camera

Diagram 2.1 shows cameras that are typically deployed in areas where there is a recurrent problem with speeding, such as on highways, near schools, or in residential neighbourhoods. They can be programmed to enforce a specific speed limit or used in areas where the speed limit varies frequently, such as work zones. The cameras can be outfitted with radar or laser technology to identify the speed of passing vehicles, or they can be outfitted with in-road sensors that determine the speed of a vehicle by measuring the time it takes to move between two spots. When a vehicle exceeds the speed limit, a photograph or video is collected and forwarded to a central database for analysis. Fixed speed cameras, which are frequently stationed in high-traffic areas such as highways, schools, or residential areas, use technologies such as radar, laser, or in-road sensors to detect vehicle speeds, replicating certain characteristics of the emergency lane camera project. When cars violate prescribed limits, data is collected and analysed in both circumstances, adding to traffic management and safety initiatives. [7]

2.3.2 Mobile Speed Camera

Diagram 2.2: Mobile Speed Camera

These cameras (Diagram 2.2) are frequently utilised in isolated or rural regions, where fixed speed cameras are impractical. They can be driven by a law enforcement officer and can be mounted on a tripod or in a vehicle. Mobile speed cameras are deployable in response to shifting traffic patterns or to target problem areas since they may be transported from one place to another as needed. Due to the limitations of fixed installations, mobile cameras are frequently deployed in isolated or rural areas, emphasising the importance of adaptability and transportability, much like the requirements of the emergency lane camera trap project, which seeks to address dynamic traffic situations during congestion by monitoring and capturing violations in various locations as needed. [8]

2.3.3 Red Light Camera

Diagram 2.3: Red Light Camera

To prevent drivers from running red lights, these cameras (Diagram 2.5) are frequently placed at junctions. When a car approaches an intersection after the traffic light has turned red, they can detect it. The cameras, which may be put on a pole or on a traffic signal, can be fitted with video detection technology or roadside sensors. A photo or video is taken and forwarded to a central database for processing if a violation is discovered. Red light cameras are strategically placed at intersections to deter red light violations, mirroring the goal of the emergency lane camera project to improve traffic safety. These cameras, which are frequently installed on poles or traffic signals, use technologies such as video detection or roadside sensors to detect vehicles approaching a red light. When a violation is identified whether at a junction or as part of the emergency lane camera project, a photograph or video is taken and uploaded to a central database for further investigation and enforcement. [9]

2.3.4 Point to point speed camera

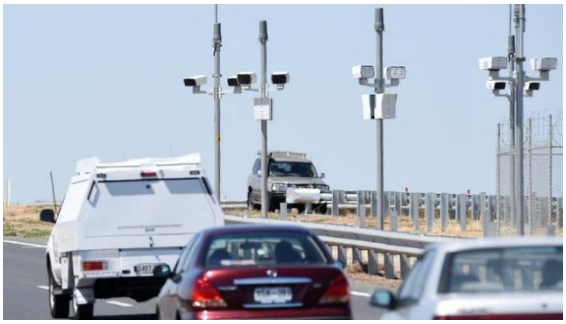


Diagram 2.4: Point-to-point speed camera.

On longer stretches of road, like highways or motorways, these cameras (Diagram 2.4) are employed to enforce speed limits. They operate by monitoring the amount of time it takes a car to go between several points on a road, then figuring out the average speed over that distance. The speed limit-enforcing length of road normally has the cameras mounted at the start and end. The cameras can be either permanent or movable. Point-to-point cameras, which are frequently used on long sections of highway or motorway to enforce speed restrictions, are an excellent example of the value of ongoing speed monitoring, a concept that is in line with the goals of the emergency lane camera project. These cameras, which can be stationary or mobile, track how long it takes a car to travel between different points along a road, eventually computing the average speed across the entire distance. Notably, to assure compliance and improve road safety, these speed enforcement systems, like the emergency lane camera project, often install cameras at both the beginning and ending of the designated road section.[10]

2.4 SMART CAMERA TRAP DESIGN COMPONENTS

The smart emergency lane camera requires camera, power supply, data storage, network connectivity, mounting hardware, software, and housing.

2.4.1 Camera

When selecting a camera, factors like resolution, field of view, battery life, budget and durability are considered. These cameras are selected for smart emergency lane trap. Table 2.1 shows the list of cameras that are selected for monitoring.

Table 2.1 List Types of Cameras

Camera	Description
ESP32 CAMERA  **Diagram 2.5** ESP32 - CAM	- Device combines microcontroller and camera for cost-effectiveness. - Small size allows inconspicuous installation in congested areas. - Integrates easily with Arduino IDE or Micro Python. - Smooth remote monitoring via Wi-Fi and Bluetooth. - Facilitates seamless data transmission for analysis and enforcement. - Strong open-source support from ESP32 community.

	- Energy-efficient and adaptable to various power sources. - Provides sufficient image quality for capturing emergency lane breaches. [11]
DJI OSMO ACTION  **Diagram 2.6:** Dji Osmo Action (Source: https://www.dji.com/global/osmo-action-4)	- DJI Osmo Action records excellent 4K video. - Versatile mounting options for various applications. - Front-facing screen aids in framing shots. - Known for powerful 4K video recording. - Insights for emergency lane camera project. - Accommodates various mounting configurations. - Effective surveillance in dynamic traffic congestion. - Built-in stabilization and front-facing screen enhance recording. [12]
Nest Cam Outdoor  **Diagram 2.7:** Nest Cam Outdoor	- Nest Cam Outdoor withstands elements for outdoor use. - Records HD 1080p video. - Connects to Wi-Fi for remote monitoring. - Large field of view for comprehensive coverage. - Night vision enhances low-light performance. - Unique insights into robust camera technology.

	- Relevant to emergency lane camera project goals. - Contributes to improved traffic safety in adverse conditions. [13]
The Arlo Pro 4  **Diagram 2.8:** The Arlo Pro 4 (Source: https://www.lbtechreviews.com/test/smart-home/arlo-pro-4-spotlight-camera)	- Arlo Pro 4 is a wireless camera. - Records excellent clarity 2K-resolution videos - Connects to Wi-Fi for remote monitoring - Large field of view for comprehensive coverage - Night vision capabilities enhance low-light performance - Motion detection features for added security - Provides convenient and high-quality surveillance. [14]

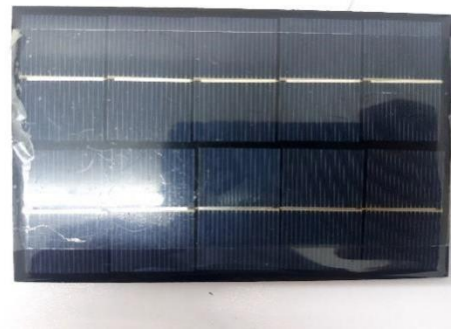
By reviewing these cameras, ESP32 camera is chosen. The ESP32 camera is a justified choice for this project due to its cost-effectiveness, seamless integration with platforms like Arduino IDE or MicroPython, compact design for inconspicuous installation, built-in Wi-Fi and Bluetooth support for smooth remote monitoring and data transfer, energy efficiency, adaptability to various power sources, and strong open-source community support.

2.4.2 Power Supply

When selecting a power supply option, Factors that are considered are reliability, sustainability, cost, and effectiveness in highways. It's also important to ensure that the power supply can provide enough power for the camera and any additional equipment that are used such as network equipment. Table 2.2 shows power supplies are selected for smart emergency lane trap.

