Development of an Improvised Solar Powered E-Grass Cutter: Utilizing Microcontroller Technology

Ramon S. Dueñas, Felipe SA. Santiago, Wilson B. Gacutan

Nueva Ecija University of Science and Technology, Cabanatuan City

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Thesis Abstract: Farmers were greatly impacted by the improvised solar-powered e-grass cutter that used microcontroller technology. This might be used to agriculture and encourage farmers to develop equipment and products made of recycled materials. The current study primarily focuses on the development, design, and evaluation of an improvised solar-powered E-Grass cutter that makes use of microcontroller technology. The actual questionnaire that was distributed to the chosen respondents was used by the researchers. The researchers utilized descriptive statistics to interpret the data because they provide a quantitative description or summary of the characteristics of the data collection. The weighted mean and percentage were employed in all statistical calculations. According to the study's findings, 26 of the respondents were farmers. Functionality, durability, and usability all received weighted averages of 3.60, 3.93, and 3.61. and safety achieved a weighted average of 3.53 overall. According to the evaluation of the farmers utilizing the E-grass cutter, the makeshift E-grass cutter's functionality, durability, usefulness, and safety all satisfied the necessary standards to carry out its intended functions.

Keywords: E-Grass Cutter Utilizing Microcontroller Technology

I. The Problem and Its Background

Introduction and Review of Related Literature and studies

Grass cutting is a ubiquitous task in agricultural and landscaping practices, contributing significantly to the maintenance of green spaces and agricultural lands. However, traditional grass cutting methods often involve manual labor or the use of fossil fuel-powered machinery, both of which can be environmentally harmful or economically unsustainable. In response to the growing need for eco-friendly and cost-effective alternatives, this research study focuses on the development of an improvised solar-powered E-grass cutter, integrating microcontroller technology for enhanced efficiency and precision. The utilization of solar power offers numerous advantages, including renewable energy sourcing, reduced carbon footprint, and decreased operational costs over time. By harnessing solar energy, this E-grass cutter aims to mitigate reliance on non-renewable energy sources while providing a sustainable solution for grass cutting needs. Additionally, the integration of microcontroller technology allows for precise control and automation of the cutting process, optimizing performance and reducing manual labor requirements.

To contextualize the development of the solar-powered E-grass cutter, this study conducts a comprehensive review of relevant literature. The review encompasses existing research on solar-powered machinery, microcontroller applications in agricultural equipment, and advancements in grass cutting technologies.

By synthesizing previous studies and identifying gaps in current knowledge, this literature review provides a foundation for the design and implementation of the proposed E-grass cutter prototype.

Through this research endeavor, its aim to contribute to the advancement of sustainable agricultural practices and technological innovation in the field of grass cutting machinery. By developing an efficient and eco-friendly solution, we anticipate positive implications for environmental conservation, economic sustainability, and agricultural productivity.

Solar-Powered Agricultural Machinery: Opportunities and Challenges

Solar energy presents a promising avenue for powering agricultural machinery, offering a renewable and environmentally friendly alternative to traditional fossil fuel-based systems. This article explores the opportunities and challenges associated with the integration of solar power in farming equipment. By examining the feasibility, effectiveness, and potential applications of solar energy in agriculture, this study aims to shed light on the role of solar-powered machinery in sustainable farming practices. By Zhang, Y., Liu, Y., & Li, H. (2021)

Microcontroller Applications in Agricultural Automation

Gupta S. Singh R, & Jain, A. (2021), said that Microcontroller technology has revolutionized agricultural automation, enabled precise control and monitored of farm machinery for enhanced efficiency and productivity. This review paper delves into the myriad applications of microcontrollers in agricultural automation systems. By analyzing the integration of microcontrollers in various farming equipment, including sensors, actuators, and control systems, this study seeks to elucidate the versatility and potential benefits of microcontroller technology in advancing agricultural practices.

Advancements in Precision Farming Technologies

According to Murali M. & Ganesh D. (2020). Precision farming technologies have revolutionized modern agriculture by offering tailored solutions for optimizing crop yields, resource usage, and environmental sustainability. This research article reviews recent advancements in precision farming technologies, focusing on tools and techniques for precise monitoring, control, and management

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of agricultural operations. By analyzing the integration of GPS, sensors, and automation in farming equipment, this study aims to elucidate the potential benefits and applications of precision technology in modern agriculture.

Environmental Impact Assessment of Traditional Grass Cutting Methods

Traditional grass cutting methods, such as fossil fuel-powered machinery and manual labor, pose significant environmental challenges, including air and noise pollution, habitat destruction, and carbon emissions. This study conducts an environmental impact assessment of traditional grass cutting methods to quantify their ecological footprint and assess the urgency of transitioning to more sustainable alternatives. By highlighting the environmental consequences of conventional grass cutting practices, this research underscores the importance of eco-friendly solutions like solar-powered E-grass cutters. Sahoo A. K, Mahapatra, A, & Sahoo S. K. (2019).

Modification of solar grass cutting machine

Base on Wankhede, (2016) study, the researchers modified the lawn mower or the automatic grass cutter, the researchers add a remote control to the lawn mower to make it easy to control, and also, they aiming for pollution control so the researcher added a solar panel to the power source to power the grasscutter or the lawn mower.

