DESIGN AND DEVELOPMENT OF TRIANGLE EMERGENCY HAZARD LIGHT FOR MOTORCYCLE UNDER 150CC

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (AUTOMOTIVE TECHNOLOGY) WITH HONOURS

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Faculty of Mechanical Technology and Engineering

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A thesis submitted
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I declare that this thesis entitled “Design and Production of Triangle Emergency Hazard Light For Motorcycle Under 150CC” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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DEDICATION

I dedicate this final year project to my loving and supportive parents, who have always believed in me and encouraged me to pursue my dreams. Your unwavering faith in me has been the bedrock of my success, and I am forever grateful for your love and guidance.

To my amazing friends, who have stood by me through thick and thin, thank you for your constant encouragement, laughter, and camaraderie. Your presence has made this journey more enjoyable and fulfilling.

Lastly, I would like to express my heartfelt gratitude to my esteemed supervisor, who has provided invaluable guidance, expertise, and mentorship. Your passion for the subject and dedication to my success have been truly inspiring, and I am honored to have had the opportunity to learn from you.

Thank you all for being a part of this incredible journey and contributing to the completion of my final year project. I couldn't have done it without you.

ABSTRACT

An emergency hazard light is a crucial safety feature for motorcycles under 150cc. However, designing a reliable and effective hazard light system can be challenging due to various factors. Issues such as suboptimal visibility and inadequate positioning can significantly compromise safety measures during emergencies. Consequently, the imperative arises to engineer a hazard light system that not only meets but exceeds the criteria of optimal design and strategic placement. To tackle these challenges, a holistic approach is adopted, weaving together advanced design techniques and judicious manufacturing methods. The intricate dance of design conceptualization unfolds within the realm of Computer-Aided Design (CAD) software, providing a canvas for precise visualization and iterative modification. A systematic evaluation, utilizing the Pugh technique, guides the selection of the most fitting design solution. Noteworthy emphasis is placed on achieving a lightweight design, elegantly integrating a power bank system and cutting-edge LEDs, thereby transcending mere functionality to epitomize efficiency. This research voyage is not confined to the theoretical realm; rather, it traverses the practical landscape, seeking to metamorphose these concepts into a tangible reality. By leveraging an amalgamation of sophisticated design techniques and refined manufacturing processes, the ultimate objective is to birth an emergency hazard light system of unparalleled efficiency and reliability for motorcycles under 150cc. The anticipated fruition of this endeavor is a system that not only elevates visibility during emergency situations but fundamentally reshapes the landscape of motorcycle safety, fostering a secure riding experience and markedly diminishing the risk of accidents.

ABSTRAK

Lampu isyarat kecemasan adalah ciri keselamatan yang penting untuk motosikal di bawah 150cc. Walau bagaimanapun, merancang sistem lampu isyarat yang boleh dipercayai dan berkesan boleh menjadi cabaran disebabkan oleh pelbagai faktor. Isu-isu seperti penglihatan kurang optimal dan penempatan yang tidak mencukupi boleh menjejaskan langkah-langkah keselamatan semasa kecemasan. Oleh itu, penting untuk membina sistem pencahayaan bahaya yang tidak hanya memenuhi tetapi melebihi kriteria reka bentuk dan penempatan strategik yang optimum. Untuk menangani cabaran ini, pendekatan holistik diadopsi, menyatukan teknik reka bentuk canggih dan kaedah pengeluaran yang bijaksana. Tarian yang rumit konseptualisasi reka bentuk berlaku di dalam rantau perisian CAD (Computer-Aided Design), menyediakan kain untuk visualisasi yang tepat dan pengubahsuaian iteratif. Penilaian sistematik, menggunakan teknik Pugh, membimbing pilihan penyelesaian reka bentuk yang paling sesuai. Penekanan penting ditempatkan pada pencapaian reka bentuk ringan, mengintegrasikan sistem bank kuasa dan LED canggih, dengan itu melampaui fungsi semata-mata untuk menunjukkan kecekapan. Perjalanan penyelidikan ini tidak terhad kepada bidang teori, sebaliknya, ia melintasi lanskap praktikal, berusaha untuk mengubah konsep-konsep ini menjadi realiti nyata. Dengan memanfaatkan penggabungan teknik reka bentuk canggih dan proses pengeluaran yang canggih, matlamat utama adalah untuk mewujudkan sistem pencahayaan bahaya kecemasan yang berkesan dan boleh dipercayai untuk motosikal di bawah 150cc. Hasil yang dijangka daripada usaha ini ialah sistem yang bukan sahaja meningkatkan kelihatan semasa keadaan kecemasan tetapi secara mendasar membentuk semula landskap keselamatan motosikal, memupuk pengalaman berkendara yang selamat dan mengurangkan risiko kemalangan.

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I would also like to express my sincere appreciation to my dearest friends for their understanding, patience, and support. Their presence has brought joy and companionship during this academic journey. Lastly, I extend my heartfelt gratitude to my family and close relatives for their unwavering support, love, and prayers. Their belief in me has been a constant source of motivation. I would like to acknowledge and express my gratitude to everyone who has assisted, supported, and inspired me throughout my studies. Your contributions have been invaluable, and I am truly grateful for your presence in my life.

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LIST OF SYMBOLS AND ABBREVIATIONS

D,d	-	Diameter
CAD	-	Computer-Aided Design
LED	-	Light-emitting diode
FEA	-	Finite Element Analysis
m	-	Meters
Cm	-	Centimeters
cc	-	Cubic Capacity
PLA	-	Polylactic Acid
3D	-	Three Dimensional
DC	-	Direct Current
V	-	Voltage
%	-	Percentage
PSM	-	Projek Sarjana Muda

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CHAPTER 1

INTRODUCTION

1.1 Background

Motorcycles are a popular means of transportation worldwide, but they are also associated with a higher risk of accidents and injuries compared to other vehicles. To increase the visibility of motorcycles and reduce the risk of accidents, emergency hazard lights are an important safety feature, especially in low light conditions or during emergencies. A literature review of existing emergency hazard lights reveals that LED lights, strobe lights, and flashing lights are available in the market. However, most of these lights are designed to be permanently installed on the motorcycle, which can be inconvenient for riders who need to switch between different motorcycles or who prefer a more portable option. Therefore, there is a need for a more compact, lightweight, and portable emergency hazard light that can be easily carried and attached to any motorcycle.

Motorcycle accidents are a major cause of road fatalities in Malaysia, with 4,634 motorcycle fatalities in 2019, according to the Malaysian Institute of Road Safety Research. As a result, the need for an effective and portable emergency hazard light has become increasingly important. The design considerations for such a hazard light include size, weight, power source, and durability. Additionally, the materials used for the hazard light must be flexible and foldable to make it easier to carry. The purpose of this study is to provide a thorough overview of the current state of emergency hazard lights for motorcycles, along with design considerations and innovations that can be used to create a portable hazard light that meets the needs of motorcycle riders in Malaysia. By addressing the limitations of existing hazard lights, this project aims to enhance motorcycle safety and decrease the likelihood of accidents and injuries on the road.

Furthermore, it is crucial to comprehend the preferences and requirements of motorcycle riders in relation to emergency hazards light. To learn more about the precise requirements of the target customers, surveys, interviews, and market research can be carried out. This user-centered design process will guarantee that the finished product meets the expectations and usability standards of Malaysian motorbike riders.

In conclusion, this project intends to improve motorcycle safety and lessen the likelihood of accidents and injuries on the road by solving the shortcomings of current danger lights and emphasizing portability, durability, and user-friendliness. Riders will have access to a flexible safety solution that increases their visibility and encourages safer riding habits through the development of a small, light-weight hazard light that is simple to carry and connect to any motorcycle.

1.2 Problem Statement

This project aims to design and develop a portable emergency hazard light for motorbikes in Malaysia. The existing market lacks a suitable solution that is lightweight, compact, and easily attachable for riders who frequently switch motorcycles. Additionally, the high rate of motorcycle accidents in the country emphasizes the need for a portable hazard light that improves visibility and reduces the risk of accidents, especially in low-light or life-threatening situations.

The proposed solution focuses on creating a user-friendly hazard light that is easy to carry and well built. Cutting-edge technologies, including advanced LED lighting, will enhance visibility and signal efficacy. The hazard light will incorporate a durable and rechargeable power source for reliable operation. Extensive user research will ensure that the design meets the specific needs of Malaysian riders.

In summary, this project aims to develop a portable hazard light that addresses the market gap in Malaysia, offering convenience, mobility, and improved visibility for motorcycle riders. The project seeks to contribute to reducing motorcycle accidents and promoting road safety by providing a user-centric and innovative solution.

1.3 Project Objective

The main aim of this project is to create a portable emergency hazard light for motorcycles that fulfills the following research objectives:

a) To design a portable and foldable hazard light for motorbikes in Malaysia that is compact, lightweight, and enhances visibility.

b) To fabricate a portable and foldable hazard light for motorbikes in Malaysia

c) To tests and evaluate the functionality and effectiveness of the hazard light within a range of 50 to 100 meters.

1.4 Scope of Project

The scope of this research are as follows:

a) Design and development of a portable emergency hazard light for motorcycles

b) Identification of design considerations and innovations required for a lightweight and compact emergency hazard light.

c) Development of a prototype that incorporates the identified design considerations.

d) Evaluation of the effectiveness and user-friendliness of the developed prototype through testing, including durability, battery life, and ease of use.

e) Market analysis and cost-benefit analysis to determine the commercial feasibility of the prototype.

f) Focus on the needs and requirements of motorcycle riders in Malaysia.

g) Exclusion of investigation of causes and solution of motorcycle accidents or fatalities beyond the scope of the emergency hazard light.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The design and production of a triangle emergency hazard light for motorcycles under 150cc play a crucial role in this pursuit. This innovative solution aims to improve safety measures and minimize potential hazards on the road. By accurately assessing and addressing emergency situations, such as breakdowns or accidents, the hazard light serves as a valuable tool for enhancing visibility and reducing the risk of further mishaps.

To ensure the successful development of this hazard light, it is essential to establish an effective methodology for designing and producing a triangle emergency hazard light tailored specifically for motorcycles under 150cc. This involves careful consideration of size, weight, and installation methods to ensure compatibility with various motorcycle models. Furthermore, the production process should focus on creating a reliable, durable, and user-friendly hazard light that can withstand the demands of different road conditions and weather situations.

By providing a comprehensive and accurate evaluation of the magnitude, location, and sources of potential hazards, this research endeavors to offer valuable insights for the design and production of an effective triangle emergency hazard light. Through the implementation of appropriate corrective and preventive measures, motorcycle riders can benefit from a safer riding experience, leading to a significant reduction in accidents and improved overall road safety.

2.2 Motorcycle Accidents Worldwide

A serious problem on a global scale, motorbike accidents are a major cause of accidents on the road that result in injuries and deaths. This review of the literature seeks to give an overview of current research on motorbike accidents in all countries, with a focus on papers released after 2018. Epidemiological studies have provided insight into the frequency and trends of motorbike accidents across various geographic areas. For instance, according to global traffic accident statistics, the number of people who died in traffic accidents worldwide in 2010 was estimated to be 1.24 million, with pedestrians, cyclists, and motorcyclists accounting for 50% of all fatalities. 92% of these fatalities, or the majority, occurred in low- and middle-income countries.(Greve et al. 2018). The study demonstrated the urgent requirement for focused actions to address this issue of public health.

Investigations into the risk factors for motorbike accidents have been thorough. According to (Shajith, Pasindu, and Ranawaka 2019), a number of factors affect motorcycle collisions. Young motorcyclists aged 21 to 25 are more likely to act aggressively or negligently, and speeding, especially in curves, is a key cause. Alcohol intake and speeding are factors in accidents. Additionally, it has been demonstrated that using the right helmets can lessen the severity of brain injuries. Motorcycle collisions can also be influenced by external elements like poor road conditions and sudden movements. Motorcycle safety may be increased by enforcing registration and licensing requirements, adopting graduated licensing schemes and encouraging the use of anti-lock braking systems. Inadequate laws, infrastructure, and data present another distinct problem for low- and middle-income nations. Thus, tackling these issues is essential for improving motorcycle safety on a global scale.

The creation of extensive motorbike accident databases has permitted in-depth investigations with regard to data gathering and analysis. For instance, (Tamakloe et al. 2022) used a sizable database of motorbike accidents to analyze the features and underlying causes of motorbike accidents in Ghana. The study helped with the creation of focused preventive measures by offering insightful information about the main factors and situations surrounding motorbike accidents.

The study concludes that focused countermeasures must be put in place in emerging nations to avoid motorcycle accidents and enhance intersection safety. Based on their findings, the authors emphasize a number of recommendations. First and foremost, it's essential to police traffic laws and encourage motorcycle riders to use safety equipment. In addition, there is a need to improve rider education, simplify licensing processes, and do rid of obstacles that prevent people from getting licenses. It's also critical to guarantee adherence to the necessary vehicle standards, such as those governing anti-lock braking systems. Right-angle collisions can be decreased with the installation of red-light cameras at crossings. The severity of crashes can be reduced by prohibiting motorcycles from utilizing specific locations and installing motorcyclist protection equipment, like roller barriers. It is advised to set aside enough money for maintenance and visibility enhancements such warning signs and retroreflective markers.

It is crucial to increase monitoring and enforcement using traffic cameras and on-the-ground police officers. Consideration should be given to redesigning the roads to include motorcycle lanes and safer intersections. Finally, restrictions on the usage of motorbikes for commercial public transportation may lessen the severity of collisions. These suggestions offer insightful solutions for resolving motorbike safety issues, not just in Ghana but also in other developing nations.

Table 2.1 Road deaths, first half of 2017-22 (International Transport Forum 2022)

Country	Jan-Jun 17-19 (average)	Jan-Jun 2020	Jan-Jun 2021	Jan-Jun 2022	% Change in 2022 over 2021	% Change in 2022 over 2020	% Change in 2022 over 2017-19
Austria	189	153	151	189	25%	24%	0.0%
Belgium	286	236	226	231	2%	-2%	-19%
Chile	811	801	751	929	24%	16%	15%
Czeh Republic	265	250	220	247	12%	-1%	-7%
Denmark	84	68	46	62	35%	-9%	-26%
France	1557	1153	1253	1553	24%	35%	-0.2%
Finland	107	110	91	75	-18%	-32%	-30%
Germany	1502	1290	1107	1267	14%	-2%	-16%
Greece	309	245	251	282	12%	15%	-9%
Hungary	267	171	207	216	4%	26%	-19%
Iceland	7	4	4	4	0%	0%	-45%
Japan	1869	1617	1442	1413	-2%	-13%	-24%
Lithuania	80	71	61	48	-21%	-32%	-40%
Luxembourg	13	10	6	13	117%	30%	0.0%
Netherlands	271	278	232	300	29%	8%	11%
Poland	1125	1087	983	891	-9%	-18%	-27%
Serbia	234	213	203	240	18%	13%	3%
TOTAL	**8976**	**7757**	**7234**	**7960**	**2.66%**	**0.58%**	**2.332%**

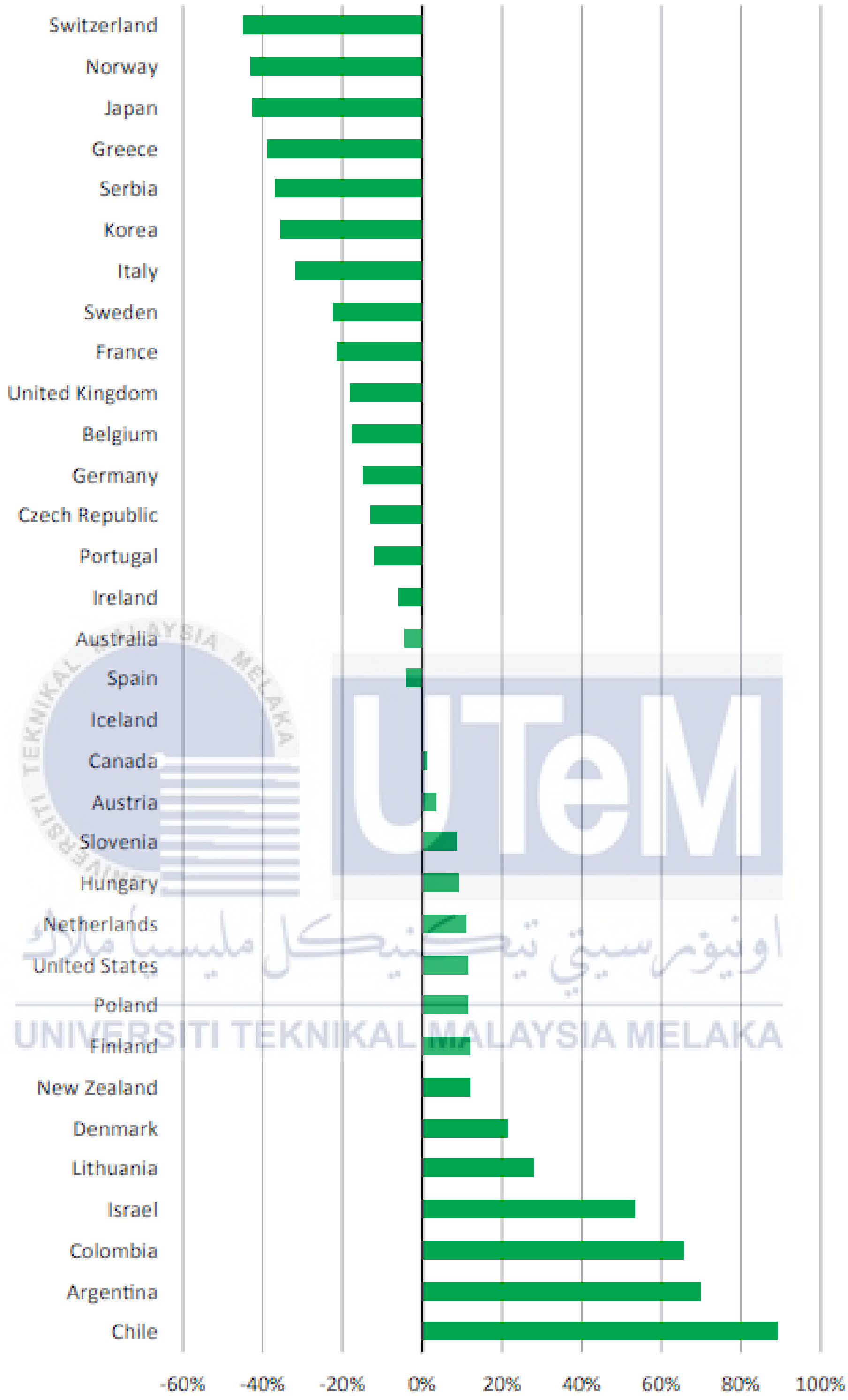


Figure 2.1 Percentage change in the number of users of powered two-wheelers killed, 2010-19 (International Transport Forum 2022)

According to (International Transport Forum 2022), the average number of fatalities among powered two-wheeler (PTW) riders in traffic accidents indicated a concerning trend between 2010 and 2019, according to data from 34 nations with validated statistics. The aggregate number of PTW user deaths increased by 7% over this time. This growing trend is concerning and emphasizes the need for improved motorcycle road safety measures.

The three Latin American nations of Chile, Argentina, and Colombia that are part of the International Road Traffic and Accident Database (IRTAD) are noteworthy. The number of motorcyclists killed in road accidents increased significantly within these countries. Deaths rose alarmingly in Chile by 89%, while they rose by 70% and 66%, respectively, in Argentina and Colombia. These numbers point to a critical safety issue, particularly for motorbike riders in these areas.

It is quite concerning how frequently motorbike riders die in these nations. The significant proportion of PTWs in the total vehicle fleet in these countries underscores the need for focused initiatives to increase motorcycle safety. Additionally, the rise in mortality among PTW users goes beyond the aforementioned Latin American nations. PTW-related mortality increased throughout this time period in 13 more nations that are part of the IRTAD database. It is important to note that fatalities reduced or stayed the same in 18 nations. Switzerland, Norway, and Japan stand out in particular since they reduced PTW fatalities significantly. While Norway and Japan both had declines of 43%, Switzerland saw a surprising fall of 45%.

These divergent trends in motorcycle safety across nations highlight the significance of exchanging best practices and putting in place practical solutions to lower motorcycle-related fatalities. The results show the urgent necessity for all-encompassing road safety measures and focused activities that take into account the particular difficulties PTW users encounter. Countries can seek to improve motorcycle riders' overall safety and lower the number of fatal incidents on the roads by addressing these issues.