Table 2.2 List of Power Supply

Power Supply	Description
Battery Power  **Diagram 2.9:** Battery Power	- Camera powered by rechargeable batteries (Diagram 2.12). - Built-in batteries last several hours. - Factors affecting battery life: temperature, usage, age. - Essential to have spare batteries or a charging solution. - Enables simple installation/removal for emergency lane camera. - Ideal for areas with restricted AC power. - Backup batteries or charging option ensure ongoing operation. [15]

AC Power  **Diagram 2.10:** AC Power (Source:https://www.directindustry.com/prod/b-k-precision/product-18583-1533079.html)	- Regular power adapter (Diagram 2.13) for camera with AC power access. - Ensures a steady and dependable power source. - No concern about battery life or charging. - Not feasible for portable cameras or areas without AC power. - Guarantees continuous camera operation. - Best suited for areas with convenient AC power, next to buildings, or electrically powered infrastructure. [16]
Solar Power  **Diagram 2.11:** Solar Power	- Solar power (Diagram 2.11) as an alternative for distant areas without AC electricity. - Utilizes solar panels to transform sunlight into electricity. - Considerable initial investment may be required. - Reliability in all-weather scenarios may be a concern. - Suitable for emergency lane trap cameras in isolated areas. - Sustainable and environmentally beneficial power source.[17}

By reviewing power supply, battery power is selected because of utilizing rechargeable batteries provides a mobile and versatile solution, enabling simple installation and removal without the need for a fixed power source. This is particularly advantageous for an emergency lane camera, as it allows flexibility in placement without concerns about access to AC power. The built-in batteries offer several hours of operation, and having spare batteries or a charging solution ensures uninterrupted functionality. Additionally, the reliance on battery power minimizes the impact of power interruptions or areas with restricted access to conventional power, making it a reliable and efficient choice for the project's requirements.

2.4.3 Mounting Hardware

When selecting mounting hardware, factors like stability, durability, compatibility, and ease of installation are considered. It's also important to ensure that the mounting hardware is compatible with any additional equipment that are installed, such as lighting or network equipment. Table 2.3 shows mounting hardware are selected for smart emergency lane trap.

Table 2.3 Table of Mountings

Mountings	Description
Pole Mount	- Fixed alternative: Pole mount (Diagram 2.12) for vertical placement. - Useful for high vantage points where tripods may not be practical.

 **Diagram 2.12:** Pole mount	- Chosen based on compatibility and weight sustainability. - Enables flexible and adjustable positioning for emergency lane trap camera. - Provides a higher vantage point for wider vision and better coverage. - Adjustable pole attachments allow setting the camera at the proper angle. - Crafted from robust materials like metal or tough plastic for stability. - Resistant to environmental variables such as wind and vibrations. [18]
Wall mount  **Diagram 2.13:** Wall mount	- Fixed option: Wall mount (Diagram 2.13) for wall or flat surface placement. - Useful for a vertical viewpoint when a pole or tripod is impractical. - Choose a compatible wall mount based on size and material. - Securely mounts the camera on a wall or flat surface. - Ideal for situations where a vertical vantage point is necessary. - Provides necessary support and stability for the camera. [19]

Pole mount is chosen. The choice of pole mounting is practical for the project, offering versatility and a high vantage point. The selected pole mount is compatible, sustaining the camera's weight, and allows flexible positioning for optimal surveillance. Crafted from robust materials, it ensures stability and resistance to environmental factors, making it a reliable and effective solution.

2.4.4 Software

When selecting software, factors like compatibility with the camera and hardware, features and functionality, ease of use, and cost are considered. It's also important to ensure that the software can provide adequate storage and data management capabilities, as well as support for any additional equipment such as lighting or network equipment. Table 2.4 shows the list of software that are selected.

Table 2.4 List of software

Software	Description
Surveillance Software	- Surveillance software organizes and monitors camera videos. - Offers features like motion detection, recording, playback, and remote access. - Examples include VeriLook Surveillance 2.0 SDK, Vizualize, Rhonda Software, and RouteMatch. - Widely used for comprehensive surveillance solutions. [20]

Video Management Software (VMS)	- Sophisticated software for monitoring and analysing camera footage. - Includes features like video analytics, facial recognition, and license plate identification. - Examples include Avigilon Control Centre, Milestone XProtect, and Axon One Centre. - Well-known Video Management System (VMS) options. [21]
Cloud Storage Software	- Camera footage easily stored and accessed with cloud storage. - Common functions include backup, sharing, and remote access. - Well-known examples: Amazon Web Services (AWS) and Microsoft Azure. - Cloud storage software for efficient data management. [22]

In conclusion, cloud storage software is suitable for this project. Cloud storage provides seamless and efficient storage and access to camera footage, ensuring easy retrieval and management. With features like backup, sharing, and remote access, it offers a comprehensive solution for organizing and safeguarding the captured data. Notably, cloud storage eliminates the need for physical storage devices, reducing the risk of data loss and providing scalability. Choosing well-known examples such as Amazon Web Services (AWS) and Microsoft Azure ensures reliability and compatibility with widely used platforms. This option aligns with modern data management practices, offering a flexible and secure solution for the project's surveillance needs.

2.4.5 Data storage

When selecting a data storage solution, factors like capacity, portability, accessibility, security, and cost are considered. It's also a good idea to have a backup plan in case of data loss or equipment failure. Table 2.5 shows the list of Data storage that are selected for LaneGaurd Pro.

Table 2.5 List of data storage

Data storage	Description
Memory card  **Diagram 2.14:** Memory card	- Memory card (Diagram 2.14) for straightforward and cost-effective data storage. - Chosen based on required capacity for camera slot. - Possibility of malfunctions or damage, emphasizes regular data backup. [23]
External hard drive  **Diagram 2.15:** External Hard Drive	- External hard drive (Diagram 2.15) for additional data storage. - Offers greater storage space than a memory card. - Enhanced accessibility when connected to a computer. - Considerations: External hard drives can be heavy and less portable. [24]

Network-attached storage	- Network-attached storage (NAS) device for centralized data storage. - Provides redundancy to prevent data loss. - Allows data access from other devices. - Setup and management of NAS devices can be more difficult and expensive. [25]

The project has opted for Network-Attached Storage (NAS) as its primary data storage solution due to its centralized organization, offering an efficient and accessible repository for camera footage. NAS introduces redundancy, minimizing the risk of data loss and ensuring the availability of crucial surveillance data. This choice aligns with the project's need for reliability, scalability, and remote accessibility, making NAS an ideal solution for storing and managing the evolving volume of camera footage. In short, NAS is selected for its centralized organization, redundancy, and adaptability, addressing the project's requirements for secure and accessible storage of surveillance data.

2.4.6 Network Connectivity

When selecting a network connectivity option, factors like reliability, stability, speed, cost, and availability in the specific location are considered. It's also important to ensure that any network connections are secure and protected from unauthorized access. Table 2.6 shows the network connectivity that are selected for this project.

Table 2.6 List of Network Connectivity

Network Connectivity	Description
Wired Connection (Ethernet)	- Wired connection provides dependable and steady connection. - Utilizes Ethernet wire from camera to nearby network switch or router. - Suitable for stable connections but may be challenging in some locations - Ideal for portable cameras. [26]
Wi-Fi	- Wi-Fi connection is easy and adaptable for camera networking. - Many cameras have built-in Wi-Fi for direct network connection. - Extremely helpful for portable cameras or areas where wiring is impractical. - Wi-Fi connections may be less reliable and prone to interference. [27]
Cellular Network	- Cellular connectivity offers an alternative for camera networking. - Utilizes a cellular modem or hotspot device for internet connection. - Provides network connection without relying on Wi-Fi or wired connections. - May be pricey and not always readily available. [28]

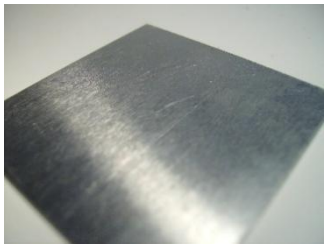
Wi-Fi has been selected as the networking solution for the project due to its ease of connectivity, adaptability, and cost-effectiveness. This choice allows for flexible and wireless camera networking, making it particularly suitable for portable cameras and scenarios where running wires is impractical. In tandem with Wi-Fi, Network-Attached Storage (NAS) has been chosen to provide a centralized and efficient data storage solution. NAS ensures reliable, redundant, and accessible storage, aligning with the project's goals of seamless surveillance and data management. Together, Wi-Fi and NAS form a cohesive and effective combination for the successful implementation of the project.