Modifications have been implemented in the current machine to enhance its usability while reducing costs. Our primary objective of controlling pollution has been achieved through these adjustments. Addition of remote control facilitates easy operation by unskilled individuals, ensuring precise lawn maintenance and a uniform surface appearance. Our project incorporates a solar-powered grass cutter designed for cutting various types of grasses suitable for different applications.

Grass Cutter Machine

Based on J. Emerg's (2018) research, the objective is to investigate advancements in grass cutter machines and their operational efficiency. Current technology predominantly involves manually operated devices for grass cutting, with various models available in the market powered by solar energy, electricity, or internal combustion engines. These existing grass cutters are limited in their ability to cut grass to specific heights. Our aim is to introduce an innovative concept primarily tailored for agricultural use. The researchers intend to fabricate a versatile grass cutting machine capable of handling both crop cutting in the field and maintaining grass surfaces.

Design of Remote Monitored Solar Powered Grasscutter Robot with Obstacle Avoidance using IoT

In K. Balakrishna's (2022) study published in Global Transitions Proceedings, an Arduino UNO-based solar-powered grass cutter is proposed for maintaining healthy grass in various settings such as parks, hotels, and public spaces. This innovative grass cutter integrates IoT (Internet of Things) technology, allowing remote control via the Blynk application supported by a Bluetooth module. The design includes essential hardware components like Arduino UNO, a solar panel for power generation, a DC motor, motor driver, rechargeable batteries, and a Bluetooth module. Programming of the model is done through Arduino IDE to manage operations such as forward, backward, right, left movements, as well as on, off, and stop functions for the grass cutter prototype. Additionally, an ultrasonic sensor positioned at the front of the model ensures obstacle avoidance during its operation. This advanced design aims to enhance efficiency and ease of use in grass cutting applications while leveraging renewable energy sources.

Manufacturing of Solar Grass Cutter

In Dala's (2016) discussion, conventional motor-powered lawn mowers are critiqued for their inconvenience and lack of user-friendliness, particularly for elderly, young, or disabled individuals. These mowers contribute to noise and local air pollution due to their combustion engines, requiring regular maintenance such as oil changes. While electric lawn mowers offer environmental benefits, they still pose challenges, especially if corded. Dala proposes a solution in the form of a self-propelling electric remote control lawn mower a robotic, user-friendly, cost-efficient, safe, and environmentally friendly prototype that can significantly reduce labor costs. To further address these issues, Dala suggests designing a solar-powered domestic lawnmower. By harnessing solar energy, this mower aims to eliminate the need for traditional power sources, making it easier to use and reducing trips for fuel refills. Importantly, it mitigates emissions associated with internal combustion engines, thus combating environmental pollution and contributing positively to global warming through the use of green, renewable energy sources like solar power.

Environmentally Friendly Solar Grass

In Bhalodi's (2020) research, the focus is on transitioning from manually operated grass cutters, which rely on non-renewable energy sources, to automatic solar-powered grass cutters. This shift aims to mitigate emissions of harmful gases associated with conventional grass cutters by utilizing renewable energy. The automatic solar grass cutter requires minimal maintenance and human intervention compared to traditional models. Addressing contemporary issues such as air and noise pollution, as well as power supply instability, the automatic solar grass cutter offers an environmentally friendly alternative. The design incorporates IR proximity sensors to detect and avoid obstacles during operation, ensuring safety. A rechargeable battery powers the cutter, enabling continuous operation even in unfavorable weather conditions when solar power generation is limited. The machine operates in both automatic and manual modes, utilizing Bluetooth for control, and integrates components like the Microcontroller ATmega 16, sensors, LCD display, Bluetooth module, solar panel, battery, and motors. Overall, this innovative design aims to reduce human effort, enhance operational efficiency, and promote sustainability in grass cutting practices.

Synthesis of Review of Literature

The synthesis of the related literature reveals a burgeoning interest in integrating solar energy into agricultural practices, particularly through the development of solar-powered machinery such as grass cutters. Solar energy, lauded for its renewable and eco-friendly

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attributes, is increasingly seen as a viable alternative to fossil fuel-dependent systems in farming. Studies by Zhang et al. (2021) and Gupta et al. (2021) underscore the transformative impact of microcontroller technology in enhancing agricultural automation, facilitating precise control and monitoring of farm equipment to optimize efficiency and productivity. Moreover, advancements in precision farming technologies, as highlighted by Murali and Ganesh (2020), have revolutionized modern agriculture by enabling tailored solutions for maximizing crop yields while minimizing resource usage and environmental impact. In contrast, traditional grass cutting methods, examined in environmental assessments like those by Sahoo et al. (2019) and Dala (2016), are critiqued for their significant ecological footprint, including air and noise pollution, habitat destruction, and carbon emissions. This prompts a growing urgency for sustainable alternatives, such as solar-powered E-grass cutters, as advocated by Bhalodi (2020) and Wankhede (2016), which not only mitigate environmental harm but also offer operational advantages like reduced maintenance and lower human interface. The evolution towards eco-friendly technologies like the Arduino UNO-based Solar powered Grasscutter, as studied by Balakrishna (2022), exemplifies ongoing innovations aimed at promoting sustainability and efficiency in agricultural machinery. Thus, while challenges remain in scaling and adoption, the synthesis highlights a promising trajectory towards leveraging solar energy and advanced technologies to foster sustainable farming practices and mitigate environmental impacts in agriculture.

