**DEPARTMENT OF ELECTRICAL/ELECTRONICS ENGINEERING**

**PROJECT PROPOSAL**

**On**

**DESIGN AND CONSTRUCTION OF A RECHARGEABLE BATTERY-POWERED ROAD SAFETY TRIANGLE WITH LED LIGHTING AND AN ALARM SYSTEM USING MOTION SENSORS**

**By**

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# **CHAPTER ONE**

## **1.0 INTRODUCTION**

### **1.1 Background of the Project**

#### **1.1.1 Origin and History of Traditional Road Safety Triangles**

Road safety triangles are passive warning devices designed to alert oncoming drivers of a stationary vehicle on the roadside, particularly in emergency situations such as vehicle breakdowns or accidents. The concept of using reflective warning signs for road safety dates back to the early 20th century when vehicle breakdowns became more frequent due to the increase in automobile usage. The modern road safety triangle, as we know it today, was developed and popularized in the 1950s and 1960s.

It was designed as a foldable, triangular sign made of lightweight materials, typically plastic or metal, with reflective surfaces on all three sides. This design was intended to maximize visibility by reflecting headlights from oncoming vehicles. The International Organization for Standardization (ISO) later standardized the design under ISO 3864-3, ensuring uniformity in shape, size, and reflective properties worldwide.

In many countries, including those in Europe and North America, carrying a road safety triangle became mandatory as part of vehicle safety kits, especially for commercial vehicles and trucks. The goal was to provide a simple and effective way to alert drivers of stationary vehicles on the road, thus preventing rear-end collisions and roadside accidents.

#### **1.1.2 Design and Functionality of Traditional Road Safety Triangles**

The standard usage involves placing the triangle at a specified distance behind a stationary vehicle to alert approaching drivers of potential hazards ahead. It also features;

* **Reflective Surfaces:** Made of high-intensity reflective material to enhance visibility when illuminated by vehicle headlights.
* **Triangular Shape:** The equilateral triangular shape is universally recognized as a warning sign.
* **Foldable Design:** For portability and ease of storage in vehicle safety kits.
* **Sturdy Base:** To ensure stability against wind and road vibrations when placed on the ground.

#### **1.1.3 Problems and Limitations of Traditional Road Safety Triangles**

Despite their widespread use, traditional road safety triangles have several inherent limitations:

* **Limited Visibility**: They rely solely on reflective surfaces, which are only effective when illuminated by the headlights of oncoming vehicles. In low-light conditions, heavy rain, fog, or snow, the reflective surfaces become less visible, increasing the risk of collisions.
* **Passive Warning Mechanism:** They are passive devices that do not actively alert or engage drivers’ attention, making them ineffective for high-speed traffic or distracted drivers.
* **No Audible Alert:** Traditional triangles do not produce any sound, which limits their effectiveness in noisy environments or for drivers who are not paying close attention to the road.
* **Placement Dependency:** Their effectiveness depends on proper placement at a recommended distance behind the vehicle. Incorrect placement or poor positioning due to uneven surfaces reduces their visibility and warning capability.
* **Battery Life Limitations (for illuminated versions):** Some modern versions come with LED lights powered by disposable batteries, but they often suffer from short battery life and inconsistent power performance, leading to failures during critical roadside emergencies.
* **Susceptibility to Environmental Conditions:** Strong winds, heavy rain, or snow can displace or knock down the triangles, rendering them ineffective as warning devices.

#### **1.1.4 Why Traditional Road Safety Triangles are Ineffective**

**Traditional road safety triangles are ineffective in several scenarios:**

• **Low-Light and Adverse Weather Conditions:** Their dependence on reflective surfaces makes them virtually invisible in fog, heavy rain, or snow.

• **High-Speed Traffic Areas:** Passive reflectivity is insufficient to alert fast-moving vehicles, increasing the risk of rear-end collisions.

• **Distracted Drivers:** They do not actively engage drivers’ attention, especially those distracted by mobile devices or other in-car activities.

• **Battery Failures:** For versions with built-in LED lights, short battery life and power failures reduce their reliability during extended roadside emergencies.

#### **1.1.5 Need for a Smart Solution**

To address these limitations, this project proposes the Design and Construction of a Rechargeable Battery-Powered Road Safety Triangle with LED Lighting and an Alarm System Using Motion Sensors. By integrating motion detection, LED lighting, and an audible alarm system, this smart device actively engages drivers’ attention while ensuring high visibility and long-lasting performance. The use of a rechargeable battery system also addresses the problem of short battery life, making it a more reliable and sustainable roadside safety solution.

### **1.2 Problem Statement**

Conventional road safety triangles face several challenges, including:

• **Limited Visibility:** They rely solely on reflective materials, rendering them ineffective in low-light or adverse weather conditions.

• **Lack of Active Warning:** They are passive warning devices that do not actively engage drivers’ attention, reducing their effectiveness as a warning mechanism.

• **No Audible Alert Mechanism:** Drivers, especially those who are distracted or driving at high speeds, may fail to notice the reflective surfaces.

• **User Dependency:** Their effectiveness depends on correct placement and maintenance by users, which is often inconsistent.