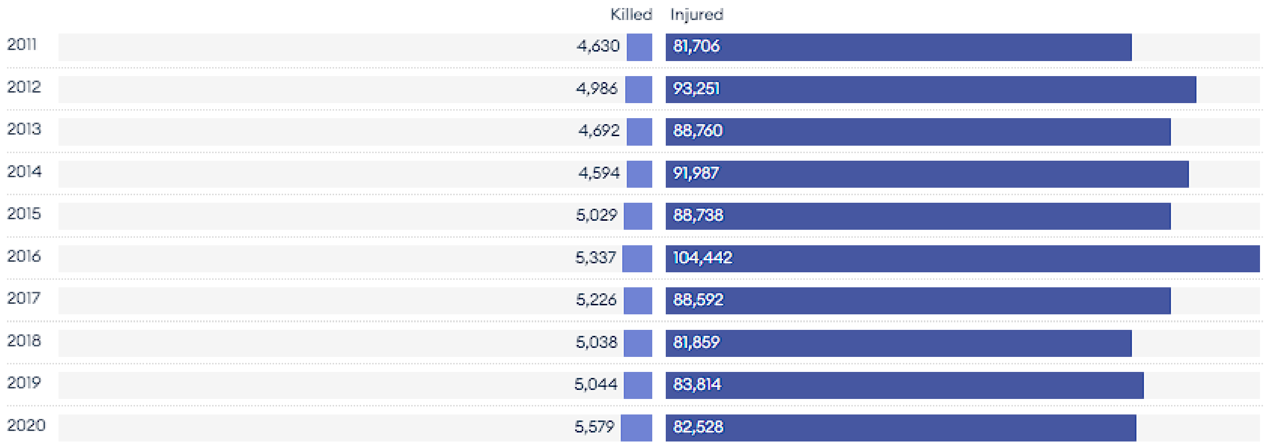


Figure 2.2 Motorcycle Fatalities and Injuries Overtime (Staff 2023)

There has been an increase in motorbike fatalities in the United States in 2021 compared to the previous year, which is alarming. The number of motorbike fatalities recorded to the National Highway Traffic Safety Administration (NHTSA) in 2021 was 5,677, a remarkable 10% increase from 2020 (Staff 2023). These concerning data show how urgent it is to look into the root causes of these tragedies.

According to (World Health Organization 2022), the yearly death toll from road accidents worldwide exceeds 1.35 million, making it one of the main causes of death for children and young adults aged 5 to 29. Furthermore, low-income countries have a three times higher risk of a road traffic fatality than high-income ones, underscoring the critical need for focused initiatives in these areas. Governments and stakeholders have a critical chance at the meeting to prioritize road safety and collaborate to realize the ambitious goal of halving traffic-related deaths and injuries by 2030.

2.3 Motorcycle Accidents in Malaysia

Due to a rising trend in annual accident rates, road accidents are a serious problem in Malaysia. In a study published in 2019, (Idris, Hamid, and Teik Hua 2019), Over 1.25 million people lose their lives as a result of these accidents each year, adding to the worrying global problem of deaths. Given the ubiquity of motorbikes as a form of transportation, the prevalence of motorcycle-related accidents and fatalities in Malaysia is particularly alarming. In light of this, the current essay examines the causes of motorbike accidents and emphasizes the urgent requirement for better road conditions in order to reduce fatalities and injuries among motorcyclists and pilgrims.

In Malaysia, motorcycle accidents are primarily caused by speeding, reckless driving, and drunk driving. These dangerous actions endanger both the safety of motorbike riders and other road users by sharply increasing the likelihood of traffic accidents. Additionally, dangerous road conditions increase the risks that motorcyclists must deal with, highlighting the need for infrastructure changes to roads that put safety first and make accident prevention easier.

Studies from (Fadaei, Ainy, and Paydar 2021) highlights the significance of putting into place efficient strategies to lower motorbike injuries and fatalities. Particularly, the separation of motorcycle lanes stands out as a key recommendation from the riders themselves. For officials and planners to create road safety plans that effectively safeguard motorcycle riders and improve their wellbeing, it is essential to acknowledge and meet these demands.

Over 60% of fatal road accidents in Malaysia involve motorcycles, which make up a large share of these accidents. Conspicuity has been a significant cause of motorbike accidents, especially while travelling at night in rural areas. However, conspicuity difficulties also have an impact on motorcycle safety in metropolitan locations, where poor lighting from both vehicles and the road makes it harder for other drivers to see motorcyclists in the road. (Khalid et al. 2020)

Table 2.2 Malaysia Road Accident and Fatalities 2010 – 2019 (Ministry of Transport Malaysia 2019)

Year	Number of Accidents	Number of Fatalities
2010	414,421	6,872
2011	449,040	6,877
2012	462,426	6,917
2013	447,204	6,915
2014	476,196	6,674
2015	489,606	6,706
2016	521,466	7,152
2017	533,875	6,740
2018	548,598	6,284
2019	567,516	6,167

The Royal Malaysian Police (RMP) and the Malaysian Institute of Road Safety Research (MIROS) use two main techniques to gather collision data and track traffic accidents and fatalities in Malaysia: authorized-based data collection and research-based data collection. These methods have different functions and offer insightful information on various aspects of auto accidents.

The research-based methodology used by MIROS, on the other hand, places a strong emphasis on the discovery of accident and injury causes that take into account engineering, human, and environmental elements. This method uses two criteria: on-the-spot research and retrospective analysis. While on-the-spot investigations involve quick assessment of collision scenes and collecting of pertinent data, retrospective analysis allows researchers to look back at incident data to find trends and patterns.

Malaysia has seen an increase in the number of traffic accidents over the previous ten years (Table 2.2). The number of fatalities has decreased steadily since peaking at 7,152 in 2016, nevertheless, indicating a good trend. Notably, in 2019 there were 6,167 reported fatalities, which was the fewest in the previous ten years. The success of different initiatives put in place to reduce fatalities is shown in these statistics, which also highlight ongoing efforts to improve road safety in Malaysia.

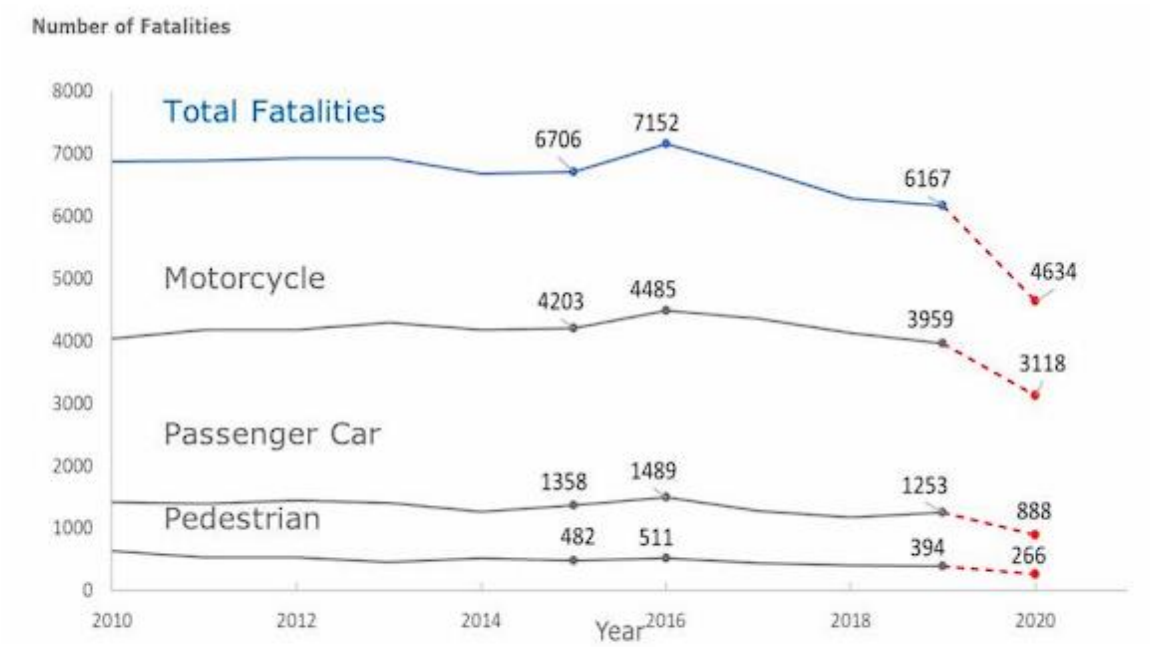


Figure 2.3 Fatalities Due to Road Crashes (Ministry of Transport Malaysia (MOT) 2022)

The majority of people killed in traffic accidents in Malaysia are motorcyclists. Enforcement of helmet laws, raising social media awareness, creating road safety programs for businesses, and strengthening infrastructure with designated motorcycle lanes are all examples of efforts to increase safety. Between 2016 and 2019, these actions have helped to reduce the number of fatalities using motorcycles. However, to maintain progress and face new issues, continual monitoring, evaluation, and intervention improvement are required. To improve motorcycle safety in Malaysia, additional study should concentrate on evaluating particular measures and comprehending rider behavior. (Ministry of Transport Malaysia (MOT) 2022)

According to the author, traffic conflicts are conditions that, unless one of the parties involved takes necessary action to prevent a collision, could result in traffic accidents. Traffic congestion is a trustworthy precursor to car accidents. Thus, decreasing disputes between motorbike riders may lower the chance of an accident. In addition to crossroads, roundabouts, U-turns, housing areas, and schools, other areas with a high risk of traffic disputes include intersections. Therefore, uniformity of vehicle type, traffic flow, and speed—which can be attained via a variety of means, particularly through supportive infrastructure and qualified drivers who adhere to safety rules on the road—is the key to reducing traffic conflict.

Studies states that aspects of motorcycle road safety can be improved thanks to safety technologies. One such is the blind spot monitoring system found in cars, which sends a suitable warning if a motorbike or other vehicle is nearby. This device can assist drivers in being aware of motorcyclists, which are frequently in their blind spots. The use of technology for rider safety still has a lot of opportunity for development, thus it must be put into practice. Thus, it has been decided to implement the following tactics to increase technology's efficacy for motorcycle safety.

2.4 Type of Emergency Hazard Light

A warning triangle is a small red triangle with a highly reflecting surface that is typically constructed of plastic and metal. To warn other vehicles and other road users that they are approaching an unexpected stationary vehicle, warning triangles are utilized.

When they break down, people frequently turn on their Hazard Warning Lights to warn other drivers. An emergency warning triangle will help provide forewarning because these are not always visible around curves or over bumps. (Freight Products 2022) This literature review explores different types of emergency hazard lights and their applications.

Figure 2.4 LED Emergency Hazard Light (Ltd 2023)

A high fidelity, wide color gamut, and highly saturated color are characteristics of a good LED light source for a nice visual experience. These characteristics are most similar to daylight or incandescent light, which is used as a reference light source. It is possible to observe objects' colors and textures more accurately by simulating natural sunshine. The associated spectrum is balanced, smooth, and optimally proportionate for human sensitivity. It ideally has no ultraviolet (UV) or infrared (IR) radiation, only wavelengths in the visible range. (Tang, Liu, and Shen 2018)

Figure 2.5 Strobe Lights (Ultra Bright Lightz 2021)

A wide variety of emergency vehicles use strobe lights. Strobe lighting is renowned for its strength and intensity, and it may be employed in a wide variety of contexts and locations. (Extreme Tactical Dynamics. 2023). Their distinctive flashing patterns help differentiate emergency vehicles and draw attention to potential danger areas, enhancing overall safety.

Figure 2.6 Rotating Beacons (Response Vehicle Lighting 2023)

Rotating beacons are a great alternative to flashing or static warning lights for a variety of applications. Our spinning vehicle beacons are a fantastic method to get drivers' attention and promote safety for everyone on the road. (Response Vehicle Lighting 2023) Rotating beacons, also known as revolving lights, are a classic form of emergency hazard lights. Rotating beacons are frequently employed in situations requiring long-range visibility, such as marine applications and tall structures. However, advancements in LED and strobe light technologies have reduced the popularity of rotating beacons due to their lower brightness and higher power consumption.

Figure 2.7 Warning Triangle Emergency (Blanco Sebastian 2020)

The use of warning triangles gives other motorists plenty of time to slow down and prepare for potential hazards. This safeguards not just them but also you and any passengers you may have who may be waiting by the side of the road. (Just Tyres 2023) These car safety triangles will aid in warning incoming traffic. The reflective material used on the triangles helps to enhance visibility, especially during nighttime or adverse weather conditions.

Figure 2.8 Barricade Lights (Cortina Safety Products 2023)

Barricade hazards lights are used to draw attention to the nearby safety equipment in the event of rain, fog, a storm, or at night when visibility is less than ideal. Motorists and pedestrians will be made aware of its presence by either blinking or remaining on to generate a constant stream of light, hopefully preventing them from colliding into any obstacles or equipment. (OTW Safety 2023)

Figure 2.9 Flashing Arrow Board (Frost Adam 2019)

Flashing arrow boards are enormous, highly visible display panels that flash a brightly illuminated arrow pattern to direct motorists. In order to maintain the safety of the work zone, arrow boards are crucial. (Roadway Traffic Products 2023)

Figure 2.10 Take Down Lights (Extreme Tactical Dynamics 2019)

In the past, take down lights were erected using powerful halogen lights, but they are now also available for LED light bars. These lights are almost never accessible for use on other emergency vehicles of the kinds other than police cars. (Extreme Tactical Dynamics 2019)

Figure 2.11 Traffic Batons (Curiel Nat 2023)

Hand-held, transportable light sticks like the marshalling wand and traffic baton can be used to draw attention from onlookers. They are typically associated with police officers directing traffic and can be seen at intersections where there are no functional street lights or at the scene of accidents. (H2 Safety India Private Limited 2023)

Figure 2.12 Solar-Powered Warning Lights (Delta Obstruction Lighting 2023)

The greatest option for major traffic control offices is presently solar warning lights and solar traffic lights. On highways and roads, it can be installed to power warning or regulation signs as well as traffic signal lights. In addition to saving energy, it significantly lowers the cost of maintenance and replacement. (Luxman 2020)

2.5 Safety Triangle Emergency

Safety triangle emergencies, also known as warning triangles or roadside triangles, are essential tools for alerting drivers and ensuring safety during roadside emergencies or accidents. This literature review explores the importance of safety triangle emergencies, their design features, and their effectiveness in improving visibility and reducing accident risks.

The use of warning triangles gives other motorists plenty of time to slow down and prepare for potential hazards. This safeguards not just them but also user and any passengers the user may have who may be waiting by the side of the road. This adds an added layer of safety for everyone since smaller, faster routes may not give you the chance to see stationary vehicles beforehand. (Just Tyres 2023)

A crucial element of warning signals is the surrounding shape. Contrary to the surface meaning that can be directly sent by colors, signal phrases, and pictorials, warning sign surroundings obscurely transmit warning information. By using warning signs, it is possible to convey risk information visually. Many sectors view the delivery of hazard information via warning signs as necessary. The fundamental components of warning signs include signal words, colors, background shapes, and graphic symbols. (Ma et al. 2018)

Safety triangle emergencies are indispensable tools for enhancing roadside safety and minimizing the risk of accidents. Their triangular shape, reflective material, and fluorescent colors contribute to their effectiveness by maximizing visibility during both day and night. Drivers should understand the importance of carrying safety triangle emergencies in their vehicles and using them correctly to ensure their maximum effectiveness in promoting road safety.

There are several benefits to using an emergency triangle. First, it can help to warn other drivers of a hazard on the road. This can help to prevent rear-end collisions and other accidents. Second, an emergency triangle can help to make vehicle more visible to other drivers, especially at night. This can help to prevent other drivers from accidentally hitting vehicle. Third, an emergency triangle can help to make vehicle more visible to emergency personnel, such as police and firefighters. This can help to ensure that they can quickly and safely reach vehicle in the event of an accident.

2.5.1 Current Prevalent Use of the Safety triangle

The safety triangle, also known as the warning triangle or roadside triangle, is a crucial device used to enhance safety on the road during emergency situations. This literature review aims to explore the current prevalence and utilization of safety triangles, examining their effectiveness, regulations, and advancements in recent years.

Safety Warning Triangles (SWT), in particular, can play a critical role in preventing such accidents through the use of appropriate signage. The SWT signal warns other drivers of potential dangers up ahead and is a part of vehicle emergency kits. Other drivers can be adequately warned of the threat far in advance, enabling them to respond quickly and avoid collisions. Even though the RMP's database lacks specific information on SWT utilization during accidents, comprehending its usage is important to solving the problem. (Abdul Khalid et al. 2021)

According to the studies, many industrialized nations employ SWT extensively, and numerous European nations have mandated its use for all types of automobiles. However, according to the Motor Vehicle Rules of 1959, only commercial vehicles in Malaysia are required to have SWT on board. Nevertheless, despite the fact that SWT is not required, the majority of automakers incorporate it as a standard feature in new cars.

Compared to other types of mishaps, rear-end collisions with parked cars on the side of the road are significantly less common in Malaysia. Drivers frequently stop their cars on the side of the road or in the emergency lanes when they experience emergencies like mechanical failures, fuel shortages, or being involved in car crashes. Due to a lack of secure parking choices in sprawling cities like Kuala Lumpur, where space is at a premium, stopped automobiles frequently block traffic lanes. This situation raises the possibility of other vehicles rear-ending these vehicles.

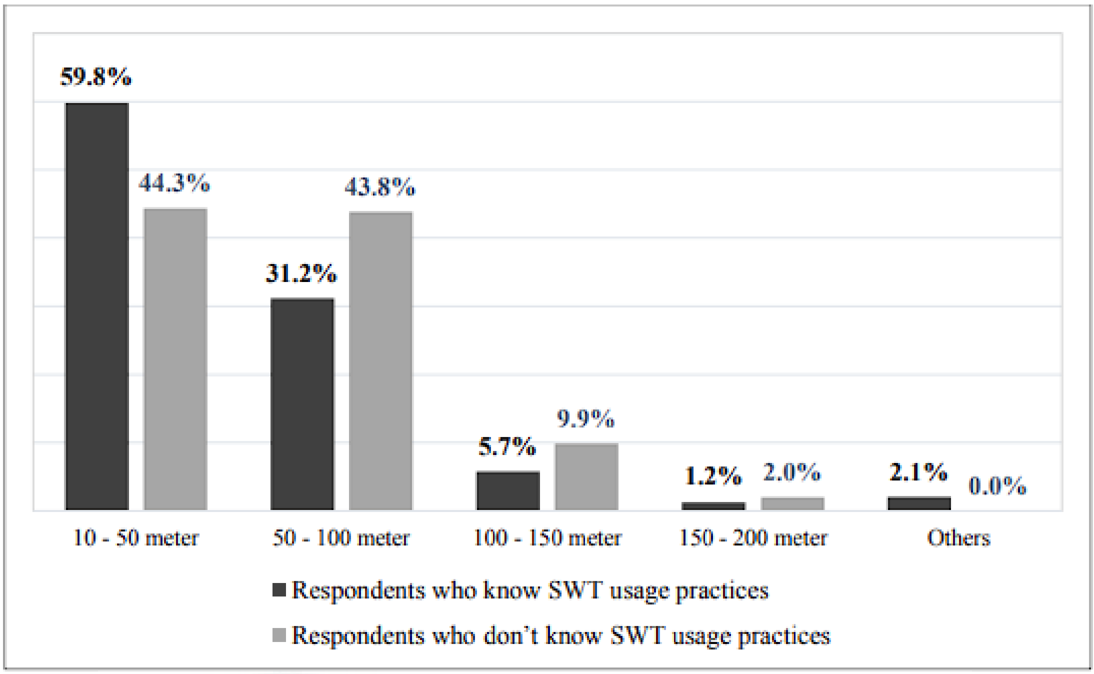


Figure 2.13 Opinions from Respondents on the Distance to Locate SWT During Emergency Situation (Abdul Khalid et al. 2021)

2.5.2 Handling Vehicle Breakdowns with Triangle Emergency Hazard Lights

Vehicle breakdowns can be challenging and potentially hazardous situations, requiring proper handling for the safety of drivers and other road users. This literature review explores the use of triangle emergency hazard lights as an effective tool for managing vehicle breakdowns. It examines best practices, guidelines, and the impact of using triangle emergency hazard lights on accident prevention and overall road safety.

Drivers should stop in a safe location (preferably off the road) and turn on their hazard warning lights when they are forced to pull over to the side of the road due to an accident or breakdown. In limited visibility, drivers should also keep their sidelights on. Everyone in the car, including the driver, should get out and stand somewhere safe, away from oncoming traffic, and away from the vehicle. Warning triangle should be placed on level ground at least 45 meters (147 feet) away from car so that it will be easily seen by other cars. LED lights on the warning triangle should be turned on. (Just Tyres 2023)

When a truck can no longer proceed safely or the driver is physically unable to operate the vehicle, drivers should only pull over on a roadway or highway shoulder. Other pauses, such rest breaks, driver swaps, or navigation adjustments should only be made in a secure and authorized parking space. It can be risky to stop on a highway or highway shoulder, especially if the route is twisting, at night, or has poor visibility because of the weather. Everyone on the road will be safer if the user and the truck are more visible during an emergency stop. (Schneider Guy n.d.)