Conceptual Framework

The conceptual framework for this study revolves around the ADDIE instructional design model, which serves as a structured approach to align emergent themes. The ADDIE model encompasses five sequential phases: Analysis, Design, Development, Implementation, and Evaluation. These phases collectively form a versatile and dynamic framework essential for developing effective training and performance support applications. Professional instructional designers commonly adopt this model to craft technology-based lessons. Importantly, the model emphasizes a continuous cycle, where evaluation informs re-analysis and subsequent adjustments in design and development, ensuring ongoing improvement and adaptation to meet educational objectives effectively.

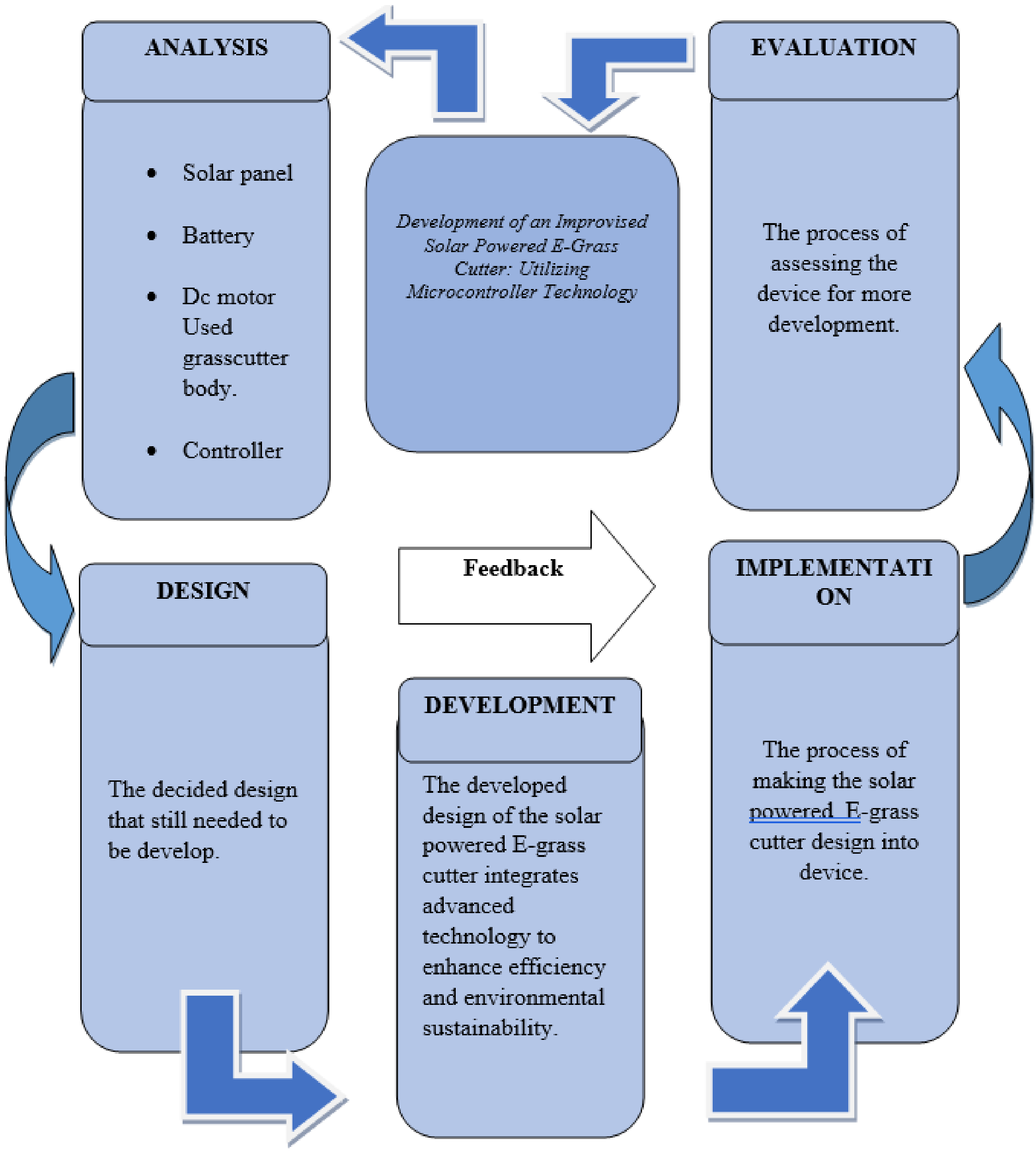

Figure 1 Research Paradigm

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Statement of the Problem

This study aims to developed solar powered E-grass cutter utilizing microcontroller technology.

Specifically, it sought to answer the following questions:

1. How may the Solar powered E-grass cutter may be developed in terms of:

1.1. analysis;

1.2. design;

1.2.1.materials and cost

1.3. development;

1.4. implementation and

1.5. evaluation?