• **Battery Life Limitations:** Existing battery-powered road safety triangles are often plagued by short battery life and inconsistent power performance, leading to frequent battery replacements or failures during critical situations. This limitation compromises the reliability and usability of the devices during roadside emergencies.

These limitations contribute to increased risks of secondary collisions during roadside emergencies, road highways were lots of broken-down vehicles can be seen and particularly in high-speed traffic areas or during nighttime conditions. Therefore, there is a pressing need for an intelligent, energy-efficient, and self-sustaining warning system that enhances roadside visibility and safety while addressing battery life challenges.

### **1.3 Aim**

The aim of this project is to design and construct a rechargeable battery-powered road safety triangle equipped with LED lighting and an alarm system using motion sensors, to enhance roadside visibility and safety during vehicle breakdowns or emergencies.

This aim focuses on developing an intelligent warning device that actively alerts oncoming drivers through a combination of motion-activated LED lights and an audible alarm, thereby reducing the risk of roadside accidents and improving overall road safety. The device aims to be energy-efficient, portable, user-friendly, and reliable under various environmental conditions.

### **1.4 Objectives**

The primary objective of this project is to design and construct a rechargeable battery-powered road safety triangle with LED lighting and an alarm system using motion sensors. To achieve this, the following specific objectives are set:

**1.** To conduct comprehensive reading and research around the project topic, including existing road safety devices, motion sensor technologies, LED lighting systems, and rechargeable battery solutions, to identify knowledge gaps and suitable technological approaches.

**2.** To identify and select appropriate methods for designing, constructing, and testing the smart road safety triangle, ensuring the integration of LED lighting, motion sensors, and an alarm system for enhanced roadside safety.

**3.** To design all components and systems involved in the project, including circuit diagrams, housing enclosure, power management system, and overall device architecture. This will also cover budget estimation, resource allocation, and detailed project planning to ensure efficient use of materials and time.

**4.** To construct the Smart Road Safety Triangle prototype using the selected components and methods, assembling all systems (LED lighting, motion sensors, alarm system, and rechargeable battery) into a fully functional device.

**5.** To test and evaluate the performance of the constructed prototype, assessing its visibility, motion detection accuracy, alarm effectiveness, power consumption, and durability. This includes verifying its long life and repeatability under different environmental conditions to ensure reliability and effectiveness as a road safety device.

### **1.5 Justification**

This project introduces a Smart Road Safety Triangle that combines LED lighting, an audible alarm system, and motion sensors to provide a proactive and intelligent solution to roadside safety challenges. The integration of motion sensors enhances visibility and alertness by activating the system only when vehicles approach, thus conserving battery power. The audible alarm system adds an extra layer of safety by alerting drivers who may not notice the visual warnings.

**Key benefits include:**

* **Enhanced Road Safety:** The dual-alert system (visual and audible) significantly improves roadside safety by actively engaging drivers’ attention.
* **Energy Efficiency:** Utilizing a rechargeable battery system with intelligent power management reduces energy consumption and promotes sustainability.
* **User Convenience:** Its portable design ensures easy deployment during emergencies, minimizing user dependency.
* **Durability and Reliability:** The weatherproof casing guarantees reliable operation in diverse environmental conditions.

This study contributes to the global effort to reduce road accidents by leveraging modern technology to create a smarter and more effective roadside safety solution.

### **1.6 Research Context**

The scope of this project includes:

* Design and construction of the Smart Road Safety Triangle using high-intensity LED lighting, motion sensors, and an audible alarm system.
* Integration of motion detection technology to trigger LED lights and the alarm system upon vehicle approach.
* Development of a rechargeable battery system with optimized power management and low-power sleep modes.
* Construction of a weatherproof and durable casing for enhanced reliability in various environmental conditions.
* Performance testing and evaluation under real-world conditions to ensure effectiveness and safety.
* Documentation of the design, construction, and testing processes, including a user manual and technical specifications.

### **1.7 Limitations of the project**

This project is subject to the following limitations:

• The system is designed to enhance visibility for stationary vehicles during roadside emergencies and does not cater to moving vehicles.

• The motion detection system is limited by the sensitivity and range of the sensors, which may affect its performance at high speeds or long distances.

• The audible alarm system is designed for short-range warning and may not be effective in extremely noisy environments.

• The rechargeable battery system is optimized for moderate usage and may require periodic recharging depending on usage frequency.

• The prototype testing is conducted under controlled conditions, which may not fully simulate all real-world scenarios.

### **Organization of the Study**

This research work is organized as follows:

* **Chapter One:** Introduction, covering the background of the study, problem statement, objectives, justification, research context, limitations, and organization of the project.
* **Chapter Two:** Literature Review, presenting a review of existing road safety triangles, motion detection technologies, LED lighting systems, alarm systems, and rechargeable battery solutions.
* **Chapter Three:** Methodology, detailing the design approach, component selection, circuit design, and system integration processes.
* **Chapter Four:** Implementation and Testing, including the construction process, prototype testing, and performance evaluation.
* Chapter Five: Conclusion and Recommendations, summarizing the findings, conclusions, limitations, and suggestions for future improvements.

This project aims to bridge the gap between traditional road safety devices and modern technological advancements, ultimately contributing to enhanced road safety standards and reducing the risk of secondary collisions during roadside emergencies.