2.4.7 Casing

When choosing a material for the housing, it is important to consider factors such as durability, weather resistance, and protection against vandalism and tampering. It is also important to ensure that the housing provides sufficient ventilation to prevent overheating of the camera and other components.[29] Table 2.7 shows the list of casing that are selected.

Table 2.7 List of Casings

Casing	Description
Plastic  **Diagram 2.16:** Plastic	- Plastic enclosures (Diagram 2.16) are inexpensive and lightweight. - Simple to install for ease of setup. - Tolerate exposure to sunlight, rain, and humidity. - Weather-resistant for durability and protection.

Fibreglass  **Diagram 2.17:** Fibreglass	- Fiberglass enclosures are strong, lightweight, and weatherproof. - Provide additional UV radiation protection. - Ideal for outdoor installations.
Aluminium  **Diagram 2.18:** Aluminium	- Aluminum enclosures (Diagram 2.18) are well-liked for camera housings. - Lightweight, strong, and resistant to corrosion. - Simple to work with during construction. - Good thermal conductivity aids in heat removal. - Conducts electricity, requiring proper grounding and shielding during design and construction.

Plastic has been chosen as the material for the project's camera enclosures due to its suitability for various reasons. Plastic enclosures, represented in Diagram 2.16, are cost-effective, lightweight, and straightforward to install. They exhibit excellent tolerance to sunlight, rain, and humidity, making them weather-resistant and durable for outdoor applications. The decision to opt for plastic is rooted in its affordability, ease of handling, and resilience to environmental conditions, aligning perfectly with the project's objectives for practical, weather-resistant, and cost-efficient camera housing solutions.

2.5 PSYCHOLOGY OF HUMANS

The study of traffic psychology acknowledges the significant impact that environmental influences have on people's driving behaviour. A technology that gets into drivers' psychology and shapes their attitudes and driving behaviours has emerged among these determining factors: speed cameras. Speed cameras try to influence and change drivers' behaviour when it comes to obeying speed limits by using psychologically based ideas like deterrence, social norms, and cognitive processing. Understanding how human psychology and speed cameras interact can help explain how these tools can effectively encourage safer driving practises and improve traffic safety.

2.5.1 Deterrence theory

The "deterrence theory" is the explanation for how speed cameras can influence people's actions or attitudes. This idea contends that people might be discouraged from engaging in undesirable behaviour, such as speeding, by the fear of punishment or adverse effects.

The deterrence theory is predicated on the idea that people assess the benefits and drawbacks of their options to make sensible judgements. The presence of speed cameras and the potential for paying a fine or penalty in the instance of speeding operate as a perceived cost or adverse effect.

The theory of deterrence explains how speed cameras influence people's actions or attitudes. Speed cameras inhibit undesired behaviour such as speeding by instilling fear of punishment or negative consequences. People consider the prospective costs and rewards, and speed cameras act as a perceived expense, impacting their decision-making. The following components are essential for achieving deterrence, according to deterrence theory:

i) Certainty

People must have the impression that enforcing speed limits and identifying speeders are certain actions. Due to its automatic and constant functioning, speed cameras increase the illusion of certainty because drivers are aware that going over the posted speed limit increases their chances of being detected. Cameras boost the perception of certainty in policing speed restrictions. Drivers are aware that speed cameras function automatically and continually, increasing the likelihood that they will be detected if they violate the speed limit. This increased sense of confidence discourages people from speeding and reinforces adherence to speed limits.

ii) Severity

The benefits of speeding must be sufficiently outweighed by the punishment or penalty for speeding. Speed cameras can document instances of speeding and give authorities the tools to impose fines or penalties, which may be viewed as serious repercussions. Emergency lane cameras help to ensure that the penalties for using emergency lanes improperly outweigh any potential benefits. These cameras provide authorities with the evidence they need to issue fines or penalties by monitoring and documenting instances of unauthorised usage. The harsh consequences of misusing emergency lanes serve as a deterrent, prohibiting drivers from engaging in this behaviour.

iii) Celerity

The penalty must be administered right away and in accordance with the offence. Speed cameras can swiftly gather the required proof, enabling authorities to fine or otherwise penalise drivers who violate the speed limit. The effectiveness of deterrence

is increased by this quick response. Emergency lane cameras provide for rapid penalty administration in compliance with offences, fitting with deterrent concepts. Authorities can efficiently fine or penalise drivers who misuse emergency lanes by obtaining evidence quickly, increasing the effectiveness of deterrent through swift response.

iv) Public Awareness

It's important to educate people about the use of speed cameras and how they're enforced. Public education campaigns, signage, and media coverage can help the punishment seem more certain, severe, and swift, which heightens the deterrent effect.

According to the deterrence theory, people are more likely to change their behaviour and obey speed limits when they perceive a high likelihood of being caught speeding (certainty), expect harsh penalties (severity), expect prompt enforcement (celerity), and are aware of the presence of speed cameras.

It's important to keep in mind that different people respond to deterrence differently, and some drivers may decide to speed even when speed cameras are present. But deterrence theory offers a framework for comprehending how speed cameras can affect people's attitudes and behaviour towards speeding.

2.5.2 Proof of Camera's Affect Humans' Attitudes

These facts and instances provide credence to the idea that speed cameras can influence people's attitudes and actions. It is crucial to remember that the efficiency of speed cameras might change depending on several variables and situations.

i) Studies on driving behaviour

Several studies have looked at how speed cameras affect driving. A study by the Insurance Institute for Highway Safety (IIHS), for instance, discovered that speed cameras were successful in lowering speeding and enhancing road safety. After examining data from numerous sites, the study concluded that speed cameras reduced speeds significantly and decreased the number of crashes involving fatalities and serious injuries.

ii) Official Report

According to official studies, the usage of speed cameras has produced beneficial results for several governmental and transportation organisations. For instance, according to the Australian New South Wales Centre for Road Safety, fixed speed cameras had a 30% reduction in fatal and serious injury crashes. The UK Department for Transport also claimed that speed cameras had a positive impact on lowering average speeds, collisions, and fatalities.

iii) Laws from The Officials

These are some laws that uses camera for inspecting [30]:

i) United Kingdom

In the UK, the use of speed cameras is governed by the Road Traffic Regulation Act 1984 and the Traffic Management Act 2004. These laws provide the legal framework for the installation, operation, and enforcement of speed cameras.

ii) United States

In the United States, the laws regarding speed cameras can differ between states and even within municipalities. Some states, such as Maryland and Washington D.C., have specific legislation permitting the use of speed cameras, while others may have more general traffic laws that authorize their use.

iii) Australia

In Australia, the use of speed cameras is regulated by state and territory legislation. For example, in New South Wales, speed cameras are governed by the Road Transport Act 2013 and the Road Rules 2014.

iv) France

In France, speed cameras are authorized by the French Highway Code (Code de la route). The law provides guidelines on the use of speed cameras, their installation, and the penalties for speeding violations.