2. How may Solar charging E-grass cutter was assessed by the farmers in terms of;

2.1. usability

2.2 Effectiveness and

2.3 Safety?

3. How may Solar charging E-grass cutter will be assessed by the electrical teachers of NEUST in terms of;

3.1 Functionality;

3.2 Durability and

3.3. Portability?

Scope and Limitation

This study focused on the development of An Improvised solar powered E grass cutter utilizing microcontroller and assessment of Solar powered E-grass cutter for agricultural workers of Barangay Mataas na kahoy General Mamerto Nueva Ecija.

Significance of the Study

This study focuses on constructing the "Solar Powered E-grass cutter for the farmers in Nueva Ecija. Furthermore, the result of the study could be highly significant and beneficial for the following:

Students. This study may serve as a guide and reference for the students undertaking a similar study.

Farmers. This study will provide new product for cutting grasses without buying a gasoline to power it.

Future Researcher. This study will be useful reference for the researcher who would plan to make any related study precisely about this research

BIT Electrical. This study can be an information resource for the future BIT electrical student; this study can also be a resource for the future research of BIT electrical students.

Definition of Terms

The following terms were conceptually and operationally defined for a better and clearer understanding of the study:

Ampere Hours (Ah), often abbreviated as Ah or amp hours, represent the measure of electric charge stored in a battery.

Direct current. refers to the continuous, unidirectional flow or movement of electric charge carriers, typically electrons, through a conductor.

Ergonomic hazard. refer to physical factors present in the work environment that have the potential to cause musculoskeletal injuries or disorders (MSDs) in workers.

Grass cutter. refers to a machine or device specifically designed for cutting grass.

Microcontroller. is a compact integrated circuit (IC) designed to function as the brain of embedded systems and electronic devices.

Renewable Energy. refers to energy derived from natural processes that are replenished continually.

Watt. (W) is indeed a unit of measurement for power. It quantifies the rate at which energy is transferred or converted.

Solar Powered. refers to the use of solar energy as a primary or supplementary power source.

Solar technologies convert sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation. This energy can be used to generate electricity or be stored in batteries or thermal storage.

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II. Methods and Procedures

This chapter outlines the adopted study methodology, detailing the materials and techniques utilized in the construction and evaluation of the "Solar Powered E-grasscutter." It discusses the tools employed to collect relevant data aimed at characterizing the product's performance, safety, durability, and design attributes. This comprehensive approach ensures a thorough analysis of how well the solar-powered E-grasscutter meets its intended objectives and operational requirements.

Research Design

Research design, for this investigation, the researchers opted for a developmental research design. This approach allows for the utilization of study results to design, evaluate, and create a tool that offers benefits to both users and the environment. By employing this design, the study aims to iteratively develop and refine the solar-powered E-grasscutter, ensuring it meets functional requirements while aligning with sustainability goals. The developmental research design facilitates continuous improvement based on empirical findings, ensuring the tool's effectiveness, usability, and environmental impact are optimized throughout its development process.

Locale of the Study

The Development of an Improvised Solar Powered E-Grass Cutter Utilizing Microcontroller Technology conducted and evaluated at the Barangay Mataas na Kahoy General Mamerto Natividad Nueva Ecija

Figure 2 Locale Map of General Memento Natividad

Legend: Municipality of General Mamerto Natividad

Brgy. Mataas Na Kahoy

Respondents of the Study

This study was conducted in Brgy. Mataas na Kahoy, General Mamerto Natividad, Nueva Ecija, involving a total of 27 respondents. Among them, 20 were local farmers from Brgy. Mataas na Kahoy, General Mamerto Natividad, 5 were electrician experts, and 2 respondents were from local industries in the municipality of Gen. M. Natividad, Nueva Ecija. The diverse composition of respondents from different backgrounds and expertise areas provides a comprehensive perspective on the solar-powered E-grasscutter's feasibility, applicability, and potential impact in agricultural and industrial settings.

Table 1 Number of Industry Experts or framers as participants of the study

Respondents	N	n	% Percentage
Farmers	20		74.1%

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Electrician Expert	5		18.5%
Local Industry	2		7.4%
	Total:	27	100%

Research Instruments

The researchers developed three sets of survey questionnaires to evaluate the solar-powered E-grass cutter in terms of usability, functionality, effectiveness, durability, portability, and safety. Respondents were invited to provide their feedback and recommendations for further enhancement of the device, which incorporates microcontroller technology. The instrument used for assessing the Solar powered E Grass Cutter measured the following indicators: usability, assessing how user-friendly the device is; functionality, evaluating how well the device performs its intended tasks; effectiveness, measuring the device's ability to achieve desired outcomes; durability, examining the device's longevity and resistance to wear and tear; portability, assessing how easy it is to transport and manoeuvre; and safety, evaluating the device's provision of safety features and protection mechanisms. This comprehensive evaluation approach ensures a thorough understanding of the device's performance and user satisfaction, guiding future improvements and developments.

