

**TRIBHUVAN UNIVERSITY**

**INSTITUTE OF ENGINEERING**

**PASHCHIMANCHAL CAMPUS**

**A PROPOSAL ON**

**DESIGN AND FABRICATION OF ELECTRIC LAWN MOWER WITH PERFORMANCE ANALYSIS OF DIFFERENT CUTTING BLADES**

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# SUMMARY

Electric mowers offer lower noise, zero emissions, and reduced operating costs, yet blade‐design performance across turf conditions remains under‐researched. In this proposal, we aim to design and fabricate a 12 V battery rotary mower featuring interchangeable cutting blades, speed controller and a height‐adjustment system. A research gap exists because no blade profile delivers consistent efficiency and minimal power draw across Nepal’s grass species. Our objectives are (1) to compare cutting efficiency and energy consumption of three different blade geometries (Disc, Straight and Mulching Blades), (2) to integrate a PWM speed controller tuned per blade, and (3) to optimize a user‐friendly height mechanism (2mm-7mm) enabling quick blade swaps. Methodology includes fabricating frame, handle and other required body parts while some parts will be purchased and performance of lawn mower will be analyzed and compared the power and time consumption while using different blades. This project will provide necessary analysis on uses of different cutting blades according to the lawns.

**Keywords:** Cutting Blades, Electric Lawn mower, Power consumption, Speed Controller

**Table of Contents**

[SUMMARY ii](#_Toc200887574)

[LIST OF FIGURES iv](#_Toc200887575)

[LIST OF TABLES v](#_Toc200887576)

[LIST OF ABBREVIATIONS vi](#_Toc200887577)

[Chapter One: INTRODUCTION 1](#_Toc200887578)

[1.1 Background: 1](#_Toc200887579)

[1.2 Problem Statement: 2](#_Toc200887580)

[1.3 Scope of Work 3](#_Toc200887581)

[1.4 Limitations 3](#_Toc200887582)

[1.5 Objectives: 3](#_Toc200887583)

[Chapter Two: LITERATURE REVIEW 4](#_Toc200887584)

[Chapter Three: MATERIALS AND METHODOLOGY 6](#_Toc200887585)

[3.1 Materials: 6](#_Toc200887586)

[3.2 Methodology: 7](#_Toc200887587)

[Chapter Four: TIME FRAME OF WORKS 9](#_Toc200887588)

[Chapter Five: BUDGET ESTIMATION 10](#_Toc200887589)

[Chapter Six: EXPECTED OUTCOME 11](#_Toc200887590)

[REFERENCES 12](#_Toc200887591)

# LIST OF FIGURES

[Figure 1: Lawn Mower (Greenworks) 1](#_Toc200887506)

[Figure 2: Mulching Blade (Ubuy Lebanon) 6](#_Toc200887507)

[Figure 3: Disc cutter (Amazon.in) 6](#_Toc200887508)

[Figure 4: Straight Blade (Briggs & Stratton) 6](#_Toc200887509)

[Figure 5: Motor (PicClick) 6](#_Toc200887510)

[Figure 7: Wheel (Amazon.in) 6](#_Toc200887511)

[Figure 6: Battery (Delko.si) 6](#_Toc200887512)

[Figure 8: Project Workflow 8](#_Toc200887513)

[Figure 9: Time Frame of Works 9](#_Toc200887514)

# LIST OF TABLES

[Table 1: Cost Estimation 10](#_Toc200695468)

# LIST OF ABBREVIATIONS

**DC**  Direct Current

**PID**  Proportional Integral Derivative (Controller)

**PWM** Pulse Width Modulation

**CAD**  Computer-Aided Design

**℃** Degree Centigrade

# Chapter One: INTRODUCTION

An electric lawn mower is a grass cutting machine that runs on electricity, either through a cord plugged on into an outlet or a rechargeable battery. These types of lawn mower are generally lighter, quieter, and more environmentally friendly, as compare to gasoline-powered mower. An electric lawn mower operates on the principle of converting electrical energy into mechanical energy to facilitate grass cutting.

This project aims to design eco-friendly electric lawn mower. The use of electrical energy as power source is to reduce carbon footprint while promoting the renewable energy. In addition to it, introduction of height adjustment mechanism and cutting blade interchangeability mechanism to cut grass.

A green lawnmower with a black bag

AI-generated content may be incorrect.

Figure 1: Lawn Mower (Greenworks)

## 1.1 Background:

The concept of the electric lawn mower is not new, with the first models appearing in the late 1920s and early 1930s, primarily as corded devices. These early electric mowers, while offering a cleaner alternative to gasoline, were limited by their tether to a power outlet, restricting their use to smaller lawns and requiring careful cord management. The 1950s marked a period of significant advancement, as electric motor technology became more powerful and efficient, enhancing the capabilities of these early models. A pivotal shift occurred in the 1980s with the introduction of cordless mowers, which utilized lead-acid batteries, offering a degree of mobility previously unavailable. However, these early batteries had limitations in terms of lifespan and weight, typically lasting 2-4 years even with proper care, and being comparatively heavier than modern alternatives.