2.5.3 Conclusion

In conclusion, traffic management tools like speed cameras have a significant influence on drivers' attitudes and behaviour. Speed cameras try to influence and change drivers' behaviour when it comes to obeying speed limits by using psychologically based ideas like deterrence, social norms, and cognitive processing. Speed cameras can effectively encourage safer driving practises and contribute to increased road safety, according to data and government pronouncements. Given that drivers are more inclined to alter their behaviour when they are aware that their activities are being observed and there is a greater probability of getting caught, the evidence points to a major psychological impact of speed cameras. Therefore, it is plausible to conclude that traffic control device cameras do have an impact on people's willingness to follow the law and that they are an important tool for promoting road safety and lowering accident rates.

2.6 SUMMARY

In conclusion, a multitude of parts and technologies can be combined to create an emergency lane trap camera. A suitable camera meeting the necessary requirements, a dependable and secure data storage device, network connectivity for data transfer, a power source, mounting hardware for installation, appropriate software for processing and analysing data, and a housing to shield the camera from environmental factors are among the required components. Depending on the project's requirements, such as the necessary image resolution, data format, and environmental factors, the precise choice of components will be made [31]. A dependable and efficient emergency lane trap camera can be made with the right combination of these elements. Several components and technologies must be integrated to make an efficient emergency lane trap camera. An appropriate camera, secure data storage, network connectivity, a power source, mounting hardware, data processing software, and a protective casing are required. A

dependable and effective emergency lane trap camera can be built to satisfy project requirements by selecting the proper combination of these parts.

CHAPTER 3
METHODOLOGY

3.1 INTRODUCTION

According to Oxford Dictionary Methodology is defined as a system of methods used to investigate the concept or theories in a particular area of study or activity.

In this chapter, author will describe the research methodology used for this project explain how to design the proposed application, elaborate the procedures and process used in designing the application and data collection as well as provide methods on how to analyse the collected data.

The methodology section of a final year project report outlines the steps followed in carrying out the research, experiments, or studies. This section is essential as it gives a detailed description of the methods utilized in the project, the data collection and analysis procedures, and the theoretical frameworks that informed the research. The methodology section is crucial in ensuring that the findings of the research are reliable, valid and can be replicated [30].

3.2 ADDIE MODEL

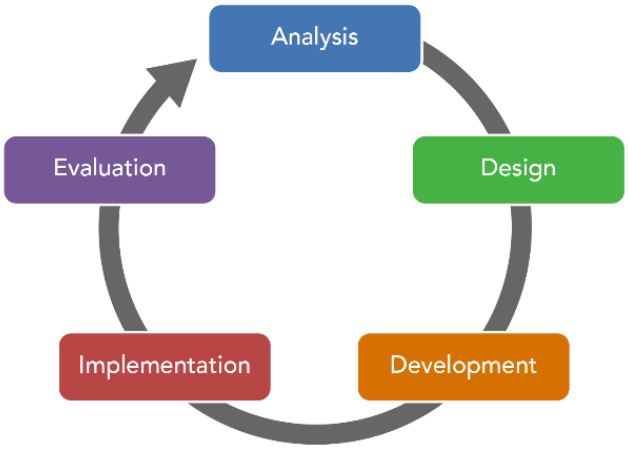


Diagram 3.1 ADDIE Model

Addie model was used to plan and construct efficient learning experiences, instructional designers and training developers employ the ADDIE paradigm.

The ADDIE paradigm is sufficiently general that it may be used to produce any kind of learning experience for any audience, from developing corporate training programmes for an ERP software upgrade to developing K–12 teaching sessions on cellular biology.[7]

At Water Bear Learning, it primarily creates eLearning programmes and training video programmes. It uses an 'eLearning course' as an example of the ADDIE model's output for the remainder of this article. The final learning product can be modified to suit the requirements.[5]

3.3 Research Formwork

Firstly, review of literature. For example, conduct a thorough literature review to establish the current state of research in the field of emergency lane camera technology.

This should include research papers, technical reports, standards, and regulations related to the technology.

Secondly, project objectives and research questions clearly define the objectives of the project and research questions to be answered. Thirdly, research design likes to determine the research design that will be used for the project. This could include a quantitative or qualitative approach or a mixed-methods design. Fourthly, sample selection to determine the target population of the project and select a representative sample for the study. This could include motorists, law enforcement officials, and traffic managers.

Next, data collection to conduct data collection using a variety of methods, including surveys, interviews, and observation. Besides that, data analysis is for use appropriate statistical and analytical tools and methods to analyse the data collected. After that, design of the emergency lane camera system this based on the findings of the research, design and develop the emergency lane camera system. This should include selecting appropriate hardware and software components and developing algorithms for image processing and data analysis.

Next, testing and validation. The test and validate the emergency lane camera system to ensure that it meets the appropriate standards and criteria. This could include field testing and evaluation using real-world traffic scenarios. Lastly, reporting and dissemination such as prepare and present a final report of the project, including the research findings, methodology, and results. Disseminate the results of the project to relevant stakeholders, including concerned authorities and the public. [31]