Table 2. Response mode for usability

Scale	Verbal interpretation	Qualitative Description
4	Very Usable	The Solar powered E-grass cutter is easy to use, durable and free source of power.
3	Usable	Device moderately used by the specified users with minimal guide or supervision.
2	Need Improvement	Slightly difficult to operate and control, such that the users cannot easily perform their corresponding needs.
1	poor	It is difficult to operate and control, such that it is difficult for the users to perform their corresponding needs and requires for restructuring.

Usability serves as a critical indicator of the effectiveness and efficiency of a product or system, directly reflecting its ability to be easily understood, learned, and used by its intended audience.

Table 3. Response mode for Functionality

Scale	Verbal interpretation	Qualitative Description
4	Very Functional	The Solar powered E-grass cutter is easy to use and exceeded the expected functionality.
3	Functioning	The solar powered E-grass cutter function in a expected functionality.
2	Need Improvement	The solar powered E-grass cutter did not function the expected functionality but still usable.
1	poor	The solar powered E-grass cutter did not function properly.

A functionality used to assess the performance, reliability, and effectiveness of the features and capabilities of a product or system. It provides insights into how well the functionalities meet the requirements and expectations of users or stakeholders. This indicator can include metrics such as uptime, response time, accuracy, completeness, and compatibility. Evaluating functionality indicators helps ensure that the product or system delivers the intended functionalities reliably and efficiently.

Table 4. Response mode for effectiveness

Scale	Verbal interpretation	Qualitative Description
4	Very Effective	The produced device exceeded the expected outcome.
3	effective	The device was successfully produced and functioning the expected functionality.
2	Need Improvement	Slightly difficult to operate and control, such that the users cannot easily perform their corresponding needs.
1	poor	It is difficult to operate and control, such that it is difficult for the users to perform their corresponding needs and requires for restructuring.

It measures the ability of something to produce the desired results efficiently and successfully. In the context of usability or user experience, effectiveness assesses how well users can accomplish their tasks or fulfill their needs when interacting with a product or system.

Table 5. Response mode for durability

Scale	Verbal interpretation	Qualitative Description
4	Very Durable	The solar powered E-grass cutter was very tough.

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3	Durable	Did not see any unwanted moving parts in the solar powered E-grass cutter.
2	Need Improvement	Some parts of solar powered E-grass cutter are moving but still functioning properly.
1	poor	Too much unwanted moving part in solar powered E-grass cutter.

It indicates the longevity and resilience of the product, reflecting its ability to maintain its functionality, performance, and appearance over an extended period. In the context of usability, durability is essential for ensuring that a product remains effective and reliable throughout its lifecycle, providing users with consistent and dependable performance.

Table 6. Response mode for portability

Scale	Verbal interpretation	Qualitative Description
4	Very Good	The Solar powered E-grass cutter is comfortable to use and has a good-looking design.
3	Good	The Solar powered E-grasscutter is comfortable to use.
2	Need Improvement	It is usable but needed to be improve.
1	Poor	The device is unusable.

Portability is essential for ensuring accessibility and flexibility, allowing users to access and use the product or application across different environments and devices seamlessly.

Table 7. Response mode for safety

scale	Verbal interpretation	Qualitative Description
4	Very Safe	Precautionary measures identified to ensure safe and well-rounded performance of the machine without posting any harm in the users.
3	Safe	“Solar powered E-grass cutter” does not meet the required invisible wiring connection.
2	Need Improvement	Does not meet the specified conditions of the machine by covering the blade with metal plate.
1	poor	Lack of instruction in proper way of cutting the crops.

Safety refers to the state of being protected from harm, danger, or risk of injury. In the context of usability, safety is an essential aspect that ensures users can interact with a product or system without experiencing adverse consequences or hazards.

Data Gathering Procedure

The data gathering procedure is a systematic approach employed to collect pertinent information or data pertinent to a specific research inquiry, project, or investigation. The actual data collection phase ensues, involving the implementation of chosen methods and instruments. Throughout this process, measures are enacted to maintain data quality, minimizing bias and errors. Recorded data is then organized systematically to facilitate subsequent analysis.

Data Analysis Technique

A weighted mean will be applied to the data regarding the respondents' evaluations of a number of parameters, such as the device's design, usability, functionality, efficiency, and safety.

1. Inference from the respondent's questionnaire and observation were used to characterize the validation of the industry experts, the respondents on the produced product material in terms of analysis, design, development, implementation, and evaluation.
2. Based on their usability, the expert staff used average analysis and interpretation to validate the Solar powered E-grass cutter. The weighted mean was employed in the data analysis process.

Table 8. Scoring guide for Usability

Scale	Verbal Interpretation	Qualitative Description
4.00 – 3.26	Very useful	The Solar powered E-grass cutter is easy to use, durable and free source of power.
3.25 – 2.51	useful	Device moderately used by the specified users with minimal guide or supervision.
2.50 – 1.76	Somewhat useful	Slightly difficult to operate and control, such that the users cannot easily perform their corresponding needs.
1.75 – 1.00	Not useful	It is difficult to operate and control, such that it is difficult for the users to perform their corresponding needs and requires for restructuring.

The weighted mean was employed in the data analysis for the "Solar powered E-grass cutter" during its validation by the competent staff, who evaluated and assessed the functionality based on average.