Although, according to (Road Safety GB 2022), It is no longer deemed safe or practical to alert other road users of a broken down car using the conventional warning triangle. This is because, particularly on congested roads and highways, drivers frequently fail to notice them. Additionally, placing the triangles may put the driver in danger of being struck by another car.

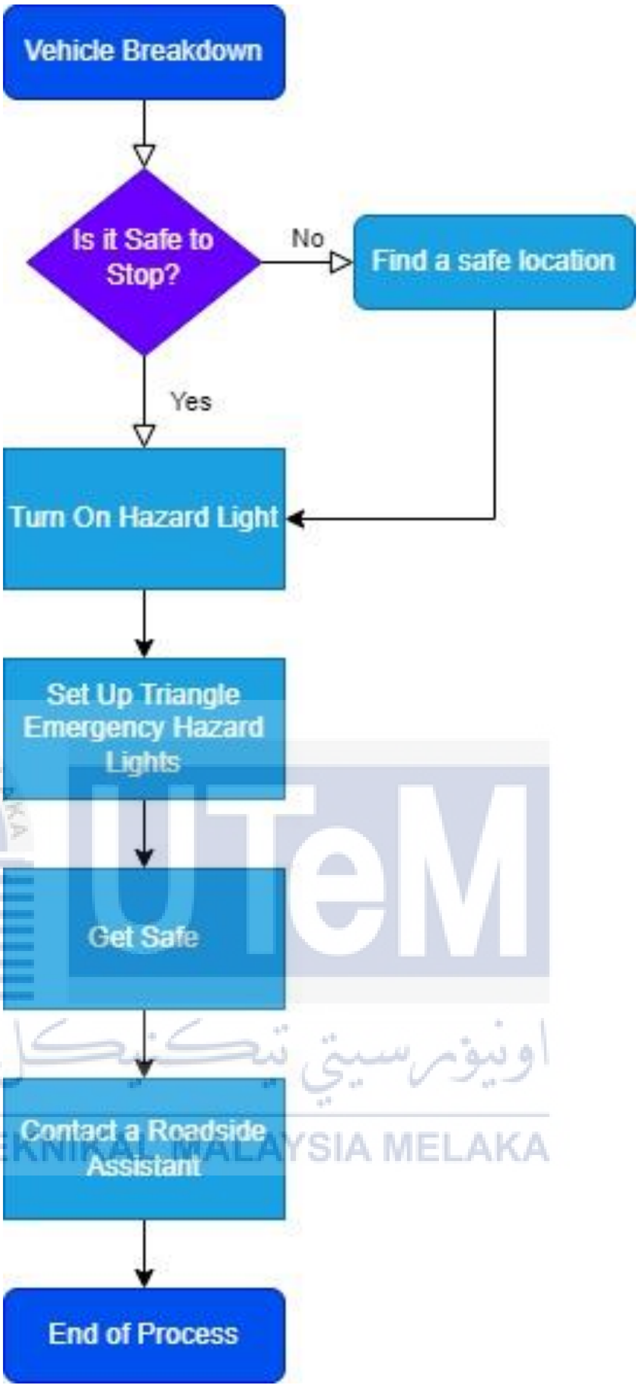


Figure 2.14 Flowchart of Vehicle Breakdown Handling Process (TheHighwayCode 2022)

Based on the article, in the event of an accident or breakdown, it's crucial to pull over somewhere relatively safe where both the passengers and the car are less likely to be in danger from oncoming traffic. A parking area, such as a service area on a highway or other high-speed route, is the safest place to stop. Lay-bys, emergency spaces, and hard shoulders are additional locations with a reasonable level of safety.

The article also states that when a car breaks down, the safety of all other drivers should come first, and action should be done to notify them and protect the passengers. Wear fluorescent or light-colored clothing during the day, reflective clothing at night or in low visibility, and move the vehicle off the road if at all possible. Driver should also set up a warning triangle at least 45 meters behind the broken-down car on the same side of the road. Additionally, it's crucial to keep the sidelights on when it's dark or difficult to see, avoid standing in front of oncoming traffic, and avoid positioning dear self so that other drivers can't see lights.

2.5.2.1 Is it Safe to Stop?

This step involves assessing the safety of stopping vehicle. Consider factors such as the location of the breakdown, traffic conditions, and visibility. If it is not safe to stop immediately, proceed to find a safe location before continuing with the next steps.

2.5.2.2 Find a Safe Location

Finding a secure spot to pull over should be the top goal in this step. It is best to look for a wide shoulder, parking lot, or a secure area away from the road where the car can be parked without hindering traffic.

2.5.2.3 Turn on Hazard Lights

The car's hazard lights must to be turned on after it is parked in a secure area. This action is essential to let other motorists know that the car is there and that it is having trouble.

2.5.2.4 Set up Triangle Emergency Hazard Lights

This step involves setting up triangle emergency hazard lights behind the vehicle. Triangle emergency reflectors are typically placed a suitable distance behind the vehicle to warn other drivers of the breakdown. Follow the manufacturer's instructions on how to properly set up the reflectors.

2.5.2.5 Get Safe

Wear high-visibility apparel if it is accessible and readily available. Where there is a safety barrier, people should get behind it, but they should also be alert for any hidden dangers such unexpected drops, uneven terrain, or debris. It is best to avoid standing where a car can accidentally crash with someone while in motion. It's best to avoid going back to the car in the rain, cold, or at night.

2.5.2.6 Contact a Roadside Assistant

Utilize the free emergency phone to call a breakdown recovery service and for guidance and assistance. While conversing, face the roadway and keep an eye out for oncoming vehicles or debris.

2.5.2.7 End of Process

This step marks the end of the process flowchart. Once professional assistance arrives or vehicle is towed, follow any further instructions or steps provided by the service providers.

2.5.3 Safety Triangle Deployment

Safety triangle deployment is a critical aspect of road safety during emergency situations. This literature review examines the importance of proper safety triangle deployment, explores best practices, and discusses the impact of effective deployment on accident prevention and overall road safety.

Proper deployment of safety triangles is crucial to ensure their effectiveness in warning approaching drivers and preventing accidents. It is essential for drivers to understand and adhere to recommended deployment guidelines to maximize the safety benefits of these devices. According to (QUICK-ADVICE.COM 2019), three emergency triangles must be carried by drivers at all times and placed in three different places when they stop. First warning triangle should, as a general rule, be positioned 10 feet directly behind the car on the side closest to the road. Then, 100 feet behind the car, align the second warning triangle so that it is directly in the middle of the car's position.

Figure 2.15 Placement of Safety Triangle (Glenn Jack 2022)

When stopping on a highway or roadside due to an accident or breakdown, FreightWaves' article "On the roadside, don't forget the safety triangles" emphasizes the significance of utilizing safety triangles to warn other drivers of potential hazards. Safety triangle placement can assist warn other drivers of potential dangers and increase everyone's level of safety on the road. In the event of an accident or malfunction, people can help keep themselves and others safe by adhering to these guidelines. (Glenn Jack 2022)

The significance of utilizing emergency triangles to warn other vehicles of potential hazards when stopped on a highway or roadside due to an accident or breakdown is covered in the article "Emergency Triangle Placement" by Paper Transport. The page offers guidelines for placing emergency triangles correctly on various types of roads, including divided highways and two-lane roads. (Paper Transport 2021)

Figure 2.16 Divided Highway Emergency Triangle Placement (Paper Transport 2021)

The article offers guidelines for where emergency triangles should be placed on various types of roads. Emergency triangles should be positioned 10, 100, and 200 feet behind the truck on a split highway. This positioning assists in warning oncoming cars of the problem up ahead.

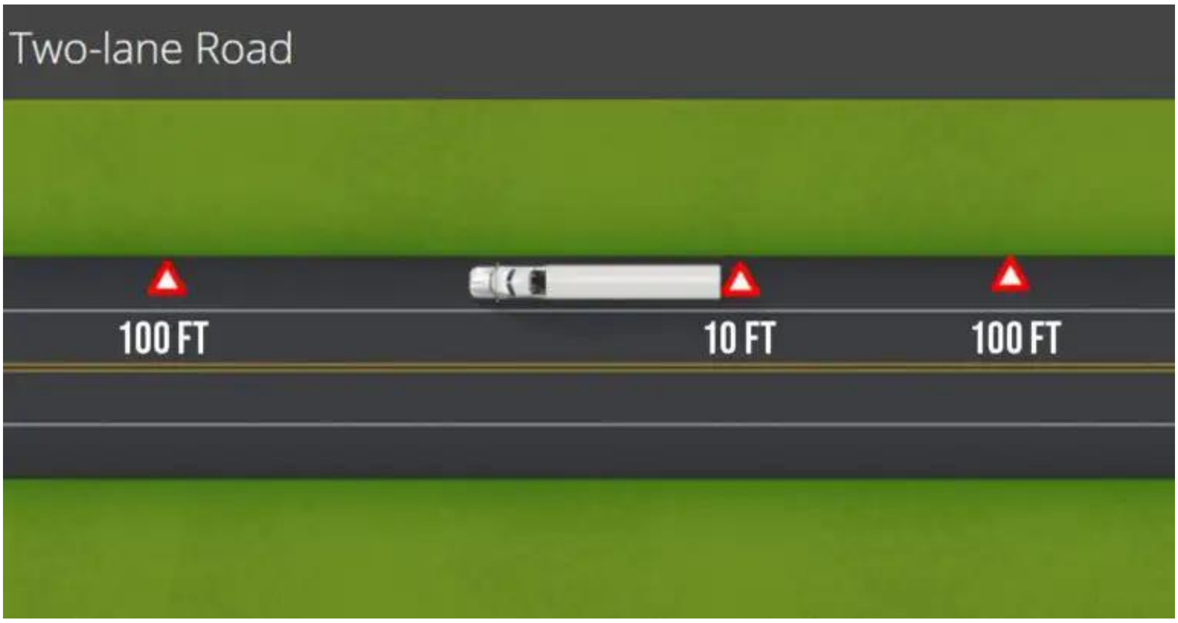


Figure 2.17 Two-Lane Road Emergency Triangle Placement (Paper Transport 2021)

Based on the article, one triangle should be positioned 100 feet in front of the truck on a two-lane road (one lane in each direction), and two triangles should be placed 10 feet and 100 feet behind the truck. This positioning assists in informing oncoming vehicles of the problem up ahead in both directions.

2.6 CATIA Software

CATIA (Computer-Aided Three-Dimensional Interactive Application) is a widely used software suite in the field of computer-aided design and manufacturing (CAD/CAM). This literature review explores the capabilities, features, and applications of CATIA software. It discusses its importance in various industries and highlights its impact on design, engineering, and production processes.

Dassault Systemes created the 3D design tool CATIA. It offers excellent visualization, good updateability, and simple programs optimization. It's extensively utilized for designing hydraulic structures in three dimensions. CATIA has the advantage over conventional two-dimensional design techniques in that it makes it simple to gather data like embankment volume and excavation volume as well as update the 3D model according to parameters. An engineer who is proficient with CATIA software needs a few days to construct a primary core model. (Wenting 2018)

Figure 2.18 CATIA Software

Since its creation more than fifty years ago, CATIA has seen the release of numerous versions. Before CATIA V6 was launched in 2011, CATIA V5 saw a number of improvements. Even though CATIA V6 has been available for some years, several businesses continue to utilize CATIA V5 due to the program's complexity. One factor for this is that CATIA V6 does not permit file storage on hardware like a hard drive or USB drive, only in the cloud. (In and Engineering 2018)

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the design, fabrication, testing, and assessment process for a foldable and portable hazard light system for motorcycles with engines under 150cc. This project's main goal is to create a small, low-weight, and highly visible hazard light system that improves safety in emergency circumstances. This chapter will provide an overview of the design process, a discussion of the Pugh technique for selecting the best design solution, a description of the manufacturing process, and a discussion of testing and assessment techniques.

3.2 Process Flowchart

Understanding the project's overall flow is crucial before getting into the specific procedures required for the design, production, and testing of the danger light system. A visual illustration of the sequential steps taken to design a portable and foldable danger light system for motorcycles under 150cc is provided by this flowchart.

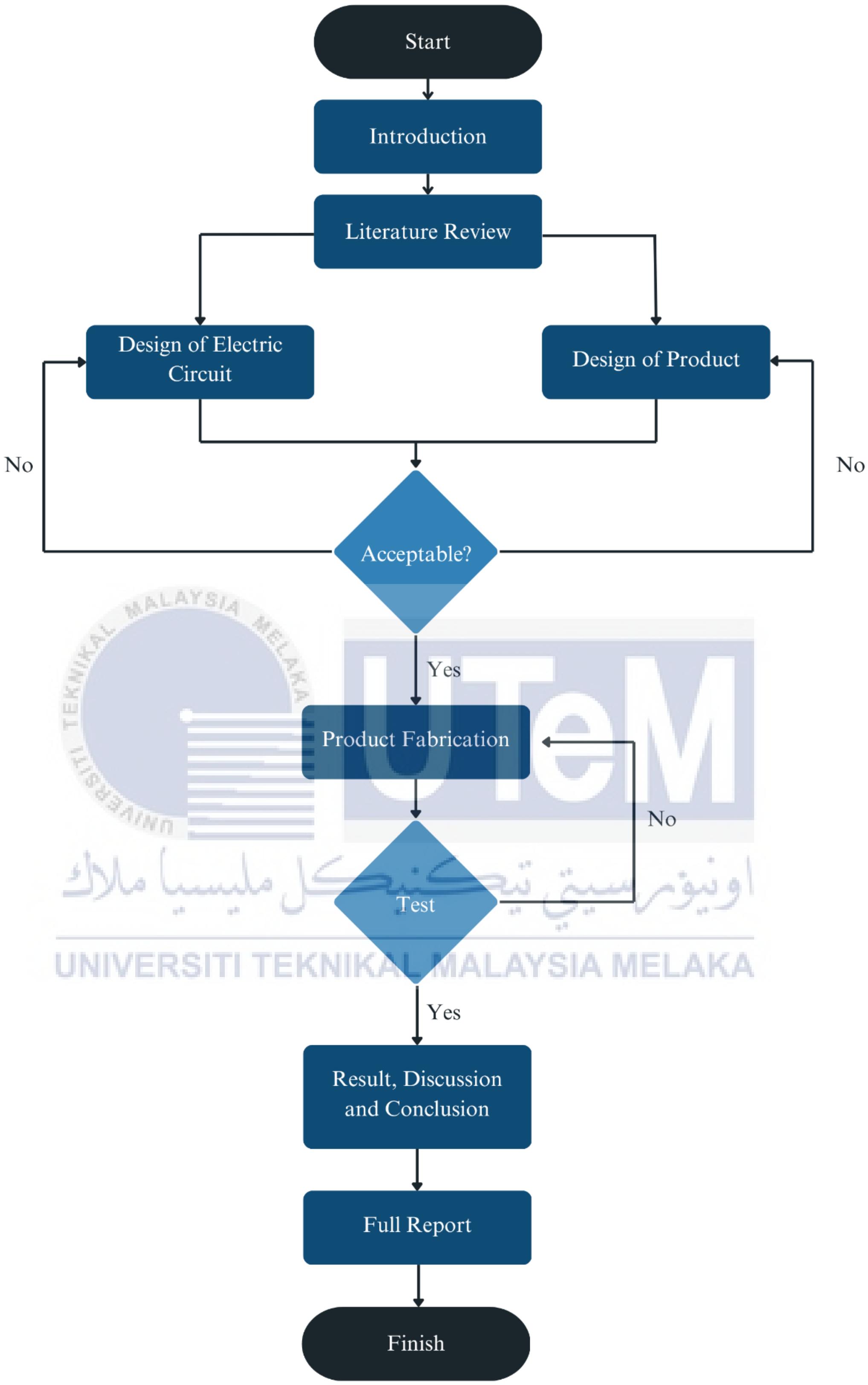


Figure 3.1 Flowchart Diagram

3.3 Product Design Specification

For motorcycles under 150cc, the creation of a folding, portable hazard light system necessitates careful consideration of product design requirements. To ensure the operation, use, and compatibility of the danger light system with motorcycles in this category, these specifications outline the fundamental qualities and requirements that it must have. The danger light system can offer a reliable safety solution during emergencies by abiding by these requirements, improving visibility and lowering the risk of accidents.

The hazard light system's size, compactness, weight, visibility, folding mechanism, durability, weather resistance, mounting compatibility, power efficiency, and user-friendliness are all addressed in the product design specifications. Each standard is important in defining the hazard light system's overall performance and operation as well as its suitability for motorcycles with engines less than 150cc.

The portable and foldable danger light system can be created to specifically address the requirements of motorcycles under 150cc by painstakingly adhering to these product design parameters. This technology gives riders on motorcycles an effective and dependable safety solution that improves visibility and encourages safer riding.

3.3.1 Efficiency

To provide optimum visibility and safety in emergency circumstances, the performance of the foldable and portable hazard light system will be optimized. The system must include powerful, highly visible lights that are intended expressly to improve visibility. The lights' wide-angle coverage maximizes visibility from all angles, increasing the likelihood that other drivers may see the motorcycle. The hazard light system also must guarantee ideal light distribution, minimizing any blockage that would reduce the lights' efficacy. The danger light system seeks to offer motorcyclists a dependable and efficient safety solution by concentrating on these performance requirements, making riding safer overall.

3.3.2 Simplified maintenance and installation

The foldable and portable hazard light system is must be made for easy installation and maintenance. The installation procedure must be simple, making it possible for mechanics or motorbike owners to set up the system without difficulty. The system will be created with ease of use in mind, making installation quick and simple without the need for technical knowledge. Additionally, the system must offer simple access for component replacement and maintenance, such as replacing LED or batteries. With this simplified process, motorbike owners may easily do critical maintenance duties, preserving the hazard light system's optimal performance. The danger light system strives to improve convenience and accessibility for users by focusing on easier maintenance and installation, ensuring long-term operation and satisfaction.

3.3.3 Durability and Weather Resistance

The compact and foldable hazard light system's durability and weather resistance are crucial factors. The system must be made of materials that are resistant to the elements and can tolerate exposure to rain, dust, and high temperatures. As a result, even in adverse weather, the danger light system is guaranteed to stay fully functional and dependable. The system must be made to be long-lasting and sturdy by using materials that can survive repeated use over an extended length of time. This focus on toughness and weather resistance guarantees that the hazard light system will continue to function effectively and reliably over time, offering motorcyclists a reliable safety option regardless of the weather conditions they may experience.

3.3.4 Safety

The design of the portable and foldable warning light system places a high focus on safety. It is made sure that the system complies with all applicable safety norms and standards by designing it in such a way that it does. The danger light system must be built with a durable construction to endure the vibrations and shocks experienced when riding. This is also to guarantees that it can survive the rigors of the road. The system also must have a reliable mounting design that efficiently prevents movement or detachment while in use. Even in difficult riding conditions, the danger light system will remain firmly in position thanks to this reliable mounting method. The hazard light system seeks to offer motorcyclists a dependable and safe safety solution, contributing to a safer riding experience for all by prioritizing safety factors including compliance, strong construction, and secure installation.

3.3.5 Weight

The weight of the portable and foldable hazard light system is a crucial consideration to minimize its impact on motorcycle performance and maneuverability. The system's lightweight design must make use of components that efficiently lower overall weight without sacrificing structural integrity. Due to its lightweight construction, the danger light system puts minimal strain on the motorcycle, preserving its peak performance and manoeuvrability. The system achieves a balance between weight reduction and structural robustness by using lightweight materials, guaranteeing that it will continue to be dependable and lasting.

3.3.6 Compatibility

It is crucial that the portable and foldable hazard light system be compatible. The system is specifically made to work with motorcycles with engines less than 150 cc, taking into account their dimensions, architecture, and electrical systems. By doing this, any compatibility difficulties with the danger light system for the motorcycle are avoided. The hazard light system also must offer choices for safe attachment to many motorbike models and styles. Regardless of the brand or model of their motorbike, riders may easily install the danger light system thanks to this adaptability. The hazard light system prioritises interoperability in order to accommodate a variety of motorcycles under 150cc, giving riders a flexible safety option that effortlessly melds with their vehicles.