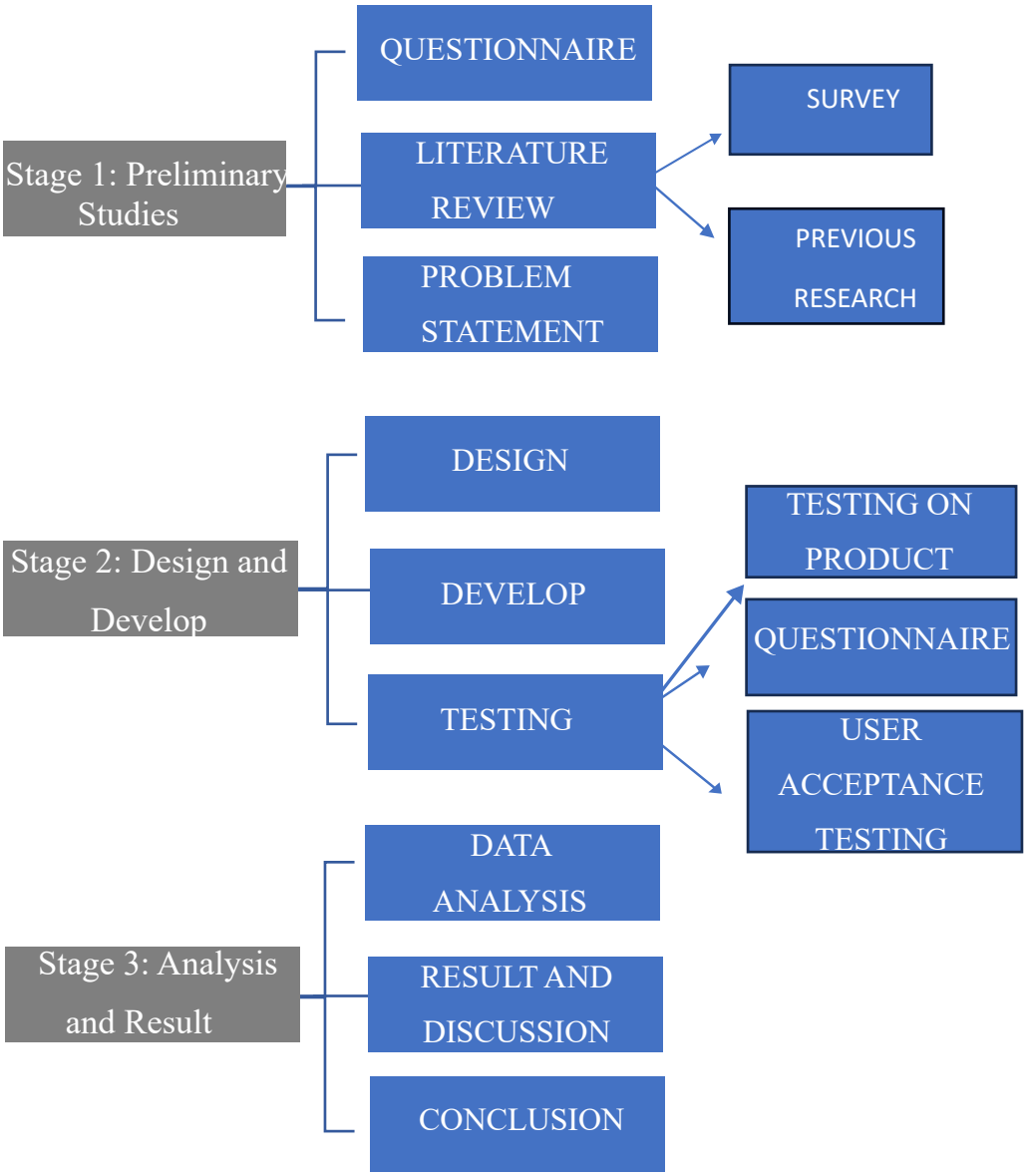


Diagram 3.2 Research formwork of emergency lane camera

3.4 Develop

Project development involves organizing and planning all the variables that go into a project, including deciding materials, creating a budget, and creating tasks for team members. It also involves the processes needed to complete a project, like changing the plans throughout project completion and identifying areas of improvement to help the project run more smoothly. Here are several items to keep in mind throughout project development:

i) Goals: The goals of a project are the intended outcomes for the project to accomplish, and they can include long-term or short-term goals for a workplace.
ii) Timeline: The timeline of a project shows the schedule for when team members should complete their project tasks, which ensures team members coordinate with the development plans and complete their tasks on time.
iii) Materials: These involve the resources and equipment needed to complete a project.
iv) Budget: This is the total amount of finances that can spend on a project, and it usually depends on the cost of materials and labour for a project.

3.4.1 Software development

In this project, certain software is used that will successfully activate the emergency lane camera. Here are 3 of the software that were used [34]:

i) Coding: Arduino

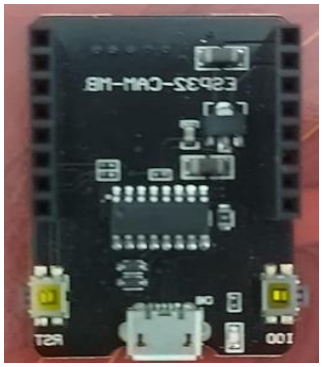


Diagram 3.3: Arduino

An open-source electronics platform called Arduino is built on simple hardware and software. A motor can be started, an LED can be turned on, and something may be published online by using an Arduino board to receive inputs like light on a sensor. Sending a set of instructions to the board's microcontroller will instruct the board what to do.

ii) System: ESP32

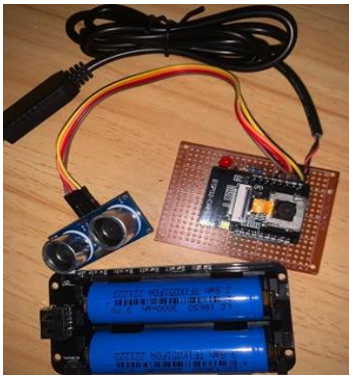


Diagram 3.4: ESP32 Software

The ESP32 software for the smart camera in the project is designed to monitor and capture any unauthorized vehicles or objects that enter the emergency lane. It utilizes the ESP32 microcontroller, which is a powerful and low-cost chipset that integrates Wi-Fi and Bluetooth connectivity.

The software is responsible for controlling the functionality of the smart trap camera, including capturing images or videos whenever motion or an object is detected in the emergency lane. It uses image recognition algorithms to recognize vehicles and differentiate between authorized and unauthorized ones.

3.4.2 Hardware development

a) Material and function

i) Ultrasonic sensor

In the project, sensors used as a motion detector where it can sense physical movement in a defined space (the field of detection) and can be used to control lights, cameras, parking gates, water faucets, security systems, automatic door openers and numerous other systems. The sensors typically send out some type of energy such as microwaves, ultrasonic waves or light beams and can detect when the flow of energy is interrupted by something entering its path. [35]

ii) ESP32 camera

Due to its small size, low cost, and superior image and video capturing capabilities, the ESP32 camera is a great fit for the project. It's a viable option for monitoring and capturing violations in emergency lanes amid traffic congestion because it has built-in

Wi-Fi for seamless data transmission and remote monitoring. “LaneGaurd” project is a wonderful fit for it because of the strong community support it enjoys and the power-efficiency that goes along with its dependability.

iii) Solar panel

Because they are efficient and environmentally friendly, solar panels are the perfect power source for the batteries in th concept. They use solar energy to charge the battery, preventing the need for regular battery replacement or recharging and assuring an ongoing power source. The objectives of the project's sustainable traffic monitoring are nicely matched by this environmentally friendly strategy. "LaneGaurd" system can be kept active even in remote areas without access to traditional power sources because to solar panels' low cost and ease of installation and maintenance.

iv) Casing

Utilizing a junction box for the housing of LaneGaurd Pro project proves to be a prudent choice for various reasons. These enclosures are adept at ensuring electrical safety by providing a secure space for connections, thus mitigating the risk of electrical hazards. Furthermore, junction boxes facilitate organized cable management, preventing potential issues arising from tangled or exposed wires. Their resistance to

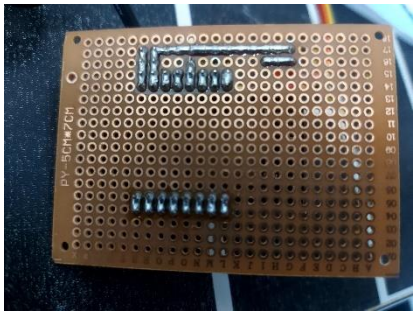
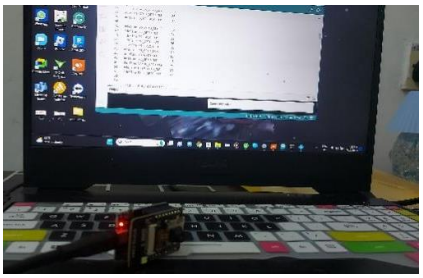
environmental factors such as dust and moisture makes them suitable for diverse conditions, ensuring the longevity and reliability of the device. The ease of maintenance and adaptability in size and configuration add to the appeal, allowing for convenient inspections, repairs, and customization based on project requirements. By incorporating a junction box, the project not only adheres to electrical safety standards but also presents a professional and neat appearance, enhancing the overall reliability and aesthetic appeal of the housing.

3.4.3 Procedure

Throughout the LaneGaurd Pro development, these are the procedures that also involved software and hardware development process. Table 3.1 shows the procedure of LaneGaurd Pro

Table 3.1 Procedure of LaneGaurd Pro

Procedure	Diagram
• System - ESP32-CAM is used for the camera system and the system is inserted with an internet connection. - The system works only when there is an internet connection. - The ESP32-CAM is attached to a circuit board.	

• Wiring - The ESP32-CAM is soldered to the board. - Power input wires are soldered beside the ESP32-CAM system. - LED is also soldered for ignition purposes.	
• Coding - Arduino is used for coding software. - The coding is set for sensors and respond to camera. Once the sensor senses the vehicle, the camera captures. - The captured image is then uploaded in Telegram bot. - The coding activates the Wi-Fi to connect.	
• Casing - Camera casings serve several functions, including protecting the camera from various environmental factors, particularly when weather conditions change. - casings provide waterproof, preventing rain or moisture from reaching the camera. • preventing overheating in warm conditions and providing insulation against the cold to maintain optimal camera performance.	

Throughout the hardware development, the system components are checked for any defect before proceeding to the next development. Then, Wiring is done by soldering the wires on chipboard. The board is then checked by connecting power to the board.

Third, coding is done to connect the sensor's response to camera and telegram bot is created for the software.