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Table 9. Scoring guide for Functionality

Scale	Verbal Interpretation	Qualitative Description
4.00 – 3.26	Very functional	The "Solar powered E-grass cutter" is easy to use and exceeded the expected functionality.
3.25 – 2.51	Functional	The solar powered E-grass cutter function in a expected functionality.
2.50 – 1.76	Somewhat functional	The solar powered E-grass cutter did not function the expected functionality but still usable.
1.75 – 1.00	Not functional	The solar powered E-grass cutter did not function properly.

In the validation of the "Solar powered E-grass cutter" by the competent staff, depending on the effectiveness these were evaluated and interpreted using average, and the weighted mean was utilized in its data analysis.

Table 10. Scoring guide for Effectiveness

Scale	Verbal Interpretation	Qualitative Description
4.00 – 3.26	Very Effective	The produced device exceeded the expected outcome.
3.25 – 2.51	Effective	The device was successfully produced and functioning the expected functionality.
2.50 – 1.76	Somewhat Effective	Slightly difficult to operate and control, such that the users cannot easily perform their corresponding needs.
1.75 – 1.00	Not Effective	It is difficult to operate and control, such that it is difficult for the users to perform their corresponding needs and requires for restructuring.

In the validation of the "Solar powered E-grass cutter" by the competent individuals, depending on the durability these were evaluated and interpreted using average, and the weighted mean was utilized in its data analysis.

Table11. Scoring guide for Durability

Scale	Verbal Interpretation	Qualitative Description
4.00 – 3.26	Very Durable	The solar powered E-grass cutter was very tough.
3.25 – 2.51	Durable	Did not see any unwanted moving parts in the solar powered E-grass cutter.
2.50 – 1.76	Somewhat Durable	Some parts of solar powered E-grass cutter are moving but still functioning properly.
1.75 – 1.00	Not Durable	Too much unwanted moving part in solar powered E-grass cutter.

In the validation of the "Solar powered E-grass cutter" by the competent staff, based on the portability these were evaluated and interpreted using average, and the weighted mean was utilised in its data analysis.

Table 12. Scoring guide for Portability

Scale	Verbal Interpretation	Qualitative Description
4.00 – 3.26	Very Portable	The Solar powered E-grass cutter using microcontroller technology is comfortable to use and has a good-looking design.
3.25 – 2.51	Portable	The Solar powered E-grasscutter is comfortable to use.
2.50 – 1.76	Somewhat Portable	It is usable but needed to be improve.
1.75 – 1.00	Not Portable	The device is unusable.

In the validation of the "Solar powered E-grass cutter" by the knowledgeable personnel, based on the safety these were analysed and interpreted using average, and the weighted mean was used in its data analysis.

Table 13. Scoring guide for Safety

Scale	Verbal Interpretation	Qualitative Description
4.00 – 3.26	Very safe	Precautionary measures identified to ensure safe and well-rounded performance of the machine without posting any harm in the users.
3.25 – 2.51	Safe	Solar powered E-grass cutter does not meet the required invisible wiring

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		connection.
2.50 – 1.76	Somewhat safe	Does not meet the specified conditions of the machine by covering the blade with metal plate.
1.75 – 1.00	Not safe	The device is not safe to use.

Ethical Consideration

In regard to the involvement to this study, the participants will not be in any way be harm. Prior the study, voluntary participant with consent will be obtained through letter. In addition, the protection of the respondent's anonymity and confidentiality will be ensured and the result of the study will free of research misconduct and plagiarism.

III. Results and Discusion

A research paper's Results and Discussion provides a framework for outlining and analyzing the study's conclusions. The section begins with the major findings from the data analysis stage being presented. The data is summarized and arranged using tables, charts, or graphs to give a clear picture of the study's findings. The results are presented, and then the interpretation and implications of the findings are discussed. This entails a careful analysis of the findings' relevance in relation to the field's larger context as well as how well they match the study questions or aims.

The study design and methodology limitations are also addressed, and recommendations for future research approaches are made to address any unanswered questions or areas that need more research. The section ends with a summary of the major conclusions and their consequences, highlighting the importance of these results in furthering knowledge and guiding future research endeavors.

Development and Assessment of Solar powered E-grass cutter utilizing Micro controller Technology

Analysis

Upon realizing that the majority of the people in their neighbourhood are farmers, the researcher ponders and analyses how to improve or create a technology that can assist farmers in this period. Growing grass in fields is one of the issues farmers faces. To combat this, they require a grass cutter, a machine that quickly cuts grass; nevertheless, purchasing diesel gasoline is somewhat pricey. For this reason, the researchers try to figure out ways to at least reduce the costs that our farmers incur for simply removing the extra grass from their fields. This is where the concept for a solar-powered E grass cutter originated.

Design

The design phase for the Solar powered E-Grasscutter begins with the researchers' comprehensive conceptualization and sketching of the device. This critical stage involves merging their understanding of traditional E-grass cutters with the intricate requirements of integrating a solar power system. Central to their efforts is ensuring the safety and efficiency of the apparatus, which necessitates careful selection of materials that meet rigorous safety standards. The integration of solar technology not only enhances the environmental sustainability of the E-Grasscutter but also emphasizes innovation in the field of agricultural machinery.