The true revolution in convenience, power, and environmental friendliness began in the 2000s and continues to the present day, driven largely by the widespread adoption of lithium-ion battery technology. Lithium-ion batteries offered significantly enhanced energy density, capable of storing approximately five times more energy than traditional lead-acid batteries, translating to longer operation times on a single charge. They also boast high efficiency (exceeding 90%) and a considerably longer lifespan, typically ranging from 5-10 years or 500-800 charging cycles, along with rapid charging capabilities (often 1-2 hours for a full charge), significantly reducing downtime. Further advancements have led to the emergence of Lithium Iron Phosphate (LiFePO4) batteries, a newer and superior iteration of lithium-ion technology, which offer even greater longevity, with lifespans extending beyond 10 years or up to 3,000 charging cycles. These batteries are also noted for enhanced safety and optimal performance across a wider range of temperatures, from -20°C to 75°C.

Beyond power sources, motor technology has also seen significant innovation. Historically, brushed motors were standard, but the advent of brushless motors represents a significant technological leap. These motors replace friction-causing brushes with magnets and an electronic controller to precisely regulate speed and torque, offering numerous benefits. Brushless motors are inherently more efficient, generating less heat and wasting less energy, which translates to more power being delivered to the blades, enabling the mower to cut through thicker and tougher grass with greater ease. They also offer increased durability and lifespan (often around 10,000 hours of use), reduced maintenance, and quieter operation.

## Problem Statement:

Following are the existing problems concerns in the project:

1. Same cutting blade is not suitable for different types of grass field.
2. Different cutting blades have different amount of power consumption rate.

## Scope of Work

This project involves the design and fabrication of electric lawn mower with performance analysis of different cutting blades in the terms of power consumption and cutting efficiency. This project will have concerns on the speed controllability, interchangeability of cutting blades and height adjustment of deck or housing. The height adjustment of deck will have lower limit of 2 mm and upper limit of 8 mm which will allow to adjust the cutting blade height in order to achieve desired grass height. The project will also involve CAD modeling, basic structural analysis, and the construction of a working prototype. Lawn mower will be tested in different lawn fields having different grass density.

## Limitations

The major limitation of the project is durability testing. In addition to it, advance automation, regulatory certification and mass production could be the limitation of the project.

## Objectives:

The objectives of the project are divided into main objectives and specific objectives, which are mentioned below:

Main Objective:

* To design and fabricate an electric lawn mower and performance analysis of three different cutting blades (Disc, Straight and Mulching Blades).

Specific objectives:

1. To design and fabricate an electric lawn mower.
2. To introduce a speed controller for cutting blades.
3. To optimize the height adjustment system on the lawn mower.
4. To analyze the cutting efficiency and power consumption of different types of cutting blades.

# Chapter Two: LITERATURE REVIEW

This chapter briefly describes the past literature and research in the field of interest.

In the journal “Design and Fabrication of Lawn Mower”, a project to fabricate a grass cutter using a helix-shaped blade was completed. They had designed, fabricated, and tested the spiral blade lawn mower (Nagarajan et al., 2017).

The journal “Simple Design of Self-Powered Lawn Mower”, a self-powered lawn mower was designed using a DC electric motor, a lift mechanism using a system of speed multiplication pulleys. They managed to reduce wear by using V-belt pulleys with minimal slip effect and collapsible blades (Okafor, 2013).

In the article “Design and fabrication of a Solar Powered Lawn Mower with Adjustable Wheels”, a solar-powered lawn mower having adjustable height was fabricated, and performance analysis was done on different types of grass. Different performance was found during the test of a lawn mower on different grass fields having different toughness of grasses (P & I, n.d.).

In the article “Development of a Small-scale Electric Lawn Mower”, an electric lawn mower was fabricated and evaluated on different types of grasses (lawn, long and mixed) with two different blades (disc cutter and wire cutter) (Ziauddin, 207 C.E.).  
  
Early experimental analysis of rotary‐mower blades quantified how bevel angle affects cutting forces and power requirements. A study published in 2015 used finite‐element modeling and field trials to show that blade angles between 25° and 30° minimize torque demand while maintaining cut quality (Design and Analysis of Cutting Blade for Rotary Lawn Mowers, 2015).

Also in 2015, an applied study described the design and fabrication of a small rotary mower, including a multi‐position wheel‐mount height‐adjustment module. Although this work achieved continuous deck‐height settings via preset holes, it did not address rapid blade interchange or power‐draw variation among blade types (Design and Fabrication of Lawn Mower, 2015).