3.3.7 Power Efficiency

The design of the portable and foldable hazard light system prioritises power efficiency. To maximise battery life and reduce the load on the motorcycle's electrical system, the system must be designed with a power-efficient architecture. The hazard light system ensures that the battery can endure for long periods of time without needing regular replacement or recharging by maximising power efficiency. This is accomplished by using LED lighting technology, which is more energy-efficient than conventional lighting systems. LED lights are perfect for improving visibility without taxing the motorcycle's electrical system because they use less power while producing strong illumination. The hazard light system aims to offer motorcyclists an energy-efficient solution that increases battery life and reduces the load on the motorcycle's electrical system, ultimately resulting in a more dependable and sustainable safety solution.

3.3.8 User-Friendliness

A crucial feature of the foldable and portable warning light system is its user-friendliness. The system must be built with simple controls that make it simple to turn on and off the hazard lights. The rider can easily and swiftly use the hazard lights when necessary thanks to the controls' thoughtful placement and easy accessibility.

3.3.9 Foldability and Portability

The portable and foldable hazard light system must be designed with foldability and portability as major components. When not in use, the system has a folding mechanism that makes for convenient transportation and small storage. With the use of this innovation, riders may conveniently store the danger light system without taking up too much room or creating a hassle. The hazard light system must be practical and simple to use for motorcyclists since it places a focus on portability and foldability. This allows them to carry and utilise the danger lights whenever necessary.

3.3.10 Cost

When designing the portable and foldable hazard light system, cost was a key consideration. The system must carefully plan with price in mind, guaranteeing motorbike owners can afford it. This is accomplished by paying close attention to component costs, production methods, and material costs throughout the design and manufacturing processes. The hazard light system must prioritize cost-effectiveness in order to offer a cost-effective solution without sacrificing performance or safety. In the end, this emphasis on price enables motorbike owners to increase their road safety without going over budget.

3.4 General Sketching of Triangle Emergency Hazard Light

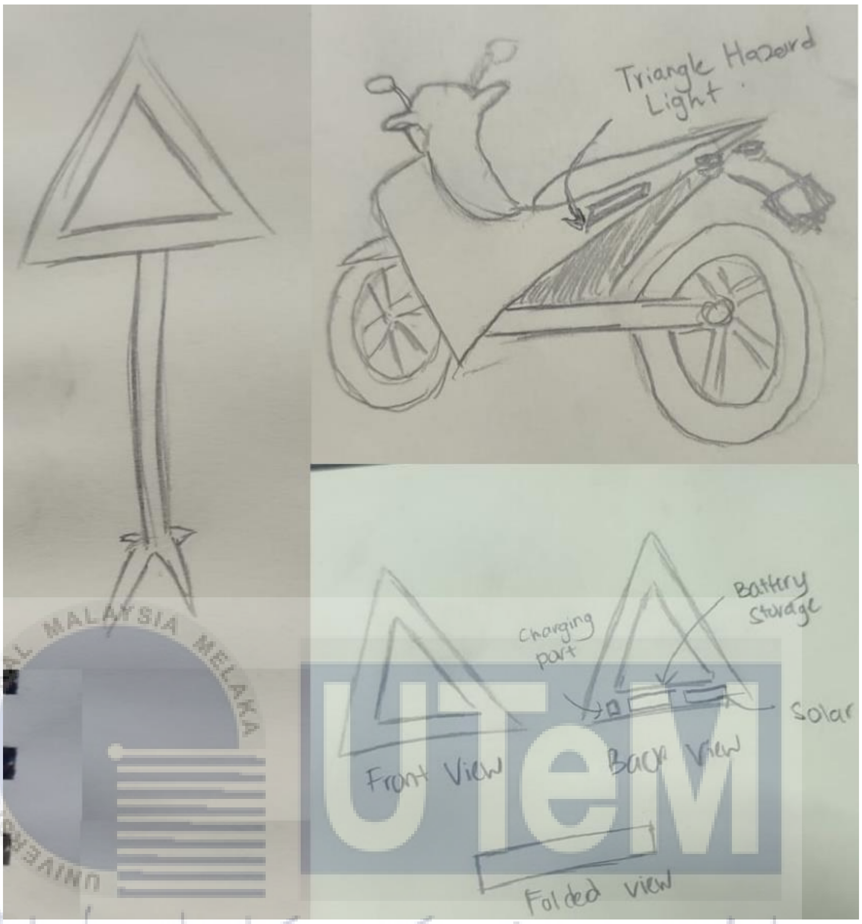


Figure 3.2 Concept and Sketching Design of Triangle Emergency Hazard Light

3.5 Concept Design Development

A key component of the overall development process for a motorbike under-150cc danger light system is the concept design development phase. This step entails coming up with design concepts in depth, eliminating choices, analyzing, and contrasting them. The goal is to determine the most promising design solution that meets the project's objectives and desired specifications by using a methodical approach. A variety of design possibilities are developed during the concept design development process, taking into account elements like visibility, location, the mounting mechanism, materials, and compatibility with motorcycles under 150cc. The following steps of the design process are built upon these concepts. Three separate design concepts are chosen carefully from among the proposals that were developed. Each design idea offers distinct qualities and strategies to handle the difficulties and demands of the hazard light system.

Then, in order to precisely visualize and modify the design concepts, the detailed design concepts are produced using Computer-Aided Design (CAD) software. The CAD models offer an actual representation of the shape and operation of the hazard light system, allowing for a complete evaluation of the advantages and disadvantages of each design. The evaluation and comparison process takes into account factors including performance, ease of installation and maintenance, safety, weight, cost, compatibility, power efficiency, user-friendliness, and mobility. To find the most practical and efficient design for the hazard light system, this concept design development approach is being used. This methodical approach guarantees that the final design is suitable to improve visibility, ensure safety, and satisfy the unique needs of motorcycles under 150cc.

3.5.1 Design A

Figure 3.3 Design A

Design A has a triangular design with a front-mounted LED light to increase visibility in an emergency. The top portion's ability to fold down makes for convenient storage and quick deployment when required. The design incorporates a solar system, which offers an environmentally friendly charging option, and a built-in battery storage to ensure sustainability and adaptability. Design A also has a charging connector that can be used as a power bank for external devices. To further understand customer preferences, extensive research and surveys were undertaken, which emphasised the value of user-friendliness and convenient storage. The bigger size of Design A, which makes storage inside the motorcycle difficult, may mean that it is not generally suitable. However, Design A attempts to meet safety requirements and improve visibility for Malaysian motorbike riders.

3.5.2 Design B

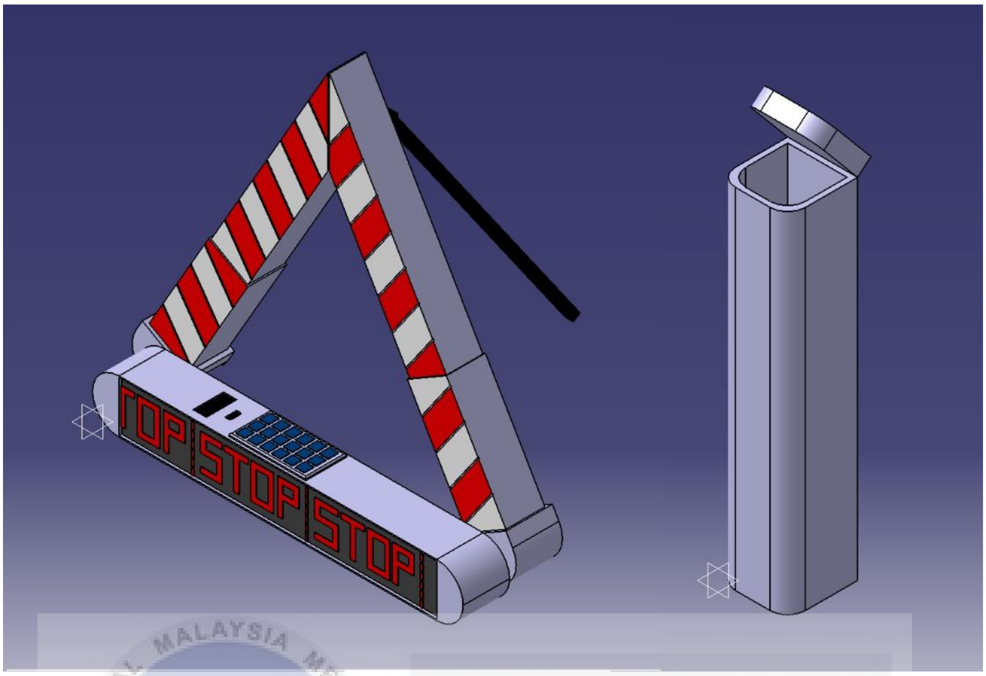


Figure 3.4 Design B

Design B focuses on creating a Triangle Emergency Hazard Light for Motorcycle Under 150cc with a different approach compared to Design A. The core goal, which is to increase motorbike riders' visibility and safety in Malaysia, has not changed. Instead of requiring a separate stand, Design B features a holder that can be screwed into position underneath the motorcycle. A front-mounted LED light on Design B's triangular hazard light ensures maximum visibility in emergency situations. The holder, which is custom made to fit particular motorbike models, enables safe attachment below the motorcycle. Based on measurements taken, the holder is suitable for motorcycles such as Y15ZR, Y16, R15, and RS150R, providing a stable mounting solution. It should be noted that not all motorbike models under 150cc may be compatible with Design B. Based on measurements, the LC135 and EX5 motorcycles present difficulties for the holder's secure attachment. It could be impossible to screw the holder beneath certain particular motorcycle types as a result.

3.5.3 Design C

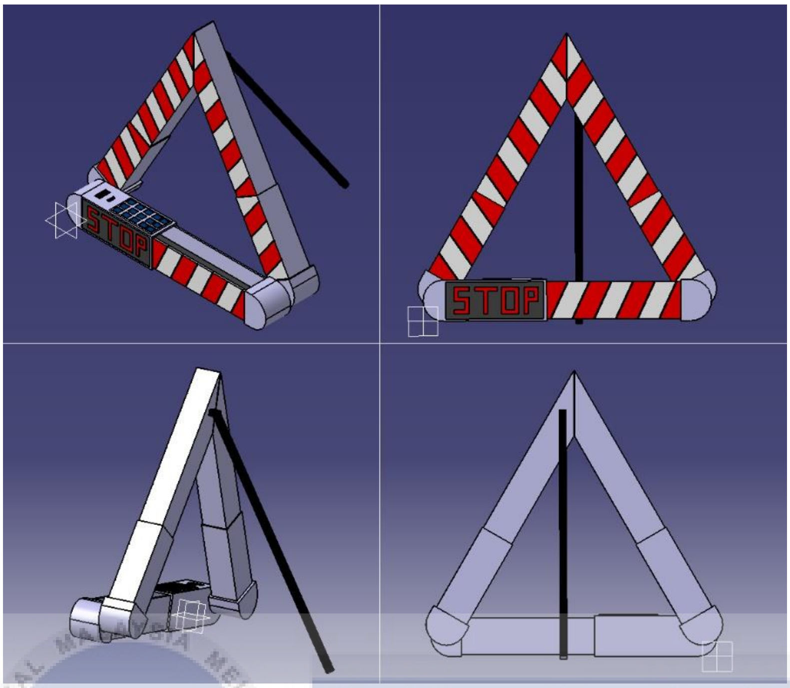


Figure 3.5 Design C

For the Triangle Emergency Hazard Light for Motorcycle Under 150cc, Design C offers a creative approach. This design aims to address the storage limitations experienced in previous designs (A and B) by eliminating the need for a stand or holder. In Design C, the triangular hazard light keeps the necessary LED light at the front, ensuring visibility in emergency situations. However, in order to enable the foldable capability, the LED panel has been carefully reduced in size and positioned to make folding the triangle's front half easier. Through this optimisation, it is made possible for the warning light to be neatly stored while yet offering adequate lighting when used. The functionality of the solar system, battery storage, and power bank included in earlier designs is also maintained in Design C. The solar system makes it possible to generate power, minimising the need on outside power sources. The power bank feature, which enables users to charge their phones or other devices during crises, is enabled by the built-in battery, which also serves as the main power source for the warning light. Design C offers better motorbike storage convenience by emphasising on space-saving design components, such as the foldable front and back of the triangle. With this design, the hazard light's overall footprint is reduced while maintaining crucial safety features. The hazard light is kept functional and adaptable thanks to the integration of the solar system, battery storage, and power bank features. The ability to conserve space while maintaining essential safety elements makes Design C a promising potential advancement. To maximise its efficiency and guarantee compliance with safety regulations for motorcycle hazard lights, more testing and improvement may be necessary.

3.6 Pugh Concept Selection Method

Table 3.1 Pugh Selection Method

Selection Criteria	A	B	C
Size	-	0	+
Stability	+	0	0
Cost	-	-	+
Easy To Use	0	+	+
Lightweight	-	+	+
Durability	+	0	-
Comfortability	0	+	+
Sum +	2	3	5
Sum 0	2	3	2
Sum -	2	1	1
Net Score	0	2	4
Rank	3	2	1

The Pugh Method, sometimes referred to as the Pugh Concept Selection Method or the Pugh Matrix, is a technique for making decisions that is used to assess and contrast several design options or concepts. It offers a methodical way to evaluate multiple possibilities in accordance with predetermined criteria and choose the best course of action. The Pugh Method entails the creation of a matrix with the evaluation criteria written as columns and the design choices listed as rows. A weight is given to each criterion to indicate how important it is. Then, using the matrix, each alternative is compared to a reference notion, usually the current or benchmark answer.

The alternatives are scored for each criterion according to how well they perform in comparison to the reference notion, using a plus or minus approach. Better performance is denoted by a plus sign (+), worse performance is denoted by a negative sign (-), and no difference is denoted by a zero (0%).The weighted ratings across all categories are added up to determine the overall score for each choice. The solution chosen as the preferred option is the one with the highest overall score since it is seen to be the most promising.

3.7 Material

The selection of materials is crucial to attaining the desired performance, durability, and overall functionality in the design of the hazard light system. The material selection procedure involves identifying and evaluating various materials that meet the hazard light system's specific requirements. When selecting materials, factors such as weather resistance, impact resistance, weight, and cost are considered. It is essential to select materials that can withstand outdoor conditions, such as rain, grime, and extreme temperatures. In addition, the materials must be durable enough to ensure that the hazard light system remains functional and dependable over time. The process of selecting materials also takes the weight of the materials into account. To mitigate the effect on the motorcycle's performance and maneuverability, it is preferable that its construction be as light as possible. Nevertheless, the materials should not compromise the structural integrity and durability of the hazard light system. Moreover, cost-effectiveness is an important consideration when selecting materials. The selected materials should be accessible and inexpensive to ensure that the hazard light system for motorcycle owners remains within a reasonable budget. The hazard light system can be designed to meet the necessary requirements for functionality, durability, weight, and cost by evaluating and selecting materials with care. The material selection procedure contributes to the overall effectiveness and performance of the hazard light system, ensuring that it can increase visibility and enhance road safety for motorcycles under 150 cc.

3.7.1 LED Module

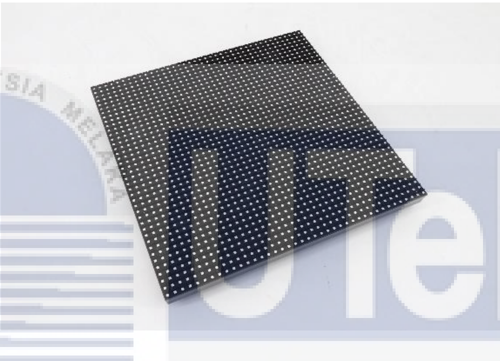


Figure 3.6 LED Module

The LED module is a crucial component of the hazard light system, providing numerous benefits including high luminosity, energy efficiency, and longevity. The LED module improves visibility, particularly in low-visibility or nighttime conditions, thanks to its brilliant and highly visible illumination. It offers wide-angle coverage, minimizing light obstruction and maximizing efficacy. The power efficiency of LED technology maximizes battery life and reduces burden on the electrical system of a motorcycle. In addition, the LED module's small size and adaptable design contribute to the lightweight and effective hazard light system. By incorporating LED modules, the design intends to increase the visibility and safety of motorcycles under 150cc, thereby decreasing the likelihood of collisions.

3.7.2 Reflective Tape

Figure 3.7 Reflective Tape

Utilizing reflective tape is an essential element of the design of the hazard light system. Microprisms or glass crystals embedded in a reflective material enable reflective tape to reflect light back to its source. This characteristic makes it exceptionally effective at enhancing the visibility of the hazard light system, especially at night or in low-light conditions. Reflective tape strategically placed on the hazard light system functions as an additional visual cue for other drivers. The reflective properties of the tape make it simpler for drivers to identify and respond to the presence of the motorcycle, thereby reducing the risk of accidents. In addition to enhancing visibility, reflective tape offers durability and weather resistance, allowing it to withstand the severe outdoor conditions that motorcycles frequently encounter. It is a cost-effective solution that is simple to apply to various surfaces of the hazard light system.

3.7.3 Solar Panel

Figure 3.8 Solar Panel

The addition of a solar panel to the hazard light system provides environmental and energy savings benefits. The solar panel converts solar energy into electrical energy to replenish the system's batteries. This self-sufficient solution reduces dependence on external power sources and reduces operating expenses. Even in partially cloudy conditions, the solar panel captures sunlight efficiently, ensuring continuous power for the hazard lighting. It eliminates the need for frequent battery replacements or recharging through conventional outlets, thereby reducing environmental impact and facilitating maintenance. The incorporation of a solar panel demonstrates the potential of solar energy to improve motorcycle safety systems.

3.7.4 Lithium-ion Battery

Figure 3.9 Lithium-ion Battery

The hazard light system includes a lithium-ion battery with multiple purposes. It functions as a power bank, storing energy generated by the solar panel and ensuring the lights have a constant power supply. In addition, the battery can charge smartphones and other devices, which provides passengers with added convenience. It is an ideal option due to its high energy density, compact size, and prolonged lifespan. The lithium-ion battery enhances the adaptability and usability of the system by providing dependable power storage and the ability to charge devices on the go.

3.7.5 Circuit Board

Figure 3.10 Circuit Board

Controlling the electrical functions of the hazard light system, the circuit board is an essential component. It controls and connects the LED module, photovoltaic panel, lithium-ion battery, and additional electronic components. It controls the power distribution, the charging processes, and the flashing patterns and cadence of the hazard lights. Its compact design and precise assembly allow for effective space utilization. The circuit board is crucial to ensuring that the hazard light system operates reliably and effectively.

3.7.6 USB and Type C Port

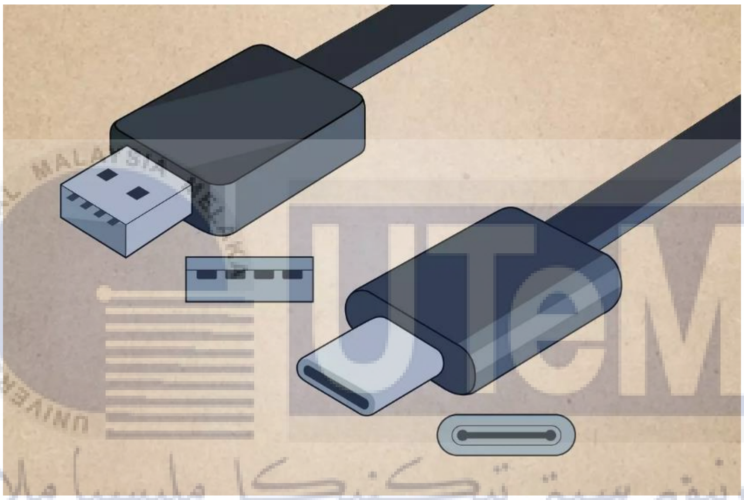


Figure 3.11 USB and Type C Port

The hazard light system is equipped with a USB port and a Type-C port, allowing for convenient lithium-ion battery charging. The USB interface enables charging of devices such as smartphones, whereas the Type-C port enables rapid and efficient charging of the battery. These ports increase the system's versatility by allowing users to simultaneously charge their devices and sustain a reliable power source for the hazard lights. The addition of USB and Type-C connectors to the hazard light system improves its usability and convenience.

3.7.7 Screw and Washer

Figure 3.12 Screw and Washer

The hazard light system includes essential hardware components such as screws and washers. These components are essential to the system's assembly and installation. The screws are used to securely fasten the various components together, ensuring that the structure is stable and long-lasting. Washers are used to distribute burden and provide additional support, thereby preventing screws from becoming loose over time. By employing high-quality screws and washers, the hazard light system maintains its integrity and dependability, even under difficult cycling conditions. These hardware components minimize the risk of detachment or movement during operation by ensuring that the system remains securely affixed to the motorcycle. During the design phase, appropriate screw sizes, varieties, and materials are chosen with care to ensure compatibility and optimal performance. The use of dependable fasteners and washers contributes to the system's overall stability, functionality, and durability.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

The design and development process of the triangle hazard light system for motorcycles under 150cc is thoroughly examined in Chapter 4. The chapter starts with a summary of the survey form and moves through the complex Pugh Selection procedure before summarizing the selected design alternatives. The narrative continues as it explains the creation of Design C, including technical drawings, digital prototyping, and the move to a physical 3D-printed prototype. This chapter offers a thorough trip through the development and testing of the triangle hazard light's system, examining finer points such as the folding mechanism, clearance and clash analysis, and a careful assessment of the triangle hazard light's performance across various road conditions. The completed prototype product serves as a tangible representation of the creative design and engineering work completed in this crucial step.