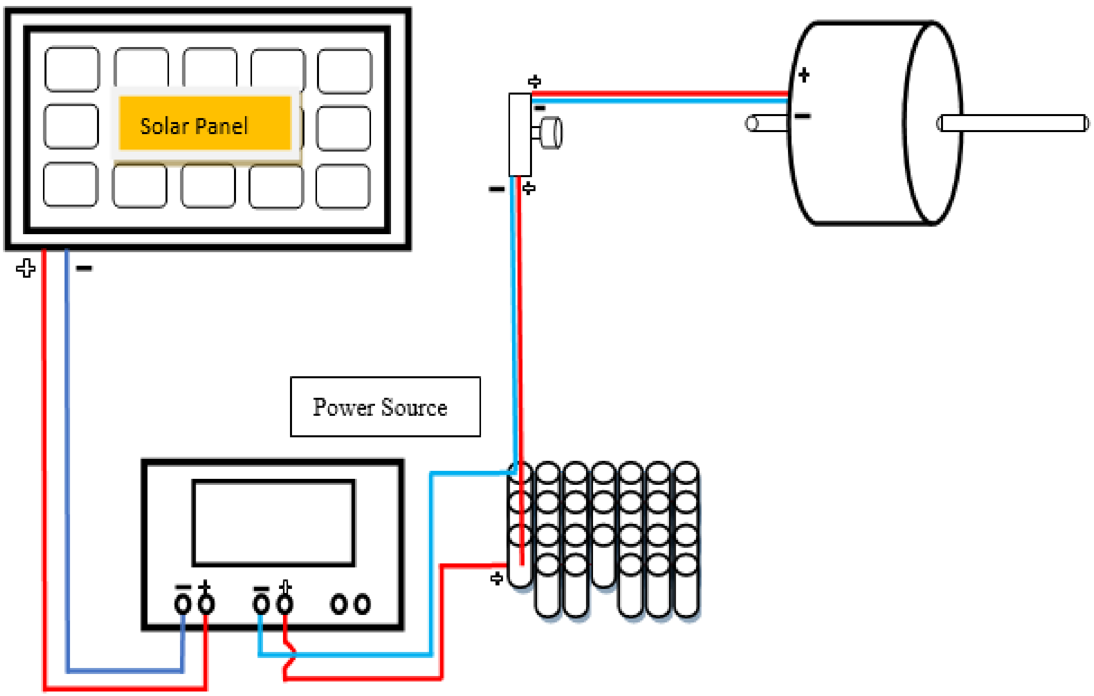

Figure 3 Wiring diagram of Solar powered E-grasscutter

In this figure show the wiring connection, device and material used to develop the Solar powered E-grasscutter; the solar panel, charger controller, batter, a dc fan motor, rotary switch and non-latching push button.

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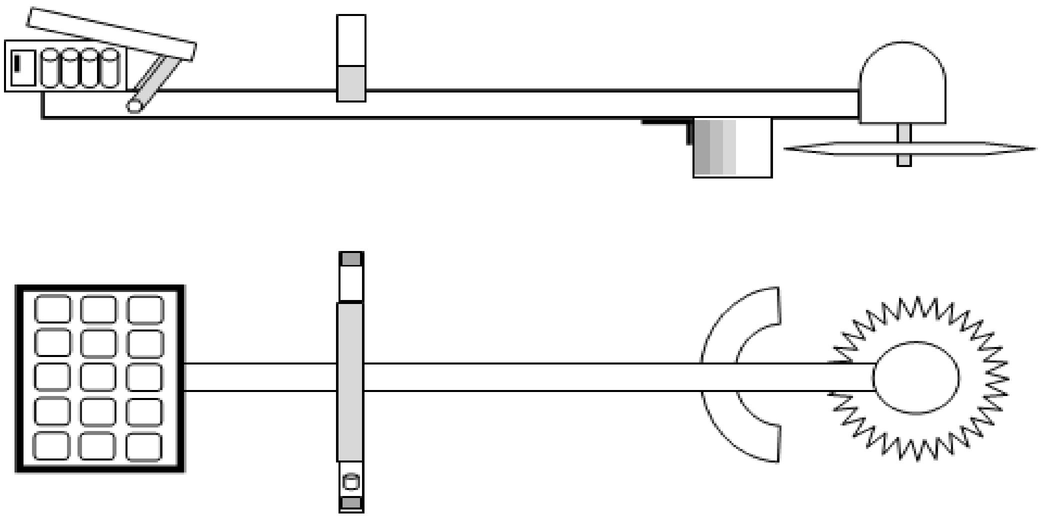

Figure 4 the skeletal design of Solar powered E-grasscutter

The researcher focused on developing the prototype design, which is detailed in Figure 4. This figure presents both the side view and top view of the device, illustrating its parts and accessories from the initial rough design stages through to the final, polished iteration that emphasizes realism and presentation.

In the side view depicted in Figure 4, key structural elements and functional components of the device are showcased. This includes the main body frame, housing for the cutting mechanism and motor, placement of the solar panel array for optimal energy capture, and the ergonomic handlebar with integrated controls such as the rotary switch and non-latching push button. Safety features such as blade guards and emergency shut-off mechanisms are also highlighted, ensuring operator safety during operation.