3.4.4 Testing

Testing is an integral part of the emergency lane camera project to ensure that the system meets the required standards and functions effectively. To ensure it, 3 methods had been used to test the product, which is test on product, questionnaire and user acceptance testing. The following are the steps for testing an emergency lane camera system.

a) Testing on product

First and foremost, testing on a product is started with testing product during various kind of condition. Conducting test on the system in real-world traffic scenarios and environments to evaluate the system's performance and effectiveness. Testing in different weather conditions and at various times of the day or night will ensure general effectiveness.

Other than that, the product also conducted a test for speed limit to test the hardware components such as cameras, servers, and communication systems to ensure that they function correctly and reliably. Conduct testing to ensure that the software modules, algorithms, and image processing capabilities are functioning optimally.

A response test was also conducted which involves testing the emergency lane camera system as a complete solution. The test should verify that the emergency lane camera system components communicate effectively and ensure relevant authorities receive notification of violations promptly.

Finally, conducting data validation testing to verify that the system accurately captures the data. Data analysis tools can be used to compare the image annotations and alarms with the video feeds captured.

b) Questionnaire

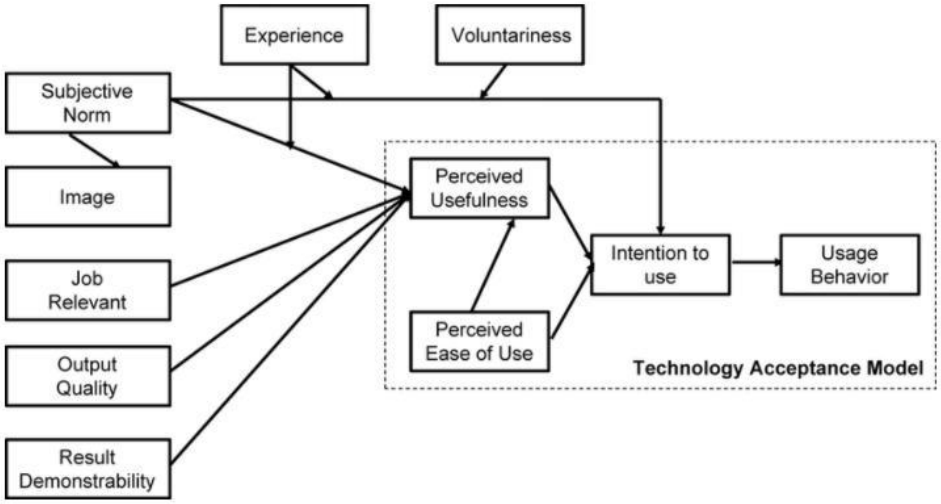


Diagram 3.5 Technology Acceptance Model (TAM)

The questionnaire for the emergency lane camera project is designed to gather feedback from drivers and other stakeholders about the effectiveness of the cameras in detecting and deterring dangerous driving behaviours. The questionnaire will ask specific questions about drivers' experiences with the cameras, including whether they have noticed any changes in driver behaviour since the cameras were installed, whether they feel that the cameras are effective in improving road safety, and whether they have any suggestions for how the cameras could be improved. This feedback will be used to make necessary adjustments to the cameras and improve the overall effectiveness in reducing accidents on highways. Using Linked Scale of Oxford Interpretation 1990.

Here are some categories of questions that are asked the public through google form:

i) Info user category
ii) Intention category
iii) Design category
iv) Ease of use category

c) User acceptance testing

Obtain feedback from end-users on the user interface, ease of use, and navigation to identify areas of improvement. This testing should include stakeholders such as traffic managers, law enforcement officials, and motorists. User acceptance testing (UAT) for an emergency lane camera would involve testing the camera system with representative end-users to ensure that it meets their requirements and is fit for its intended purpose. This could involve testing the camera's image quality, its ability to capture license plate numbers, its durability in different weather conditions, and its ease of use and maintenance. The goal of UAT is to ensure that the camera system is functional, reliable, and user-friendly, and that it meets all relevant safety and regulatory requirements.

For user acceptance testing The Technology Acceptance Model (TAM) are used. TAM models are useful for analysing the acceptance and adoption of smart trap cameras for an emergency lane project. The TAM model focuses on two main constructs: perceived usefulness and perceived ease of use. By assessing these factors, researchers can gain insights into how individuals' attitudes and intentions towards using these cameras can influence their actual usage behaviour.

3.5 Data Analysis

To carry out this study, there are data collection methods that have been practiced obtaining data that is important for the analysis stage. Among the data collection methods is the questionnaire method. Data collection can be classified into two types, namely primary data, and secondary data.

3.6 Conclusion

In the initial stage, project develop, testing, questionnaire, user acceptance testing, and data analysis is done systematically in a methodological study to find out the facts and information to support the research instrument and describe it more clearly in this study.

After the analysis of the data is done, it is important to make a conclusion on the results and hypotheses, in example whether the camera trap is effective or not. After the analysis of the data is done, it is important to make a conclusion on the results and hypotheses, whether the camera trap is effective or not.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter provides an explanation of the reasons behind the project's development. This project's findings were presented in accordance with the following goals.

i) To design a smart trap camera for emergency lane.
ii) To produce a smart trap camera for emergency lane.
iii) To test the effectiveness of smart camera for emergency lane.

Table 4.1 shows the objective, method, and element of this project.

Table 4.1 Objective, Method, and Element of Project

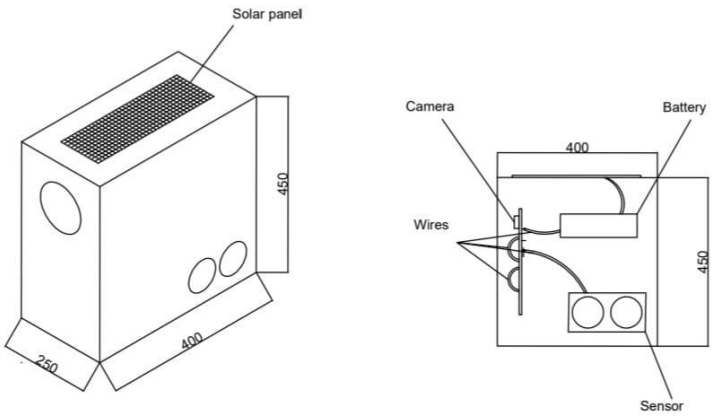
Subtopic	Objective	Method	Element of data presentation	About
4.1	To design a smart trap camera for emergency lane.	Design	AutoCAD	The design of LaneGaurd Pro product using software.
4.2	To produce a smart trap camera for emergency lane.	Develop	Product	Developed LaneGaurd Pro product using hardware.

4.3	To test the effectiveness of smart camera for emergency lane.	Testing	Table/graph	The usability of LaneGaurd Pro product.

4.2 Design LaneGuard Pro using AutoCAD.

Throughout the LaneGaurd Pro development, AutoCAD was used to picture the model. Table 4.2 shows the diagram that had been created.