4.2 Synopsis of Survey Form

This survey was designed to better understand Malaysian motorcycle riders' thoughts and preferences regarding these hazard lights by obtaining their insightful opinions and helpful insights. The survey was carried out online using an easy-to-use survey form, making it straightforward for participants to respond. The survey form has already been made and is partially available in Appendix D.

64 respondents to the survey headed "Perception of Triangle Emergency Hazard Lights for Motorcycles Under 150cc" responded positively. These people, who were Malaysian motorcycle riders, voluntarily provided their insightful viewpoints and thoughts on a variety of important issues pertaining to hazard lights and traffic safety. The survey encompassed various aspects of motorcycle safety and perception. Participants were asked about their gender, age, and driving experience to capture a diverse range of perspectives. Additionally, questions were posed to gauge their frequency of riding motorcycles during nighttime or low-visibility conditions, their experiences with breakdowns or emergency situations, and their beliefs regarding the effectiveness of emergency triangle hazard lights in enhancing motorcycle visibility in traffic. By examining these components, the survey seeks to provide comprehensive insights into how Malaysian motorcycle riders perceive and prefer triangle emergency hazard lights. The 64 responders who freely offered their thoughts and experiences have greatly improved our comprehension of this topic and laid the groundwork for upcoming discussions and advancements in motorcycle safety initiatives.

The survey results provide valuable insights into the perception of triangle emergency hazard lights for motorcycles under 150cc. Out of the 64 respondents, the majority were male, accounting for 91% of the participants, while females comprised 9%. In terms of age, the survey had a strong representation of younger riders, with 83% falling within the 18-24 age range. Additionally, driving experience varied, with 67% having 1-5 years of experience and 27% having 5-10 years.

The survey examined the riding behaviors and experiences of the participants, and it was found that a sizable portion of them (65%) frequently rode motorbikes at night or in low visibility. In addition, 59% of participants said they have encountered emergencies or breakdowns while riding. When it came to how emergency triangle hazards lights would affect motorcycle visibility, 73% of respondents thought they would improve it somewhat, while 27% didn't think they would make much of a difference. 64% of participants said they would be happy to install hazard lights if they were reasonably priced, while 36% said they were unnecessary. In addition, 81% of respondents said they were more likely to use hazard lights under particular riding circumstances, while only 19% said they wouldn't use them at all. Responses to the topic of whether hazard lights should be standardized and made mandatory varied; 36% favored making them mandatory, while 59% thought riders should be able to choose whether to use them. Participants also discussed what they expected from hazards light features, which included a compact design (31%), light weight (17%), ease of use (16%), durability, affordability, portability, and weather resistance.

Overall, the survey's results provided insight into how Malaysian motorcycle riders felt about triangle emergency hazard lights and what they preferred. The findings offer insightful information that can improve motorcycle safety campaigns and aid in the creation of efficient hazard light systems for motorcycles under 150cc.

4.3 Pugh Selection

Table 4.1 Pugh Selection Method

Selection Criteria	A	B	C
Size	-	0	+
Stability	+	0	0
Cost	-	-	+
Easy To Use	0	+	+
Lightweight	-	+	+
Durability	+	0	-
Comfortability	0	+	+
Sum +	2	3	5
Sum 0	2	3	2
Sum -	2	1	1
Net Score	0	2	4
Rank	3	2	1

The Triangle Emergency Hazard Light for Motorcycle Under 150cc was evaluated and the best design proposal was chosen using the Pugh Method, often known as the Pugh Matrix or Decision Matrix. The Pugh Method is a systematic technique that examines and assesses several design options in accordance with pre-established criteria. Design A, Design B, and Design C were three of the design ideas that were taken into consideration. Each design was evaluated and compared in accordance with a set of standards, including size, easy to use, suitability for motorcycles with engines under 150cc, stability, the comfortability, and cost. Following a thorough analysis, it was found that Design C had the highest net score, placing it first in the Pugh Method selection. Design C received positive evaluations for its innovative foldable feature, which enabled easy storage inside the motorcycle's storage compartment. This feature solved the storage constraints seen in the earlier design (designs A and B).

The LED light, solar system, battery storage, and power bank functions were also kept in Design C, giving improved visibility and adaptability during emergencies. The solar system's inclusion enabled self-sustainability and decreased reliance on outside power sources. With a high net score and a position in the Pugh Method selection, Design C was chosen as the best option for additional development. Triangle Emergency Hazard Light for Motorcycle Under 150cc is a potential design concept because of its space-saving qualities and the retention of essential safety functions.

4.3.1 Summary

The Pugh Method was utilised in Chapter 4 of the project to pick the best design concept for the hazard light system. The Pugh Method offered a methodical way to examine and assess various design options based on predetermined criteria. The design concepts were evaluated using the Pugh Matrix in comparison to a reference concept, taking into account elements like mobility, visibility, user-friendliness, and durability. The results of the survey replies were also published in the chapter, which added important context to the preferences and needs of motorcycle riders with regard to danger lights. These observations aided in the decision-making process and made sure that the selected design concept matched the requirements of the intended users.

The Pugh Method and survey results were crucial first steps in choosing a promising design concept for the hazard light system. Although additional analysis, such as FEA analysis, testing fit, and functionality and effectiveness evaluation within a range of 50 to

100 metres will be conducted in the following phase of the project (PSM 2), the Pugh Method and survey responses served as important preliminaries.

The project has made substantial progress in discovering and assessing potential design solutions by utilising the Pugh Method and taking into account the feedback from the survey respondents. This creates a strong foundation for the project's later phases and moves us one step closer to creating a cutting-edge and efficient danger light system that improves motorcycle safety on the road.

4.4 Crafting Design C: From Digital Prototyping to 3D-Printed Prototype

This phase represents a significant turning point in the project go from the computer conceptualization of Design C in CATIA to its actual realisation. Through the use of CATIA's cutting-edge software tools, the form of the hazard light is visualised and rigorously evaluated for functioning to make sure it complies with user preferences and safety regulations. The project's overall goals are guided by the iterative refining process. Using CATIA's virtual integration and interaction simulations, a thorough assessment of Design C's suitability for motorcycles under 150cc is the first step in the journey. The section then moves on to the technical drawing stage, where the accuracy of CATIA is used to describe structural details, measurements, and important components that are necessary for the next phases of manufacturing.

Next, focus turns to the triangle hazard light's electrical circuit. A thorough examination of the CATIA-designed circuitry guarantees the LED system's smooth integration and helps the “STOP” light perform at its best in an emergency. Simultaneously, focus is placed on the material aspect. The choice of PLA (Polylactic Acid) for 3D printing is underscored, elucidating the material's characteristics and its suitability for the envisioned hazard light. The utilization of 3D printing technology with CATIA-designed PLA further emphasizes the commitment to both innovation and sustainability.

The story comes to a head with the creation of the last 3D-printed prototype, which is a concrete illustration of Design C's development. This physical manifestation becomes a tangible product for additional assessment and improvement and stands as a witness to the thorough CATIA-driven design process. A major step towards taking Design C from concept to reality is the journey from CATIA digital prototyping to 3D-printed reality, which includes the nuances of circuitry and material selection. This process paves the way for further testing and validation and, in the end, the creation of an innovative hazard light for motorcycles under 150cc.

4.4.1 Digital Prototyping of Design C using Software

In this phase, the emphasis moves to the digital domain, where Design C is applied to get from a conceptualised idea to a physical virtual model using advanced software tools. Before moving on to real prototypes, digital prototyping provides a thorough grasp of the design's functional and visual characteristics, making it a crucial phase in the development cycle. Using cutting-edge computer-aided design (CAD) software, the goal is to precisely convert Design C's complex details into an interactive, three-dimensional model. The digital prototype makes it easier to see Design C in a simulated setting by precisely displaying its form and structure, which helps to understand the aesthetics of the hazard light.

An important tool for determining whether Design C works with motorcycles under 150cc is digital prototyping. Virtual integration with typical models including Y15ZR, LC135, R15, Y16, RS150R, and EX5 is used to evaluate the design's fit and viability for a wide variety of motorcycles. As part of the digital prototyping process, the user interface and experience are also taken into account. Through interaction simulations, the usability of Design C may be evaluated to make sure that its implementation and extra features—like the solar system and power bank functionality—meet user expectations. This section provides a thorough explanation of the digital prototyping approach used for Design C, highlighting its significance as a critical stage in the development process, guaranteeing compliance with safety regulations, user preferences, and overall project objectives.

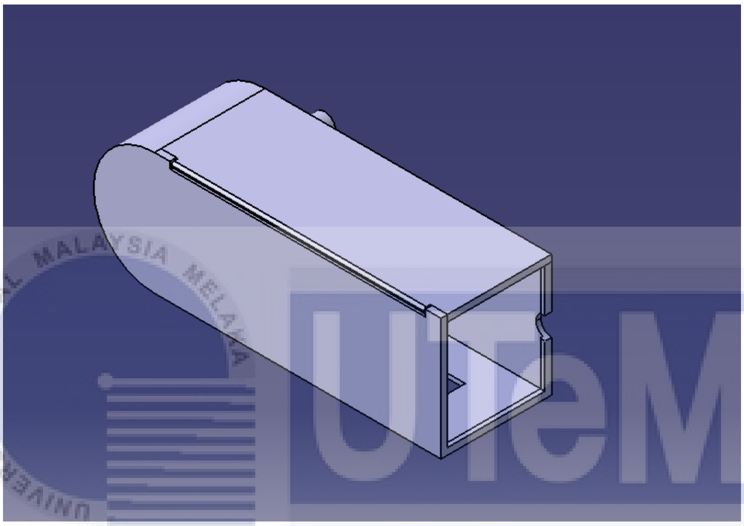


Figure 4.1 Base Left

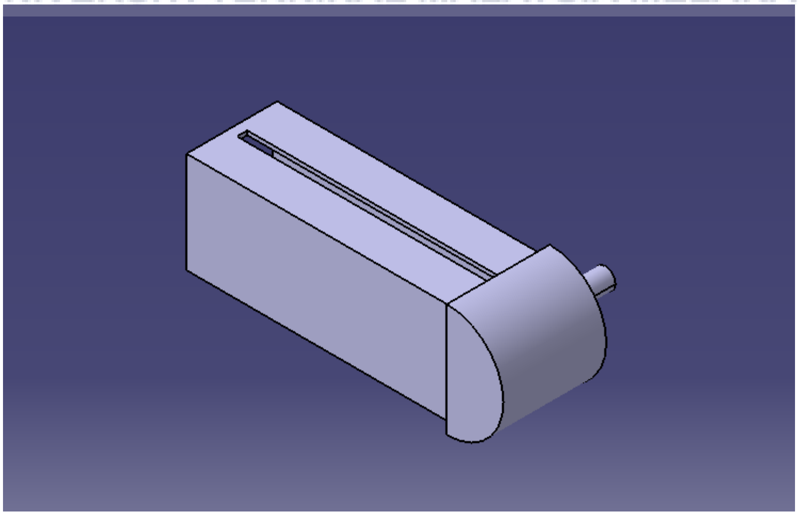


Figure 4.2 Base Right

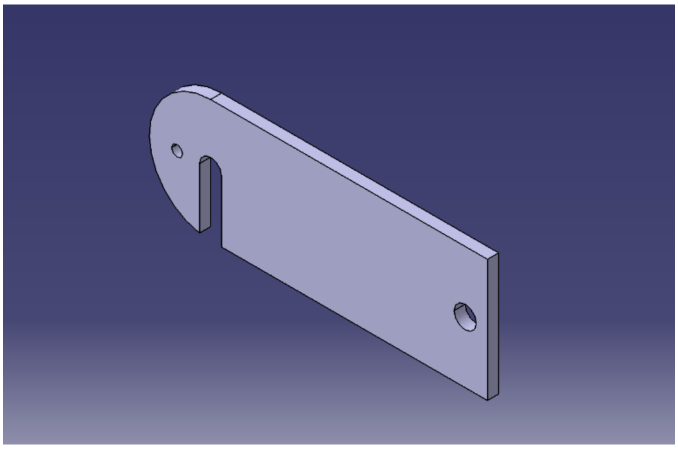


Figure 4.3 Part of Triangle Hazard Light

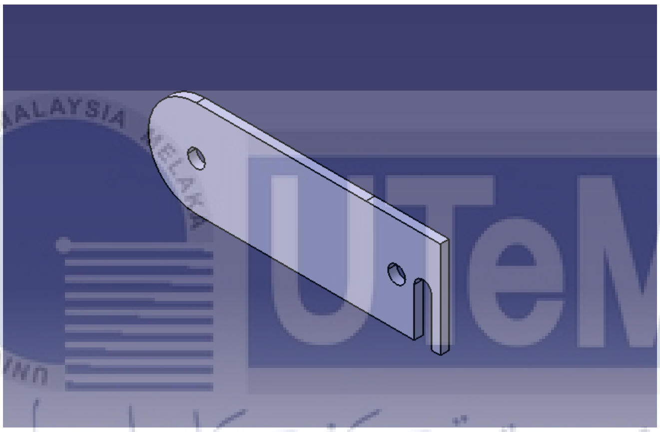


Figure 4.4 Part of Triangle Hazard Light

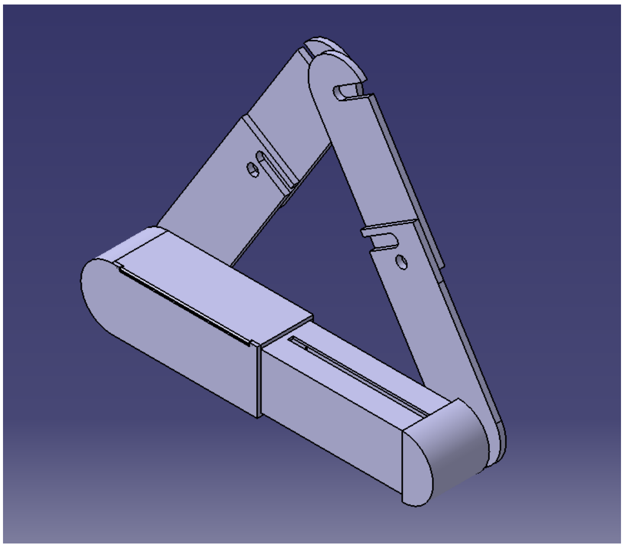


Figure 4.5 Assembly of Triangle Hazard Light

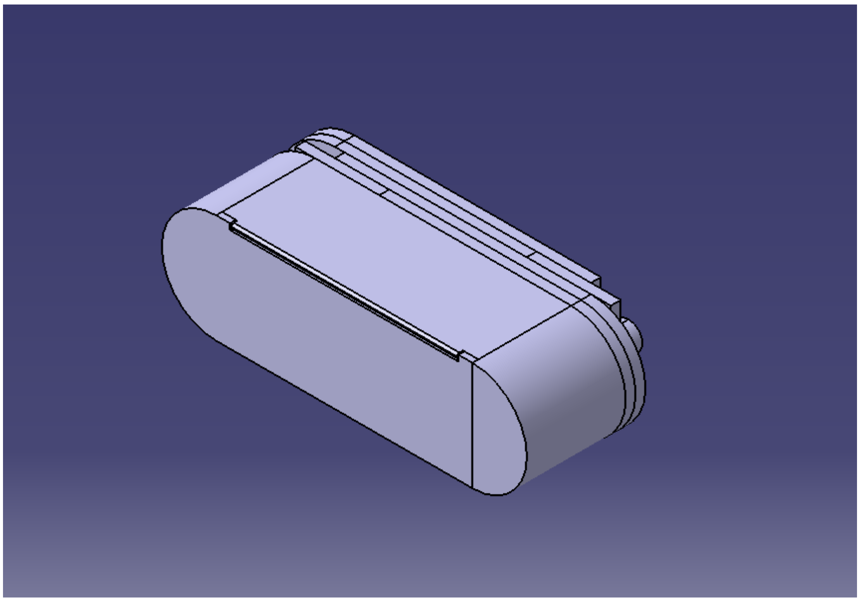


Figure 4.6 Folded Triangle Hazard Light

4.4.2 Technical Drawing of Design C

Through in-depth technical drawings, the technical details of Design C are carefully documented in this part. These sketches provide an essential starting point for the conversion of the digital prototype into the actual physical form of the Triangle Emergency Hazard Light. The technical drawings include precise and industry-standard drafting techniques, along with complete schematics of the major components, measurements, and structure of the hazard light. The deployment mechanism and foldable feature integration will clearly depicted in the designs, guaranteeing a full comprehension of the mechanical details of the design. These technical drawings also serve as a crucial guide for the manufacturing process, providing exact specifications to make Design C a reality. The technical details of Design C are clarified in this part, which bridges the gap between the digital and actual prototypes.

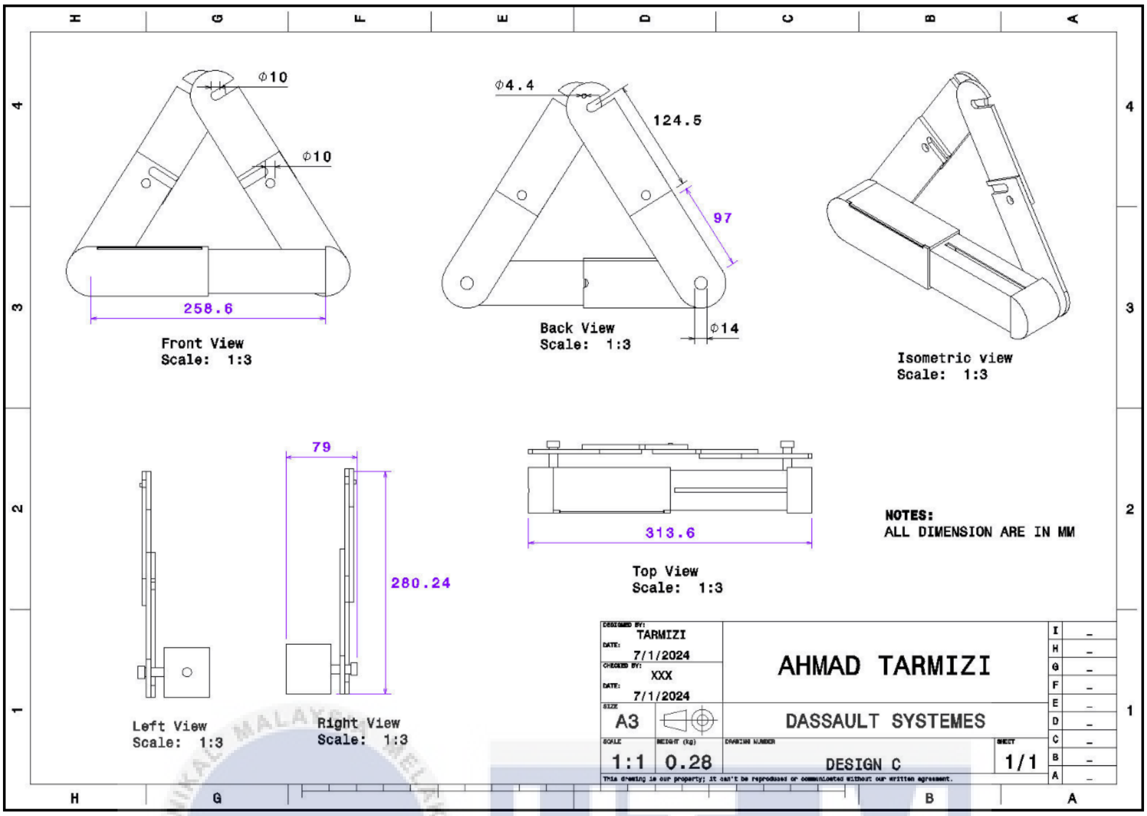


Figure 4.7 Drawing of Design C

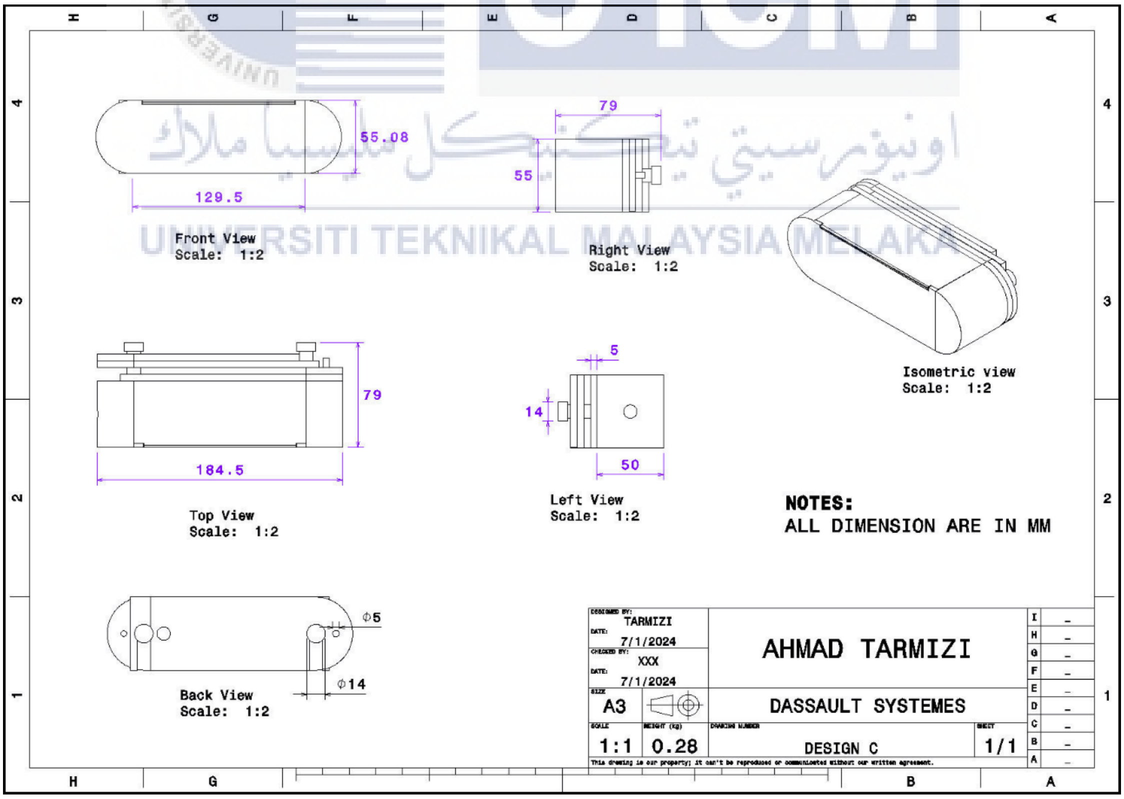


Figure 4.8 Drawing of Design C (Folded)