Focusing on geometry optimization, Ogunjimi et al. (2018) developed a response‐surface model to relate blade curvature, tip radius, and cutting speed to efficiency and power draw. Their tests on standard lawn grasses demonstrated that a convex curvature with a 0.05 mm edge radius can improve cutting efficiency by up to 15% while reducing energy consumption by 10% (Optimization Model of Lawn Mower Blade Geometry to Attain Improved Cutting Efficiency, 2018)[.](https://www.eajournals.org/wp-content/uploads/Optimization-Model-of-Lawn-Mower-Blade-Geometry-to-Attain-Improved-Cutting-Efficiency.pdf?utm_source=chatgpt.com)

On the control side, Messaadi and Amroun (2021) applied a fuzzy‐PID controller with pulse‐width modulation to a DC motor test bench. They reported a 30% reduction in current spikes at start-up and more stable speed regulation compared to open-loop PWM, suggesting strong potential for blade‐specific speed tuning on electric mowers (Messaadi & Amroun, 2021)[.](https://arxiv.org/abs/2108.05450?utm_source=chatgpt.com)

Most recently, Li and Chen (2024) presented a theoretical analysis of straight‐blade roller mowers. Through analytical modeling and bench tests, they confirmed that sliding‐cutting angles of 25°–30° and a grind‐edge radius near 0.05 mm minimize chopping power for common turf species, providing clear design guidelines for low‐power operation (Li & Chen, 2024).

# Chapter Three: MATERIALS AND METHODOLOGY

## Materials:

The equipment and the materials that will used in the project are: -

1. Blades
2. Disc cutter
3. Straight Blade cutter
4. Mulching blade
5. Body Frame and Chassis
6. Wheels
7. Motor
8. Battery
9. Speed controller

A circular saw blade with arrows

AI-generated content may be incorrect.A black blade with a hole in the center

AI-generated content may be incorrect.

A black blade with a white label

AI-generated content may be incorrect.

Figure 2: Mulching Blade (Ubuy Lebanon)

Figure 3: Disc cutter (Amazon.in)

Figure 4: Straight Blade (Briggs & Stratton)

A close-up of a pair of wheels

AI-generated content may be incorrect.A grey battery with a black label

AI-generated content may be incorrect.A black round electric motor with colorful wires

AI-generated content may be incorrect.

Figure 5: Motor (PicClick)

Figure 7: Wheel (Amazon.in)

Figure 6: Battery (Delko.si)

## Methodology:

Methods are the specific procedures used to identify, select, process, and analyze information about a topic. This project tries to perform well-designed quantitative and qualitative research in a very clear and direct manner.

After a background study and proper assessment, the project starts with design and fabrication of a Lawn Mower. First, the conceptual design and CAD modeling of the lawn mower is done until a satisfied design is obtained. Then, we will manufacture the required parts which are feasible to be manufactured in the workshop. Now, other required parts of the lawn mower are ought to be purchased from the market. Then, final assembly of the lawn mower according to the conceptualized design will be carried out. Finally, the tests for smooth operation, blade efficiency, and power consumption under various circumstances will be conducted using appropriate mixtures, and the data will be recorded, analyzed, and evaluated to obtain the final results. Hence, Results along with the whole procedure is to be documented and to be reviewed.

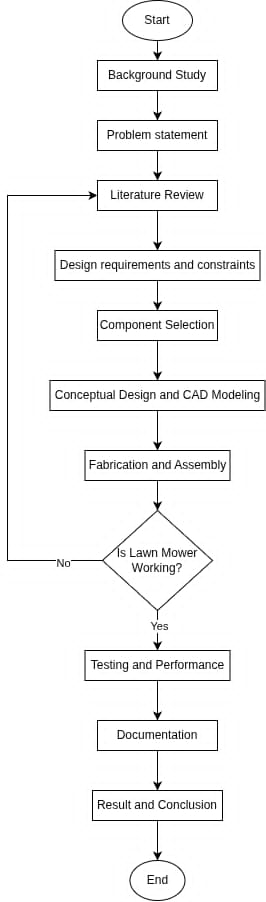


Figure 8: Project Workflow

# Chapter Four: TIME FRAME OF WORKS

The following Gantt chart shows the workflow along with the duration required for the project.

Figure 9: Time Frame of Works

# Chapter Five: BUDGET ESTIMATION

Budget estimation of the project includes the cost of the required materials are mentioned in *Table 1.*

Table 1: Cost Estimation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.N | Particulates | Nos. | Price per piece (Rs.) | Estimated Cost (Rs.) |
| 1 | Motor (12V, 3000rpm) | 1 | 9100 | 9100 |
| 2 | Disc Cutter | 1 | 2000 | 2000 |
| 3 | Straight Cutter | 1 | 1500 | 1500 |
| 4 | Mulching Blade | 1 | 1800 | 1800 |
| 5 | Battery (Li-ion) | 2 | 5000 | 10000 |
| 6 | Battery Charger | 1 | 4000 | 4000 |
| 7 | Wheel | 4 | 800 | 3200 |
| 8 | PWM Speed controller | 1 | 840 | 840 |
| 9 | Additional costs |  |  | 2000 |
|  | Total |  |  | 34,440 |

# Chapter Six: EXPECTED OUTCOME

At the end of this project, an electric lawn mower will be designed and fabricated. In addition, three different types of cutting blades (disc, straight and mulching blade) will be tested on different fields having different densities of grasses, and the performance of those cutting blades will be compared in terms of their power consumption and cutting efficiency. This project will contribute to understanding the performance of different cutting blades and help us to select efficient cutting blades according to the lawn density. Additionally, the electric lawn mower will be eco-friendly, pollution-free, and economical.

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