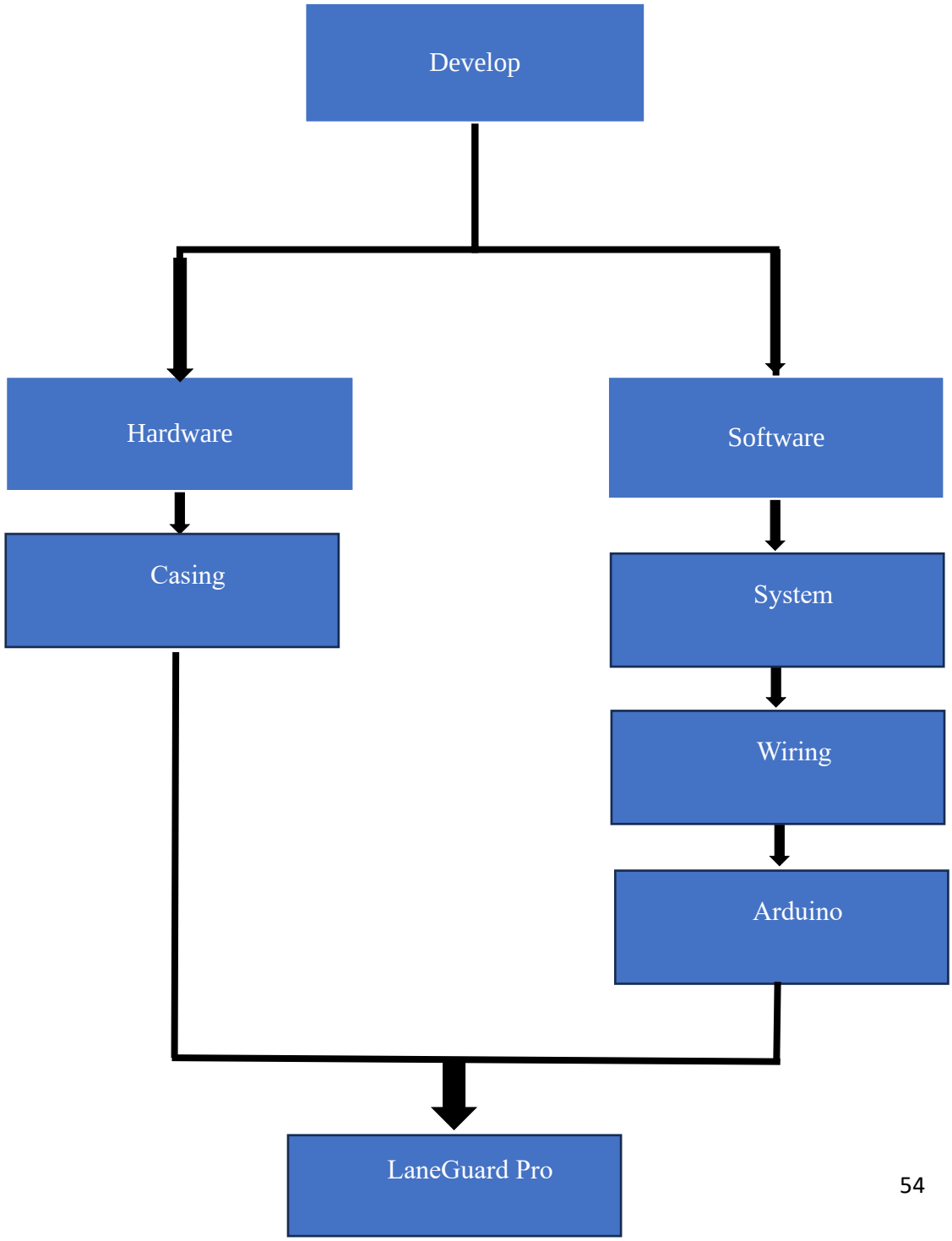
Table 4.2 AutoCAD Design Diagram

Content	Diagram
Model is created using AutoCAD to picture the model.	

4.3 Develop LaneGaurd Pro

Throughout the LaneGaurd Pro development, it involved software and hardware development process. Diagram 4.1 shows the process development of LaneGaurd Pro

Diagram 4.1 Process Development of LaneGuard Pro



4.3.1 Picture of Actual Product

Diagram 4.2 LaneGaurd Pro product

4.4 USABILITY OF LANEGAURD PRO PRODUCT.

The usability of LaneGaurd Pro can be used to highway authorities such as The Road Transport Department Malaysia (JPJ) and The Malaysian Public Works Department (JKR). Two tests are conducted for this product which are:

4.4.1 Testing the effectiveness.

This testing is conducted under two categories which are conditions and sensor. Table 4.3 shows the testing result for conditions during daytime, Table 4.5 shows the testing result for conditions during nighttime and table 4.7 shows the testing result for sensor.

Purpose: To test camera effectiveness during various weather and condition on daytime

Table 4.3 Weather Conditions (Daytime) Testing Table

DAYTIME	**COMPONENTS**				
	CAMERA				
DAY	1	2	3	4	5
DATE	17/11	18/11	19/11	20/11	21/11
TIME FRAME	10 – 11 am	12 – 1 pm	1-2 pm	3-4 pm	4-5 pm
TEMPERATURE	29ºC	30ºC	31ºC	29ºC	26ºC
WEATHER CONDITION	-sunny -a little foggy	-sunny	-sunny -high temperature	-cloudy	-raining -foggy
REMARKS	Good	Good	Blur	Good	Blur

According to the result, it can be concluded that this camera can work well except in heavy rain weather and hot temperature above 31 degrees Celsius. This can be justified by referring to the results presented in Table 4.3, which show that the camera was able to capture images successfully on days 1, 2, and 4, when the weather conditions were not extreme. However, on day 3, when the temperature rose above 31 degrees Celsius, the camera did not work. Similarly, on day 5, when heavy rain and foggy conditions were present, the camera was not able to capture clear images. Therefore, it can be concluded that the camera can work well in most weather conditions but may not function properly in extreme hot or wet conditions. In conclusion, for future planning an improvement can be made on the camera area is placed and stored in a heat-resistant case and the quality of the camera can be improved so that it can capture images in various conditions and weather. Table 4.4 shows the images captures result for the test.

Table 4.4 Result Testing on Weather Condition (Daytime)

Day	**Example of Image Taken**
One	
Two	

Three	
Four	

Purpose: To test camera effectiveness during various weather and conditions at nighttime.

Table 4.5 Conditions (Nighttime) Testing Table

NIGHTTIME	**COMPONENTS**				
	CAMERA				
DAY	1	2	3	4	5
DATE	17/11	18/11	19/11	20/11	21/11
TIME FRAME	7-8 pm	8-9 pm	8-9 pm	9-10 pm	8-9 pm
TEMPERATURE	27ºC	28ºC	27ºC	25ºC	26ºC
WEATHER CONDITION	-cloudy	-cloudy	-cloudy	-heavy rain -foggy	-heavy rain -foggy
REMARKS	Good	Good	Good	Blur	Blur

Based on table 4.5, the result of the testing carried out for 5 days, it was found that on the 4th and 5th day of testing, the camera cannot capture the image clearly due to heavy rain and foggy conditions at that time. According to the result, it can be concluded that the camera can work well except during heavy rain and foggy conditions. Table 4.6 shows the result for the test. In conclusion, for the future an improvement to quality of camera can be made so that it can capture images in various weather at night.

Table 4.6 Result Testing Table on Weather Condition (Nighttime)

Day	**Example of Image Taken**
One	
Two	
Three	

Four	
Five	

Purpose: To test sensor's average distance to detect vehicle movement.

Table 4.7 Sensor Testing Table

SENSOR	**REMARKS**					**AVERAGE**
DAY	1	2	3	4	5	
RIGHT CAPTURES	5	5	5	5	5	1.5 meters
FALSE CAPTURES	2	1	1	2	2	Up to 1.5 meters

Based on table 4.7, the result of the testing carried out for 5 days, it was found that on 2nd and 4th day the sensor cannot detect vehicle movement for few times because of

the distance was up to 1.5 meters. Based on the result, it can conclude that the camera can work well except when the distance is up to 1.5 meters. In conclusion, for the future an improvement to sensor can be made so that it can detect vehicle movement in any distance.

4.4.2 Questionnaire

Questionnaire is taken by referring to the technology acceptance model to get the acceptance of road users towards LaneGaurd Pro product. The questions are divided into four categories which are Point of view, Intention of use, Design of product and ease of use of the product. Table 4.8 shows the result of questionnaire.