4.4.3 Tree Diagram of The Structure

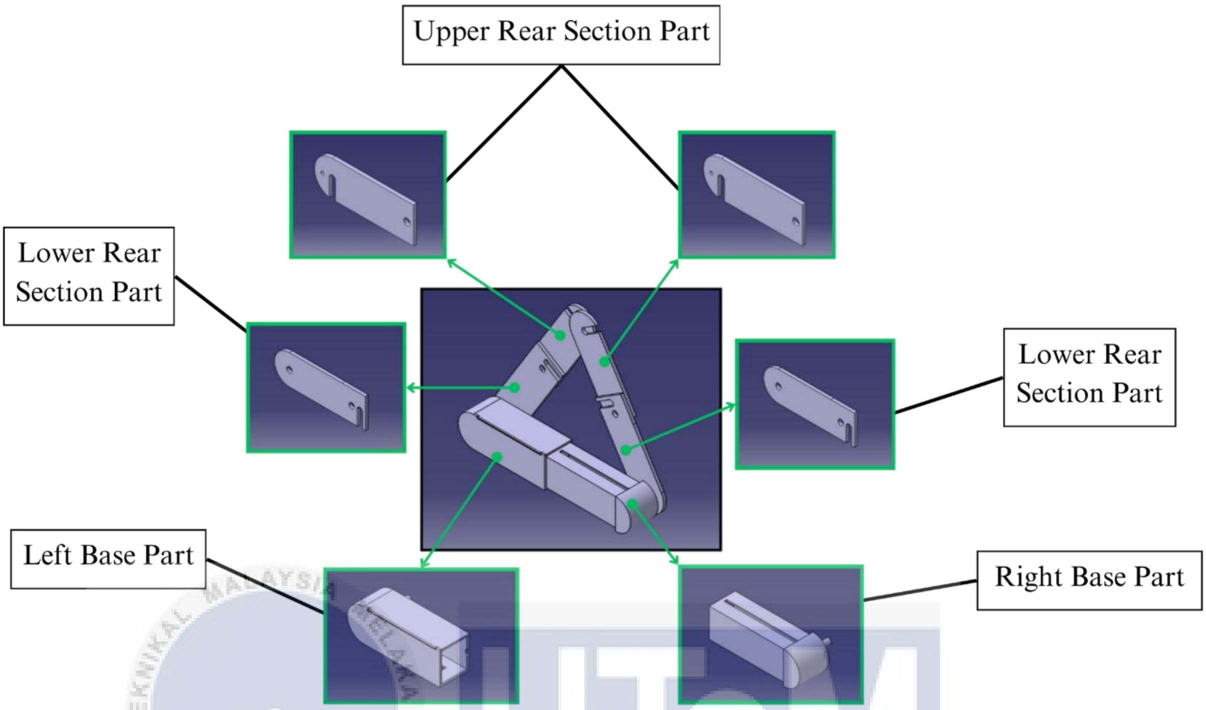


Figure 4.9 Tree Diagram of Triangle Hazard Light

A thorough tree diagram has been created within the parameters of Design C in order to clarify the structural hierarchy of its many parts. This graphic depiction makes the connections between various components evident, providing a clean, well-organized picture of the composition of the design. A closer look at the tree diagram in this part reveals the subtleties of the hierarchical structure of the design. In addition to helping with documentation, the visual aid helps with the strategic improvement of Design C by guaranteeing that its different parts are arranged in a way that is both efficient and logical.

4.4.4 From Digital to Print: PLA 3D Printing for Design C

Figure 4.10 PLA (Team Xometry 2022)

This section explores the process of using PLA 3D printing to fabricate Design C, moving the focus from the digital to the reality. Polylactic acid, or PLA, is the material of choice for creating the triangle hazard light since it is inexpensive, eco-friendly, and bio-based. The project's goal of affordability and accessibility for Malaysian motorbike riders is well aligned with the choice to employ PLA. The translated digital prototype from CATIA is the first step in the PLA 3D printing process. Layer by layer, the complex design takes shape thanks to meticulous refinement through digital prototyping and technical drawings. As PLA is so versatile, it may be precisely used to replicate the intricate nuances and details seen in the digital model. The environmental sustainability of PLA, which is made from renewable materials like cornstarch, is one of its main benefits. This is in line with the goal of affordability as well as a dedication to environmentally sustainable solutions, which are essential in the current environment.

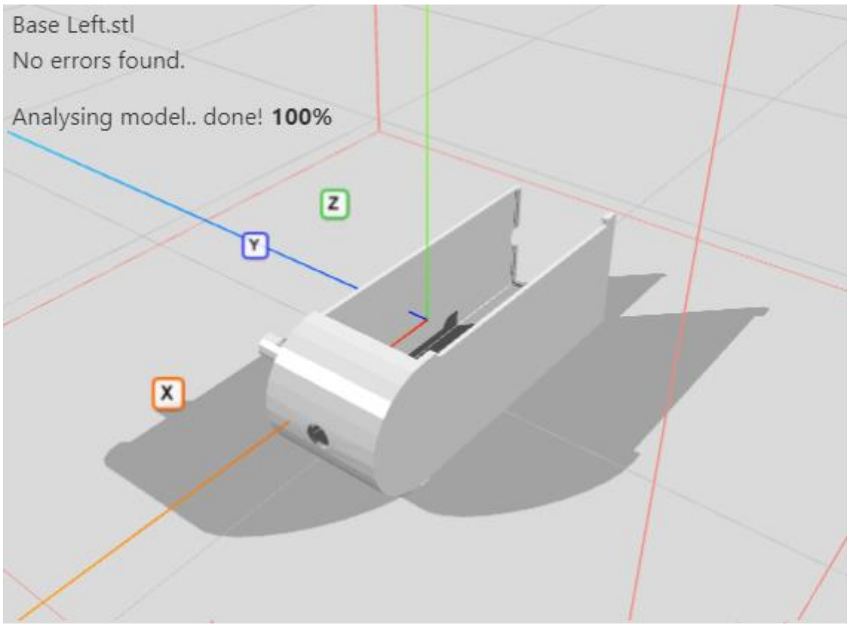


Figure 4.11 3D Printing of Right Base Triangle Hazard Light

The actual 3D printing procedure uses a 3D printer to add layers of PLA material one after another, gradually constructing the hazard light. Compared to conventional subtractive processes, this additive manufacturing approach minimises material waste while guaranteeing accuracy in creating the design. PLA is more affordable than its component parts. Its ability to work with 3D printing technology makes it possible to create elaborate structures and complex geometries without compromising affordability. This makes Design C a reality in a way that is both creative and profitable. The PLA 3D printing process further underlines the practicality of Design C, making it not only an advanced hazard light but also a solution accessible to a diverse range of riders.

4.4.5 Formulating the Electrical Circuit for Design C

This section discusses the carefully planned connections of the electrical circuit in Design C, coordinating a smooth interaction of parts for maximum efficiency. Rechargeable batteries are the central component of the circuit and are kept safe in specific battery holders. The battery's positive terminal forms a nexus with the positive terminals of the Step-Up Adjustable DC-DC Switching Boost Converter, the Battery Charging and DC-DC Boost Module, and the Solar Charger Controller, demonstrating the precision of the connection. The battery's negative terminal is precisely connected in parallel to the matching negatives of the Step-Up module, the Solar Charger Controller, the Battery Charging and DC-DC Boost Module, and the Battery.

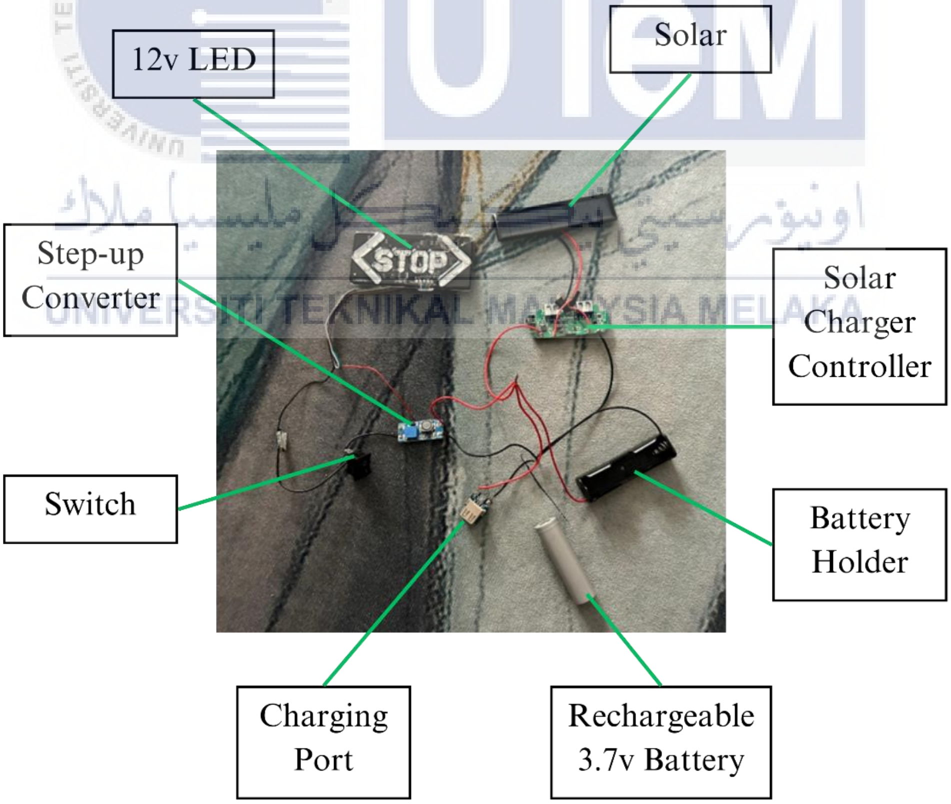


Figure 4.12 Circuit Design of Triangle Hazard Light

The solar component, with dimensions 10cm x 4.5cm x 0.8cm and an input voltage of 12V DC, plays a pivotal role. Its negative lead grounds to the matching negative terminal, and its positive lead lines up with the positive terminal of the solar charger controller. The circuit is guaranteed a steady and effective supply of solar-generated power by means of this mutually beneficial connection.

Figure 4.13 Solder Components

Soldering is a crucial step in achieving this precision. Careful soldering strengthens the connections between parts, guaranteeing durability and conductivity. By creating a strong connection between the wires and terminals through soldering, the circuit's dependability in various environmental circumstances is increased.

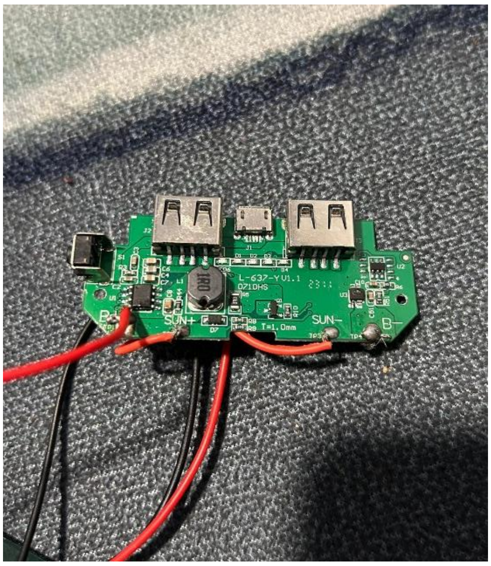


Figure 4.14 Solar Charger Controller

The primary focus of solar and battery integration is a solar charger controller module. By controlling the energy flow in both directions between the solar panel and the battery, its clever design makes for the best possible charging experience. This feature guarantees a steady and consistent power supply, which is necessary for extended operation of the triangle hazard light.

Figure 4.15 Battery charging and DC-DC boost module

The DC-DC Boost Module and Battery Charging Module shows itself to be a multipurpose powerhouse. Its double function includes providing an output for charging external devices, like phones, in addition to effectively charging the circuit's battery. This dual-purpose feature improves Design C's usefulness and practicality while meeting the various needs of motorcycle riders.

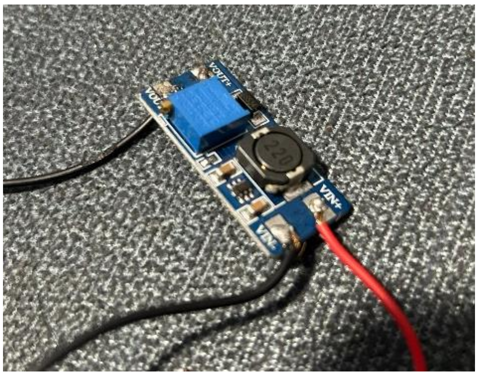


Figure 4.16 Step-Up Boost Converter

The Step-Up Adjustable DC-DC Switching Boost Converter carries on the precision. It raises the battery's output voltage to a steady 12V when placed strategically, guaranteeing the dependability of the LED system. This complex connection makes sure that the "STOP" LED, which is an essential part of visibility, has a steady power source, ensuring that it will remain bright even in low visibility.

Figure 4.17 Switch

The Step-Up Adjustable DC-DC Switching Boost Converter carries on the precision. It raises the battery's output voltage to a steady 12V when placed strategically, guaranteeing the dependability of the LED system. This complex connection makes sure that the "STOP"

LED, which is an essential part of visibility, has a steady power source, ensuring that it will remain bright even in low visibility. The meticulous attention to detail used to connect each component in this area, strengthened by soldering, highlights the electrifying accuracy with which the electrical circuit of Design C was formulated. The attention to detail in the connectivity provides both optimal operation and an intuitive interface, demonstrating the dedication to innovation and usability in motorcycle safety design.

4.4.6 Finalized Prototype Product

Figure 4.18 Triangle Hazard Light

Figure 4.19 Folded Triangle Hazard Light

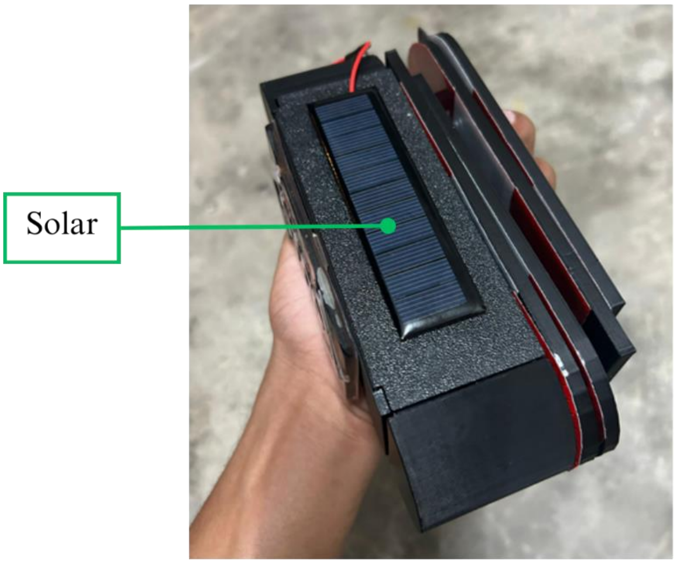


Figure 4.20 Folded Triangle Hazard Light

Figure 4.21 Folded Triangle Hazard Light

Figure 4.22 Folded Triangle Hazard Light

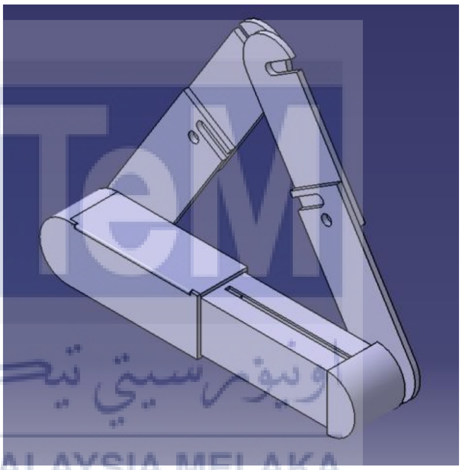
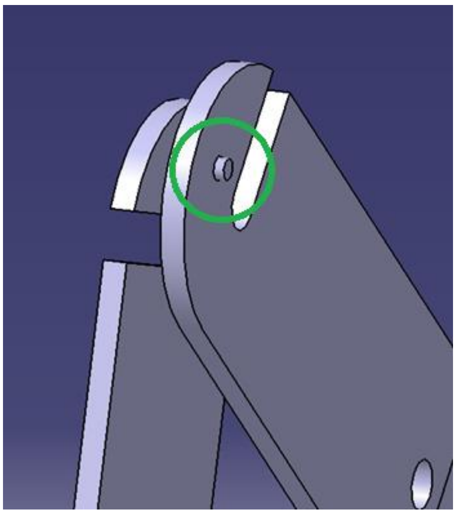
The completed prototype of the Triangle Emergency Hazard Light for Motorcycles Under 150cc is the result of this extensive design and development process. This last phase is the result of combining creative design, painstaking engineering, and user-centered design. When opened, the prototype as shown in Figure 4.20 embodies a compact and stylish design that is suitable for motorcycles under 150cc. This arrangement guarantees motorcyclists a discrete yet reliable safety solution. That being said, it should be noted that not all motorcycle seats will accommodate the triangle hazard light due to the various storage arrangements for motorcycles. Furthermore, the folded state of the hazard light is depicted in Figures 4.21 and 4.22, highlighting its portability and compactness for substitute storage options.

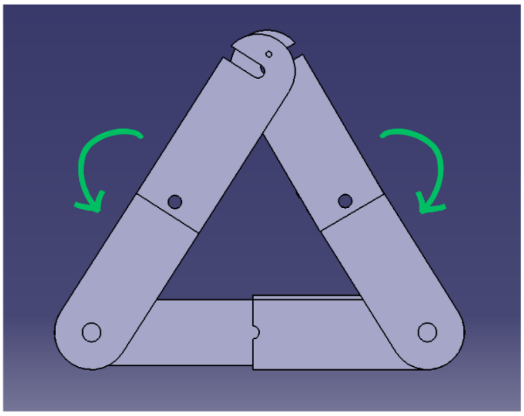
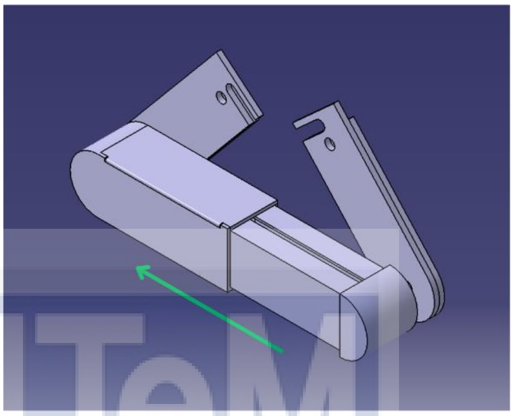
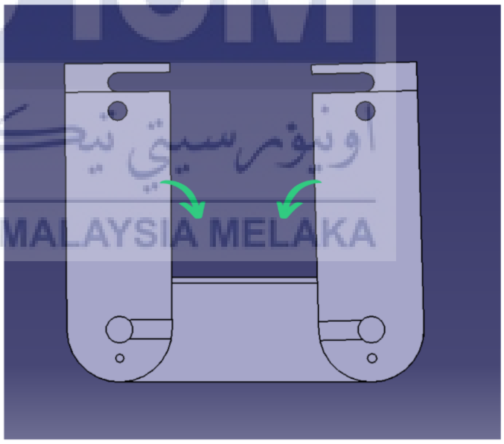
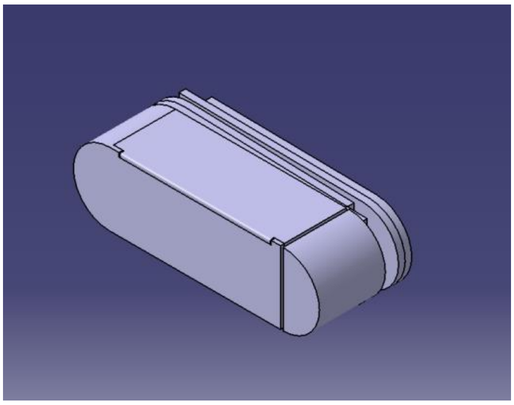
Beyond its appearance, the prototype has state-of-the-art features. The integrated solar panel, which guarantees a sustainable power supply in addition to improving the eco-friendliness of the hazard light, is shown in Figure 4.20. The USB connector is clearly visible in Figure 4.21, confirming the triangle hazard light's use as a power bank that allows riders to easily charge their devices. The user-friendly interface of the hazard light is highlighted by the switch to activate the "STOP" LED, which is shown in Figures 4.21. This ensures prompt and effective operation when needed. Notably, the triangle hazard light's left base has a flawlessly integrated circuit design that maximises both form and effectiveness.

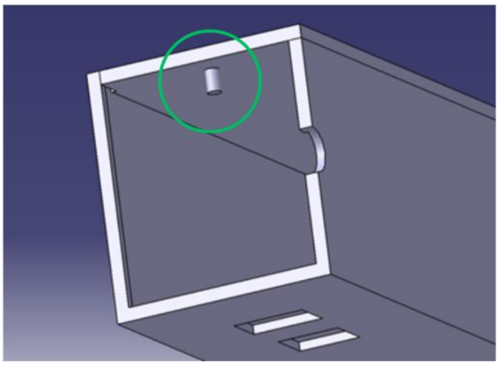
4.5 Folding Mechanism

The Triangle Hazard Light's folding mechanism is shown in table 4.1, along with an accompanying photo.

Table 4.2 Folding Mechanism

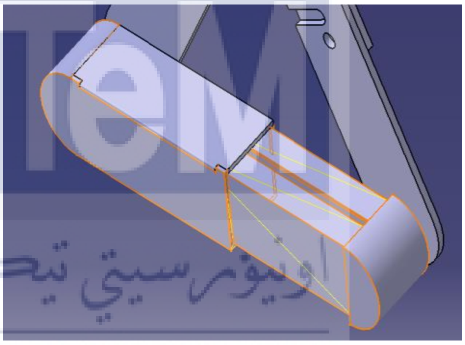
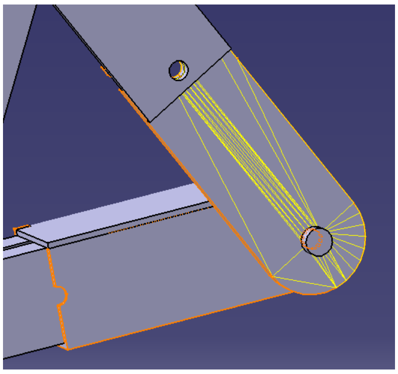
Step	Picture
In the first step, the triangle is unfolded and in a stable position.	
The next step is to remove the pin from the slot at the top of the triangle and ensure that both of the part is not connected to each other.	

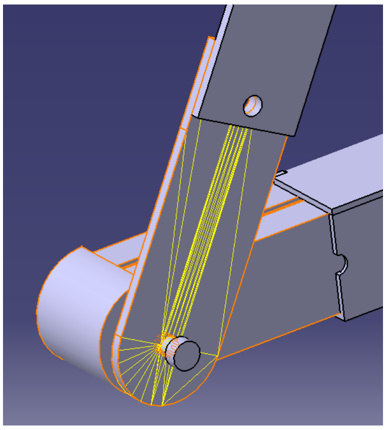
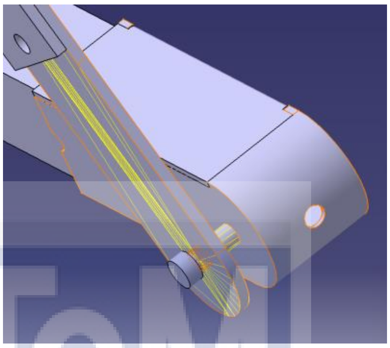
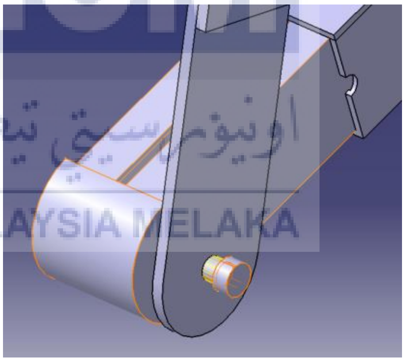
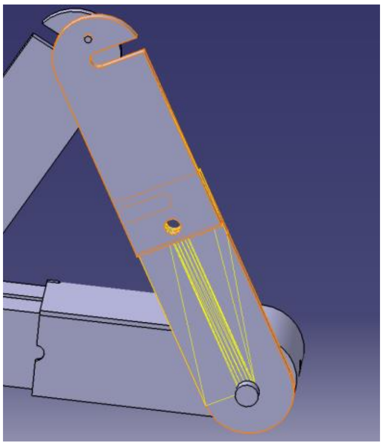
Then, fold the top triangle inward into its designated slot.	
The fifth step involves sliding the Right Base of the Triangle Hazard Light inside its corresponding slot.	
The final step is to fold both parts of the back of the triangle into their respective slots.	
The concluding photograph showcases the Triangle Hazard Light in its compact and folded configuration.	

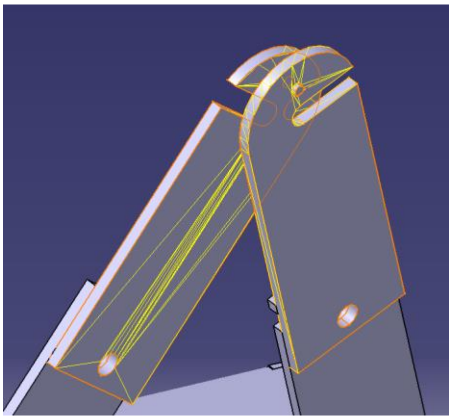
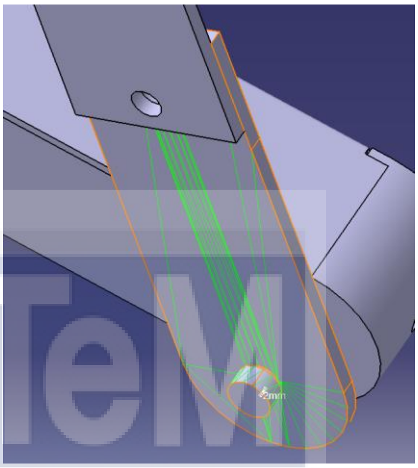
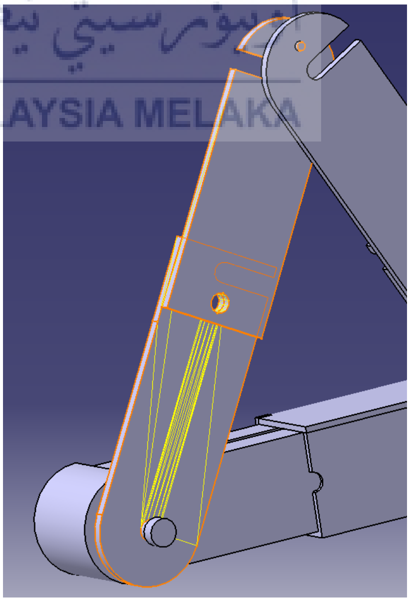
Additionally, there is a stopper inside the Left Base designed to prevent the Right Base from dislodging or moving out of place.	

4.6 Clearance and Clash Analysis

Table 4.3 Outcome of Individual Component Clash Verification

No.	Type	Status	Picture
1	Contact	Relevant	
2	Contact	Relevant	

3	Contact	Relevant	
4	Contact	Relevant	
5	Contact	Relevant	
6	Contact	Relevant	

7	Contact	Relevant	
8	Clearance (2mm)	Relevant	
9	Contact	Relevant	

In CATIA, Clash Analysis is a crucial tool used to examine possible conflicts or interferences between components in a 3D assembly, guaranteeing smooth physical assembly and operation. This analysis gives a thorough examination of how various elements interact and highlights locations where modifications may be required to avoid collisions. The color-coded lines are essential for communicating information during the analysis. Potential points of contact or interference are indicated by the yellow line, which represents the movement trajectory between the components. Green lines guarantee a seamless assembly by assuring that parts in certain locations are free from collisions. On the other hand, orange lines indicate potential conflicts or locations that require additional attention. Designers can use the interpretation of these lines as a visual guide to improve the model and make the necessary changes for a seamless and efficient assembly procedure.

4.7 Analyzing Triangle Hazard Light Performance Across Different Ranges

This section provides a thorough analysis of the Triangle Emergency Hazard Light for Motorcycles Under 150cc, with a particular emphasis on how well it works at different distances and in various types of environmental conditions. The assessment covers a range of 50, 75, and 100 metres, providing an in-depth examination of the visibility of the triangle hazard light.

Each test scenario includes a side-by-side comparison with a typical automobile triangle hazard light to give a reliable baseline and provide information about the motorbike hazard light's comparable performance. The testing will be carried out in two different road conditions, which will take into consideration the variety of terrains that motorcycle riders may encounter: a straight road and a curving path.

In addition, three different lighting scenarios which is daylight, night with street lamp illumination, and night without any street lamp illumination will be evaluated. These varied circumstances are meant to mimic actual situations, enabling a more sophisticated comprehension of the hazard light's operation in various contexts. The full evaluation that results from the junction of these variables illuminates the effectiveness of the Triangle Hazard Light in improving motorcycle visibility and, by extension, rider safety.

4.7.1 Testing for Straight Road

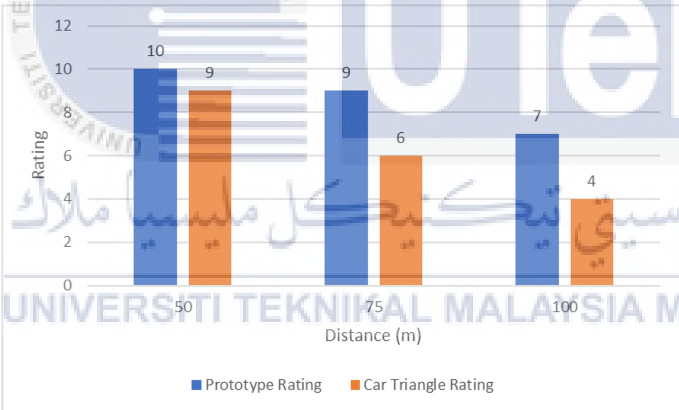
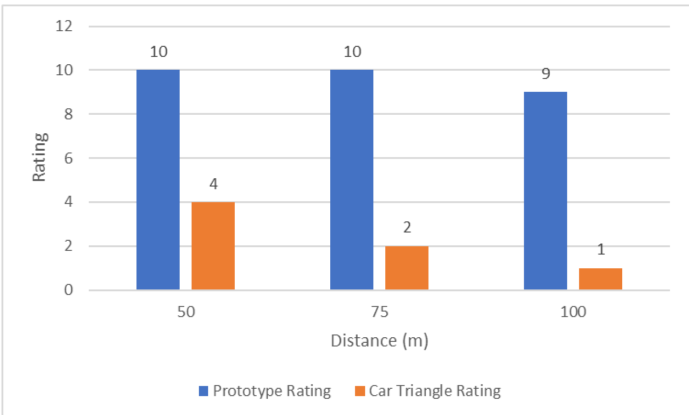
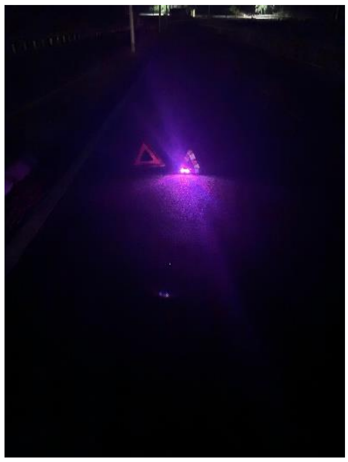
Table 4.4 Straight Road Visibility Ratings Comparison Table

Distance (m)	Environment Condition	Prototype Visibility	Car Triangle Visibility	Prototype Rating (1-10)	Car Triangle Rating (1-10)
50	Daylight	High	High	10	10
75	Daylight	Moderate	High	7	8
100	Daylight	Low	Moderate	3	5
50	Night with Street Lamp	High	High	10	9
75	Night with Street Lamp	High	Moderate	9	6
100	Night with Street Lamp	Moderate	Moderate	7	4
50	Night without Street Lamp	High	Moderate	10	4
75	Night without Street Lamp	High	Low	10	2
100	Night without Street Lamp	High	Low	9	1

The Straight Road Visibility Ratings Comparison Table illustrates the effectiveness of the prototype triangle hazard light in various lighting conditions and distances when compared to a standard car triangle hazard light. The prototype and car triangle both show excellent visibility in daylight conditions at a distance of 50 meters, receiving a perfect score of 10. The visibility of the prototype stays moderate as the distance increases to 75 meters, earning it a grade of 7, while the visibility of the automobile triangle significantly diminishes, earning it a rating of 8. The visibility of the prototype drops to low at 100 meters in the day, receiving a rating of 3, while the visibility of the automobile triangle stays moderate, with a value of 5.

The prototype retains good visibility at 50 metres during testing conducted at night with street lamps, earning a grade of 10, and the car triangle also functions well, with a rating of 9. But at 75 metres, the visibility of the prototype remains excellent rating 9, whilst the visibility of the car triangle drops to mediocre rating 6. Due to its reflector and flashing "STOP LED" that flashes in blue, red, and green, the prototype retains great visibility rating 9 at 100 metres in the absence of street lamps and acts as a useful alarm system for other riders and cars. In the same circumstances, the automobile triangle receives a 1 for low visibility. The results show that the novel features of the prototype hazard light account for its exceptional performance, particularly in low light. The prototype's light can be seen for up to 100 meters, demonstrating its potential to improve motorcycle and car safety during night.

Table 4.5 Comparison of Prototype Visibility in Different Environmental Conditions. (Straight Road)

Environment Condition	Bar Graph	Picture
Daylight		
Night with Street Lamp		
Night without Street Lamp		

The comparison shows that the car triangle's visibility is marginally better in daylight than it was with the prototype. But in low light situations, especially in "Night without Street Lamp" and "Night with Street Lamp," the true power of the prototype is revealed. The prototype outperforms the car triangle hazard light in these conditions, demonstrating its effectiveness in producing distinct and visible messages even in low-light settings. Considering the modest size of the prototype, this becomes even more impressive. The prototype's carefully thought-out blinking LED feature turns out to be crucial, greatly improving its performance in low light. These results demonstrate the prototype's applicability for use at night and point to its potential to improve road safety in similar situations.

4.7.2 Testing for Curved Road

In order to evaluate the performance of the triangle hazard light prototype under realistic and dynamic riding conditions, it was imperative to undertake testing on curved roads. Due to the shifting angles and perspectives that come with curved roadways, evaluating the hazard light's ability to retain visibility and efficacy in these situations is crucial. Through testing, the prototype's adaptability to different road geometries and its capacity to provide reliable alerting capabilities throughout bends and curves are revealed.

The testing results are intended to verify the hazard light's dependability in practical riding scenarios, guaranteeing that it will continue to be a useful safety aid on both straight and curved highways. The comparison table will show how the prototype performs in terms of visibility ratings under various environmental conditions on curved roads, akin to the Straight Road Visibility Ratings Comparison Table, providing a thorough understanding of its performance in various riding scenarios.

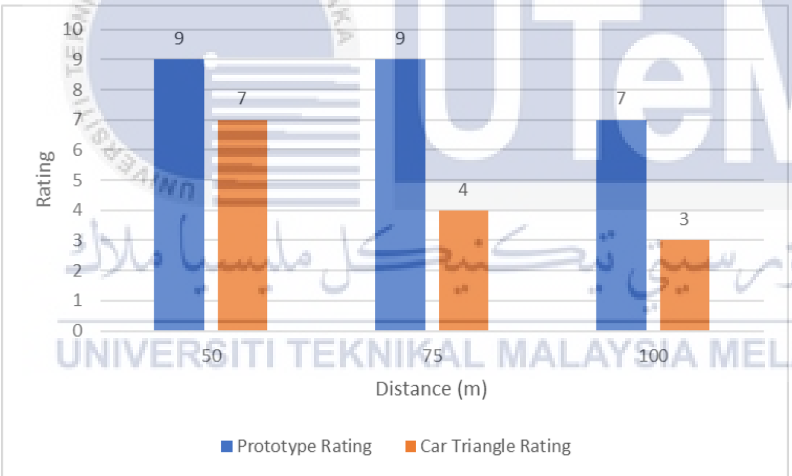
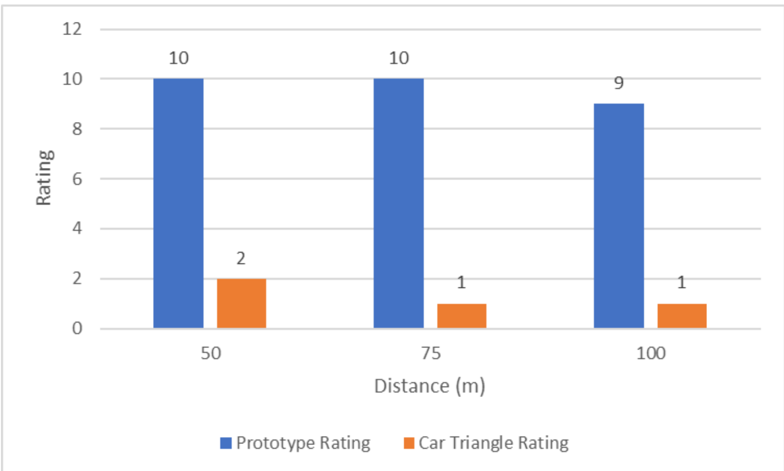
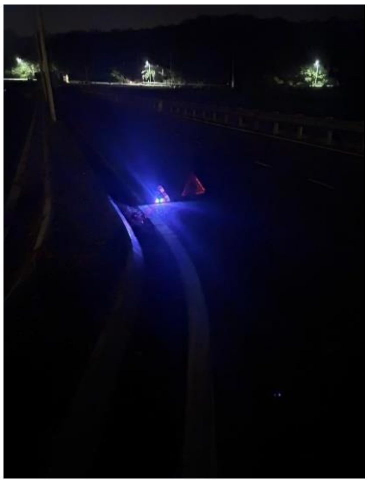
Table 4.6 Curved Road Visibility Ratings Comparison Table

Distance (m)	Environment Condition	Prototype Visibility	Car Triangle Visibility	Prototype Rating (1-10)	Car Triangle Rating (1-10)
50	Daylight	High	High	9	9
75	Daylight	Moderate	Moderate	5	7
100	Daylight	Low	Low	3	4
50	Night with Street Lamp	High	Moderate	9	7
75	Night with Street Lamp	High	Moderate	9	4
100	Night with Street Lamp	Moderate	Low	7	3
50	Night without Street Lamp	High	low	10	2
75	Night without Street Lamp	High	Low	10	1
100	Night without Street Lamp	High	Low	9	1

The triangle hazard light prototype shows good visibility at 50 meters in daylight on a curving road, matching the visibility of the car triangle, both of which receive a grade of nine out of ten. When the distance reaches 75 meters, both hazard light's visibility drops to a moderate level. The car triangle has a moderate visibility rating of 7, while the triangle hazard light prototype receives a rating of 5. The challenge increases to 100 metres, at which point both triangle hazard light visibility drops to a low level. The triangle hazard light prototype receives a rating of 3, while the car triangle hazard light receives a rating of 4.