Table 4.8 People's perception of LaneGaurd Pro

Question	**Rating**				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Point of View					
Do you think the concept of camera traps is important for monitoring the emergency lane?	1 (2.2%)	0 (0%)	3 (6.5%)	7 (15.2%)	36 (76.6%)
Did you find many road users tend to use the emergency lane for legitimate reasons (e.g., vehicle breakdown, medical emergency)?	1 (2.1%)	1 (2.1%)	7 (14.9%)	12 (25.5%)	26 (55.3%)

Intention					
Emergency camera lanes are an effective way to enhance public safety?	0 (0%)	2 (4.3%)	2 (4.3%)	12 (25.5%)	31 (66%)
Do emergency camera lanes improve response times for emergency services?	0 (0%)	0 (0%)	4 (8.5%)	16 (34%)	27 (57.4%)
The implementation of Lanegaurd Pro can contribute to reducing traffic accidents?	1 (2.1%)	0 (0%)	6 (12.8%)	16 (34%)	24 (51.1%)
How likely will you consider using LaneGuard Pro to improve emergency lane monitoring?	2 (4.3%)	0 (0%)	7 (14.9%)	12 (25.5%)	26 (55.3%)
Design					
How satisfied are you with the perceived quality of LaneGuard Pro based on the provided information?	1 (2.1%)	0 (0%)	7 (14.9%)	14 (29.8%)	25 (53.2%)
Do you think the design of Lanegaurd Pro is suitable for Malaysia's weather?	1 (2.1%)	0 (0%)	8 (17%)	18 (38.3%)	20 (42.6%)

Did you think that a camera is the most important thing to resolve the misuse of emergency lane problems?	2 (4.3%)	0 (0%)	7 (14.9%)	18 (38.3%)	20 (42.6%)
Please rate the importance of specific quality criteria for an emergency lane trap system. like Lane Guard Pro.	0 (0%)	2 (5%)	3 (7.5%)	17 (42%)	18 (45%)
Ease of Usage					
How useful do you believe LaneGuard Pro would be for road users and authorities in improving emergency lane usage?	0 (0%)	0 (0%)	6 (12.8%)	12 (25.5%)	29 (61.7%)
Do you agree with the potential impact of LaneGuard Pro in reducing misuse of emergency lane and improving road safety.	1 (2.1%)	1 (2.1%)	6 (12.8%)	16 (3.4%)	23 (48.9%)

By referring to table 4.8, it can be concluded that the majority responders strongly agree with the point of view questions which are 65.95 % on average, strongly agree with intention category questions which are 57.4 %. Design category questions have 45.85% for strongly agree option and 55.3% for strongly agree in ease of usage category. The mean score of each category is calculated to get the interpretation.

Table 4.9: Interpretation level for LaneGaurd Pro based on Oxford Interpretation (1990)

Level	Mean score
Low	1.0 – 2.4
Medium	2.5 – 3.4
High	3.5 – 5.0

Table 4.10: Level of Response for LaneGaurd Pro

Category	Mean score	Interpretation
Ease of usage	4.37	High
Intention of use	4.40	High
Design	4.24	High
Point of view	4.47	High

Based on the findings that have been summarized in Table 4.10, the analysis found that the mean for each item of the evaluation aspect was in the range between 4.24 and 4.47. The mean score that has been obtained for each level is at a high level based on Table 4.9 interpretation of Oxford 1990. The results of the study show that LaneGaurd Pro is very helpful for road users to ensure smooth traffic flow. In addition, road users also provide comments suggesting improvements to this product.

CHAPTER 5

DISCUSSION, RECOMMENDATION AND CONCLUSION

5.1 INTRODUCTION

Discussions are conducted to raise questions related to the project throughout the production of the project. This discussion is to ensure that all work methods can be carried out and reported in the report as well as the completed project can be fully operational. These discussions are also conducted from time to time to ensure that the objectives are fully achieved. On the other hand, the results of the work produced are likely to be at a moderate level and less satisfactory if there is no proper planning. After discussion and research, a project called LaneGaurd Pro was produced. The process of modifying and programming LaneGaurd Pro includes several stages. Among the matters and issues that need to be discussed are in terms of the quality of the project, the survey, and the level of effectiveness of the project. In addition, daily tasks are also arranged to be done every week to ensure that the production of the project runs smoothly.

5.2 DISCUSSION

LaneGaurd Pro has successfully achieved the objective. The purpose of this project is to produce smart trap cameras for emergency lanes and reduce emergency lane abuse statistics. In terms of cost, this project is very affordable, and the cost can be reduced if the production is made a real measure. In terms of quality, this project can reach a

satisfactory level because it is made from quality materials. During the production process of this LaneGaurd Pro, there were issues and problems faced, namely the poor quality of the camera. To deal with this problem, the camera used can be improved in the future.

The result showed that road users were agreeing that LaneGaurd Pro is the effective device to reduce emergency lane misuse. Based on questionnaire that had been done, most road users agree with the level of effectiveness of this project. Most of responders is male which is 60.3% and the highest age range is 20-30 years old for 54.8% which is active road users. The mean value method is used for calculation and for interpretation for each category is high. The mean score for point of view category is 4.47, intention category (4.40), design category (4.24) and ease of use category (4.37). So, this product was highly recommended to be used.

5.3 RECOMMENDATION

After a few tests that had been taken and because of the above findings, there are some suggestions that would like to suggest that can be used as a follow-up action for the improvement of LaneGaurd Pro. This device is a good product but there are some things that need to be improved so that this LaneGaurd Pro becomes more quality and effective in the future. So, here are some suggestions to improve this device for better use for road users.

First, if this device will be used later, the camera used by LaneGaurd Pro can be changed to an AI camera because this camera can capture pictures and can detect number plates more clearly. In addition, the quality of the resulting images is better.

Not only that, based on tests that have been taken after a few days, the pictures taken on a rainy day are less clear. So, the suggestion is to add a durable storage place to put

this device to reduce the disturbance when this device is in use. As a result, the result of the photo and number plate will not be affected.

The conclusion, this improvement is important to produce the best quality device for the project. LaneGaurd Pro can give the effectiveness of how this device functioned for emergency lane. By using LaneGaurd Pro it can reduce the misuse of emergency lane in Malaysia which often occurs. It can also discipline road users and the road conditions in Malaysia will become more orderly.

5.4 CONCLUSION

In conclusion, a product has been created that is useful, and it benefits mainly road users which is in line with the main objective. This project took 6 months to produce. In addition, experience, and traditional knowledge such as report writing and data collection methods and providing more systematic information are gained. The experience gained was how to solder the board in the right way, do the coding using Arduino, prepare the camera case, and so on. Overall, the main objectives of the project are achieved. The objective of the specification is to design a smart trap camera for emergency lanes. Next, produce smart trap cameras for emergency lanes. The effectiveness of smart cameras for emergency lanes is determined through 3 methods, namely testing on product, questionnaire, and user acceptance test. Discussion and collaboration between group members is also some of the keys to success in completing this project.

The Lane Guard Pro was successfully implemented and tested on the emergency lanes. Besides that, the camera effectively detected and alerted authorities of any unauthorized vehicles using the emergency lane, the camera's high-resolution images provided valuable evidence for enforcement purposes and the Lane Guard Pro significantly improved the safety and efficiency of emergency lanes, preventing misuse and ensuring quick response to emergencies.

Further actions may include by sharing the success of the Lane Guard Pro project with relevant parties, such as stakeholders, project managers, and government agencies, providing a comprehensive report documenting the implementation process, test results, and benefits achieved, conducting training sessions or workshops to educate officials and personnel about the functionality and operation of the Lane Guard Pro system and exploring possibilities of expanding the project to other areas with similar requirements.

Overall, the Lane Guard Pro project has been deemed a success in enhancing the safety and effectiveness of emergency lanes.

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