Transitioning to nighttime scenarios under street lamp illumination, the hazard light prototype excels, maintaining high visibility at 50 and 75 meters with respective ratings of 9. It performs better under these circumstances than the automobile triangle, which is rated moderately 7 and 4 at the same distances. The prototype for the hazard light retains excellent visibility in places without street lamps, earning a flawless rating of 10 at 50 metres. The visibility ratings for both triangle hazard light drop as the distance grows to 75 and 100 meters, however the prototype continuously performs better in low light conditions than the car triangle, highlighting its usefulness in giving riders clear visibility on curved roadways.

Table 4.7 Comparison of Prototype Visibility in Different Environmental Conditions. (Curved Road)

<table>
<tr><th>Environment Condition</th><th>Bar Graph</th><th>Picture</th></tr>
<tr><td>Daylight</td><td>
</td><td></td></tr>
<tr><td>Night with Street Lamp</td><td>
</td><td></td></tr>
<tr><td>Night without Street Lamp</td><td>
</td><td></td></tr>
</table>

Curved road testing is very valuable since it sheds light on how well the hazard light prototype adapts to actual riding situations. The triangle hazardlight light prototype performs admirably in the daytime at 50 meters of visibility, albeit it does indicate a decrease with increasing distance, which is similar to the difficulties presented by curving routes. Tests conducted at night with street lamps lighting on the prototype of the hazard light show that it consistently outperforms the car triangle hazard light, especially at 100 meters. When there are no street lamps present, the prototype's multicolored flickering LEDs provide increased visibility. This performance highlights the prototype's resilience in improving safety and attests to its effectiveness in a variety of riding scenarios.

The car triangle has marginally higher visibility during the day, but the triangle hazard light prototype performs exceptionally well at night without street lamps, which highlights its effectiveness. The prototype outperforms the car triangle hazard light in terms of clear visibility, especially at long range, because to its smaller size and multicoloured blinking LEDs. This result confirms the prototype's reputation as a dependable safety feature, especially in low-light conditions typical of riding on curving roads at night.

CHAPTER 5

CONCLUSION

5.1 Conclusion

At the end of this project, a multidisciplinary strategy was used in an ambitious attempt to lead the way in Malaysia in terms of motorcycle safety innovations for motor vehicles under 150cc. By placing a strong emphasis on portability, foldability, lightweight design, and increased visibility, the main goals were to completely transform the field of hazard light design. By utilising state-of-the-art technologies and incorporating user feedback, the iterative design approach produced a prototype that successfully exemplifies these design concepts. The hazard light's fundamental innovation is its ability to combine excellent style and functionality in a seamless manner. It satisfies the practical requirements of portability and foldability in addition to blending in well with the design of smaller bikes, improving user experience and safety. The operational prowess of the hazard light was confirmed by employing stringent testing techniques to thoroughly assess its functioning and effectiveness within a practical range of 50 to 100 metres. Beyond simply creating a working prototype of a warning light, this project is important because it marks a significant advancement in the definition of safety requirements for various motorcycles. The project makes riding a motorbike safer and easier by incorporating user-centric design and solving important safety issues. The process of developing a concept into a working prototype creates a model for how design, technology, and safety might be integrated in the ever-changing field of motorcycle safety.

5.2 Recommendations for Advancements

In considering how the triangle hazard light might be improved and tailored to fit different motorbike models, there are some encouraging directions to pursue. First, it would be more convenient and accessible to have the triangle hazard light if it were possible to design a smaller version that neatly fits beneath the motorcycle seat. This adaption ensures that the hazard light becomes an essential safety feature without sacrificing storage space, in line with the dynamic storage limits of different motorbike designs.

Furthermore, the addition of a customised triangle hazard light holder is a remarkable improvement. This holder can be easily to attach to various areas of the motorcycle, which guarantees a secure location while allowing for effortless portability. This innovation tackles the problem of where to store the warning light when not in use by giving riders the option to attach it in convenient and strategic places. These developments enhance the triangle hazard light's usefulness and solidify its position as an essential safety add-on for motorcycles of all shapes and sizes.

These recommendations open the door to a hazard light that is more widely configurable, encouraging improved riding safety for riders with a variety of motorcycle models and riding situations.

5.3 Project Potential

The project's potential to revolutionise motorcycle safety for bikes under 150cc is apparent. The versatile triangle hazard light system is made to be portable and adjustable, making it suitable for a range of motorcycle models and providing improved visibility in a variety of riding scenarios. Once it gets past the design stage, this innovation significantly reduce the risks of motorbike accidents and offer safer riding experiences.

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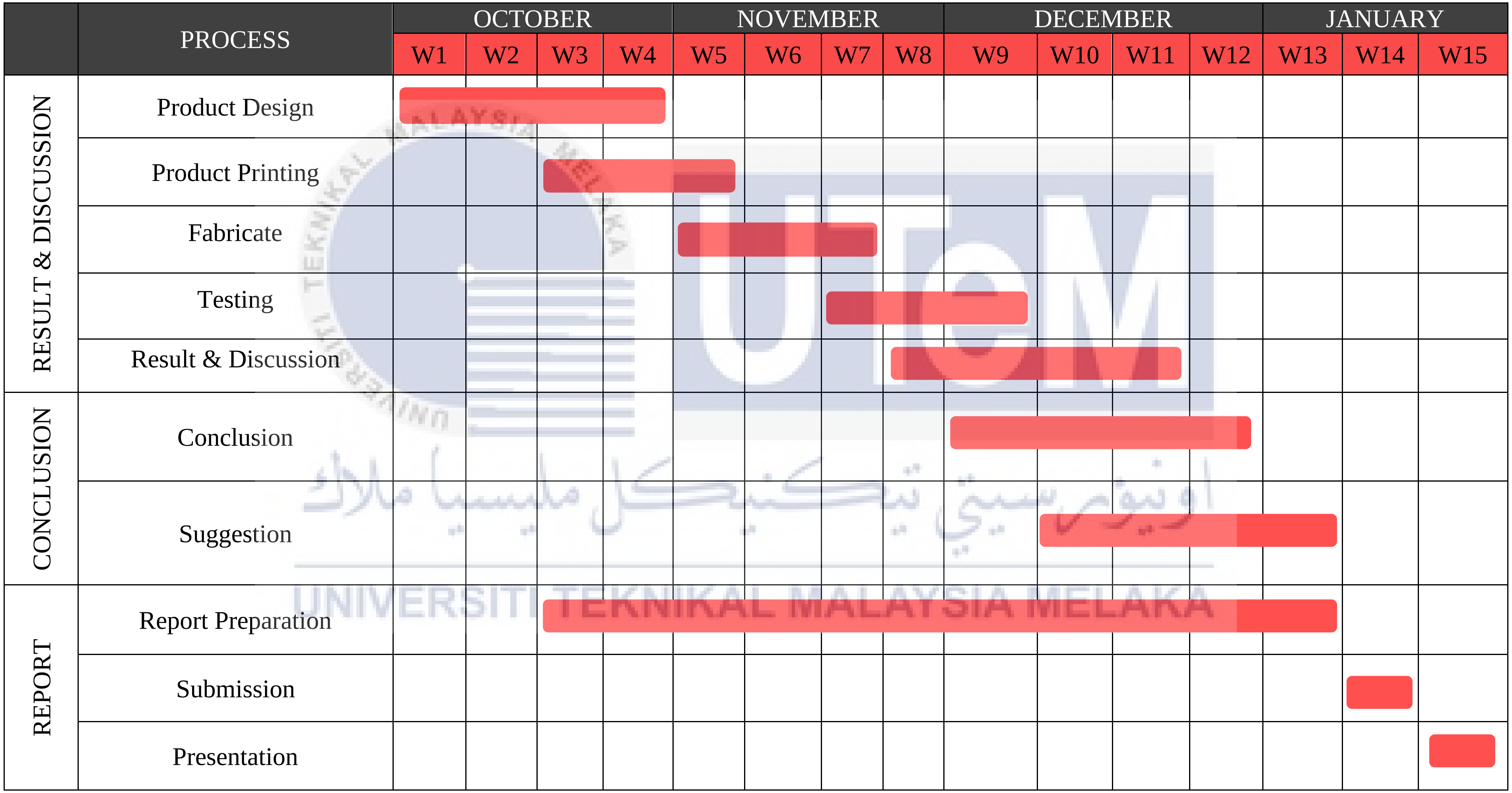
APPENDICES

APPENDIX A Gantt Chart for PSM 1

	PROCESS	MARCH			APRIL			MAY						JUNE		
		W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
CONCEPT	Title Selection															
	Introduction															
	Background															
	Problem Statement															
	Objective															
	Scope															
	Literature Review															
METHODOLOGY	Project Flow Chart															
	Sketching Ideas															
	Survey															
	Product Design															
	Method Selection															
	Material Selection															

APPENDIX B

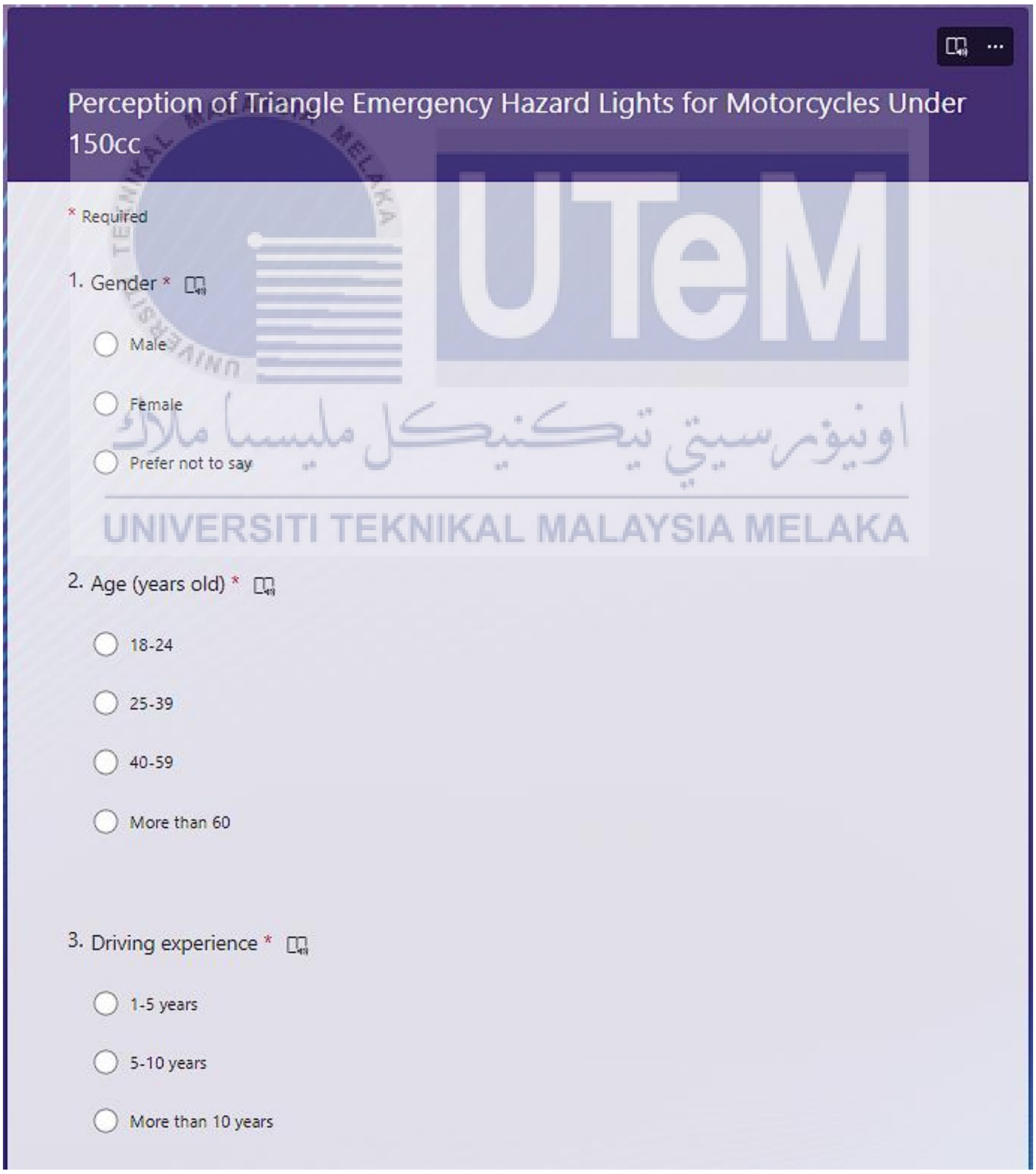
Gannt Chart for PSM2



Perception of Triangle Emergency Hazard Lights for Motorcycles Under 150cc

Welcome to the survey! Your participation in this survey is greatly appreciated. The purpose of this survey is to gather insights and opinions regarding the usage and perception of these safety features. Thank you for taking the time to provide your valuable input!

Start now



Perception of Triangle Emergency Hazard Lights for Motorcycles Under 150cc

* Required

1. Gender *

- Male
- Female
- Prefer not to say

2. Age (years old) *

- 18-24
- 25-39
- 40-59
- More than 60

3. Driving experience *

- 1-5 years
- 5-10 years
- More than 10 years

4. How frequently do you ride a motorcycle during nighttime or low-visibility conditions? *

- ◯ Frequently
- ◯ Occasionally
- ◯ Rarely

5. Have you ever experienced a breakdown or emergency situation while riding a motorcycle? *

- ◯ Yes, I have experienced a breakdown/emergency situation.
- ◯ No, I have not experienced a breakdown/emergency situation.

6. Do you believe that emergency triangle hazard lights would enhance the visibility of motorcycles in traffic? *

- ◯ Yes, to some extent
- ◯ No, not significantly

7. Would you consider installing emergency triangle hazard lights on your motorcycle as an additional safety feature? *

- ◯ Yes, if they are reasonably priced
- ◯ No, I don't see the need for them
- ◯ Unsure

8. Are you more likely to use emergency triangle hazard lights during specific riding conditions? *

(e.g., rain, fog, heavy traffic)?

◯ Yes, in specific conditions

◯ No, not specifically

9. Do you believe that emergency triangle hazard lights should be standardized and made mandatory for motorcycles under 150cc? *

◯ Yes, they should be mandatory.

◯ No, it should be optional for the riders.

◯ I'm not sure.

10. What features or functionalities would you expect from emergency triangle hazard lights for motorcycles under 150cc? *

(e.g., Compact Design, User-Friendly Controls, Durability and Longevity, Weather Resistance)

Enter your answer

11. In your opinion, how important are triangle emergency hazard lights for motorcycles in enhancing road safety? *

Not important at all	Not very important	Somewhat important	Important	Extremely important
◯	◯	◯	◯	◯

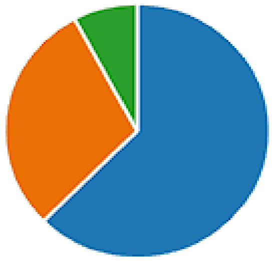
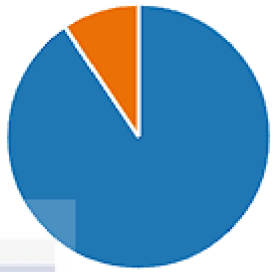
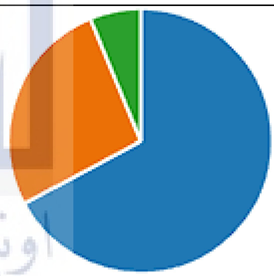
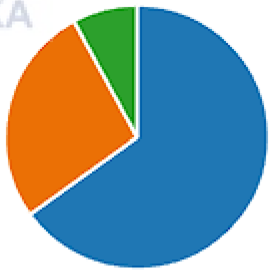
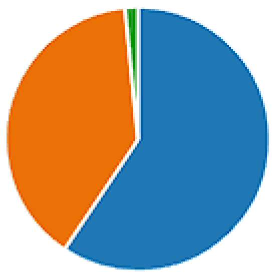
12. Would you likely to support government initiatives or incentives to encourage the use of emergency triangle hazard lights on motorcycles under 150cc? *

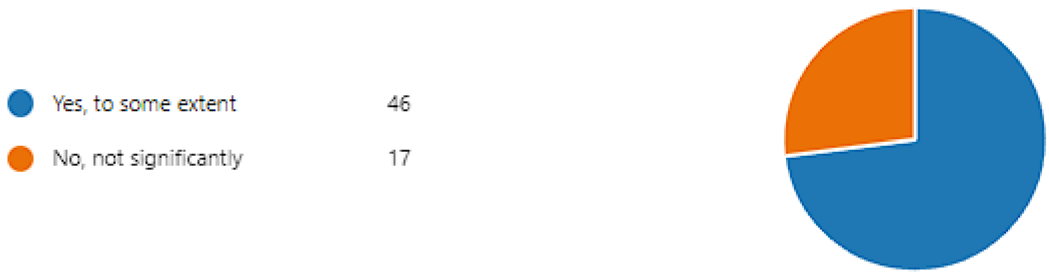
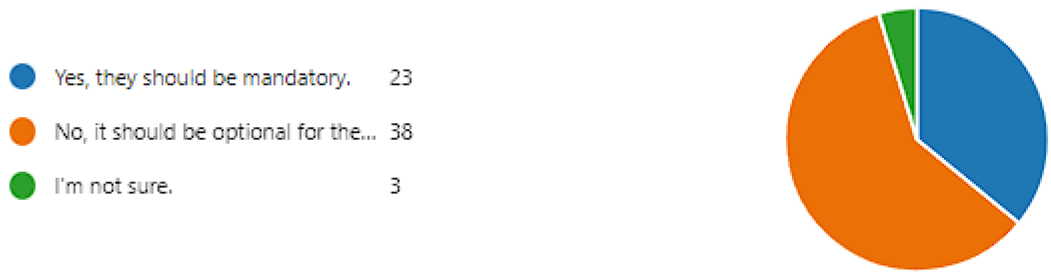
	Very Unlikely	Unlikely	Neutral	Likely	Very likely
	○	○	○	○	○

13. How likely are you to recommend the use of emergency triangle hazard lights on motorcycles to other riders? *

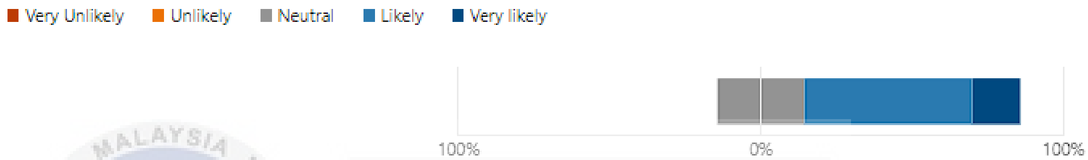
	Very Unlikely	Unlikely	Neutral	Likely	Very likely
	○	○	○	○	○

Submit

Questions	Responses
Percentage of gender in pie chart	18-24: 40 25-39: 19 40-59: 5 More than 60: 0 
Percentage of age in pie chart	Male: 58 Female: 6 Prefer not to say: 0 
Percentage of driving experience in a pie chart	1-5 years: 43 5-10 years: 17 More than 10 years: 4 
Percentage of frequency riding motorcycle during nighttime or low-visibility conditions in pie chart	Frequently: 41 Occasionally: 17 Rarely: 5 
Percentage of ever experienced a breakdown or emergency situation while riding a motorcycle in pie chart	Yes, I have experienced a breakd...: 38 No, I have not experienced a br...: 25 Other: 1 

Questions	Responses
Percentage of believe that emergency triangle hazard lights would enhance the visibility of motorcycles in traffic in pie chart	
Percentage of consideration installing emergency triangle hazard lights on motorcycle as an additional safety feature in pie chart	
Percentage of likely to use emergency triangle hazard lights during specific riding conditions in pie chart	
Percentage of believe that emergency triangle hazard lights should be standardized and made mandatory for motorcycles under 150cc	

Questions	Responses
Question on features or functionalities would riders expect from emergency triangle hazard lights for motorcycles under 150cc	

<table>
<tr><th>Questions</th><th>Responses</th></tr>
<tr><td>Percentage of importannce of triangle emergency hazard lights for motorcycles in enhancing road safety in pie chart</td><td>
</td></tr>
<tr><td>Percentage of likely to support government initiatives or incentives to encourage the use of emergency triangle hazard lights on motorcycles under 150cc in pie chart</td><td>
</td></tr>
<tr><td>Percentage of likely riders to recommend the use of emergency triangle hazard lights on motorcycles to other riders in pie chart</td><td>
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