The top view provides a comprehensive look at the spatial arrangement and interaction of components within the device. It illustrates the strategic placement of the solar panels to maximize sunlight exposure, the routing of wiring connections between the solar panels, charge controller, batteries, and DC fan motor. The block diagram conceptualization further outlines how each component interfaces with others to achieve efficient solar-powered operation of the E-grasscutter.

Throughout the design process, from initial concept to finalization, meticulous attention was given to refining the device to be both functional and visually appealing. This approach not only enhances the device's usability in real-world agricultural applications but also ensures it meets aesthetic standards for presentation and public demonstration. The integration of a block diagram aids in understanding the operational flow and interconnectivity of components, facilitating future development and improvements based on practical testing and feedback.

Development

In this part, the researchers do some adjustment to the created plan and design to be more accurate or realistic for the prototype to properly work

Implementation

Throughout the implementation phase, monitoring and quality assurance mechanisms are implemented to track progress and ensure adherence to the implementation plan. Regular check-ins, progress reports, and site visits help maintain oversight and ensure that activities meet quality standards. Flexibility is essential during implementation, with the ability to adapt strategies or timelines in response to emerging challenges or changing circumstances. Open communication and collaboration among team members, stakeholders, and partners foster alignment and synergy towards project goals.

Evaluation

In this phase the researcher gave a 4-scale checklist questionnaire to the farmers and experts respondents to evaluate the Solar powered E-grasscutter. The respondents have given an open time to answer the survey questionnaire.

Table.14 Assessment result for the Usability of E grass cutter using microcontroller technology

Descriptors	Weighted Mean	Verbal Interpretation
The solar powered E-grass cutter cut grass easily.	3.61	Very Usable
The solar powered E-grass cutter using microcontroller technology cut short grass easily.	3.73	Very Usable
Average weighted mean	**3.67**	Very Usable

The assessment result from farmers on the usability of solar powered E-grass cutter obtained an average weighted mean of 3.67.

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Table.15 Assessment result for the Safety of E grass cutter using microcontroller technology

Descriptors	Weighted Mean	Verbal Interpretation
All wiring connection and components of the E grass cutter is properly safe and covered	4.0	Very Safe
Average weighted mean	**4.0**	Very Safe

The assessment result from the farmers on the safety provision of solar powered E-grass cutter obtained an average weighted mean of 4.0. The average weighted mean since the device obtained 4.0 ***Very Safe*** is the verbal interpretation meaning it exceed all expectations standards. Its means further that the device how well-rounded performance without causing any harm to the users.

The Signifies that the respondents approved the safety of the solar powered E grass Cutter.

Table16. Assessment result for the Functionality of E grass cutter using microcontroller

Descriptors	Weighted Mean	Verbal Interpretation
The Solar powered E grass Cutter efficiently meet and functional all the stated needs and no weaknesses are found	3.80	Very Functional
Average weighted mean	**3.80**	Very Functional

The assessment result on the functionality of solar powered E-grass cutter obtained an average weighted mean of 3.80. The verbal interpretation is very functional meaning that the device exceeded all expectations and standard of the device

Table17. Assessment result for the Effectiveness of E grass cutter using microcontroller

Descriptors	Weighted Mean	Verbal Interpretation
It consistently performs well rapidly cut the grass and operates easily	3.80	Very Effective
Average weighted mean	**3.80**	Very Effective

The assessment on the effectiveness of solar powered E-grass cutter obtained an average weighted mean of 3.80, the verbal interpretation is very effective meaning that the solar powered E grass cutter exceed all the expectations and standards of the device. Based on the result of the assessment thus implies that the efficiency of the device gave the best result in terms of security.

Table18. Assessment result for the Durability of E grass cutter using microcontroller

Descriptors	Weighted Mean	Verbal Interpretation
It demonstrates exceptional resistance to various environmental factors and continues function reliability over an extended period of time	3..75	Very Durable
Average weighted mean	**3.75**	Very Durable

The assessment on the durability of the Solar powered E Grass cutter got the verbal interpretation of 3.75 very durable meaning that the device exceeded all expectations and standards of the device.

Table19. Assessment result for the Portability of E grass cutter using microcontroller

Descriptors	Weighted Mean	Verbal Interpretation
It is compact lightweight designed for effortless transportation moving or relocating is a simple task	3.80	Very Portable
Average weighted mean	**3.80**	Very Portable

Portability refers to the ability of the device to be easily carried or move from one location to another. The portability assessment of the constructed device was assessed by the farmers and experts' respondents

The results had an average weighted mean 3.80 on the portability of the device the verbal interpretation is very portable exceeding all expectations and standards of the device This signifies that the respondents agreed on the portability of the developed device

The summary of the ratings given by the respondents in all aspects was shown on table 20.

Table.20 Summary of Assessment Results on the Usability, Safety and Functionality of Solar charging E-grass cutter.

Descriptors	Weighted Mean	Verbal Interpretation
Usability	3.67	Very Good

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Safety	4.00	Very Good
Functionality	3.80	Very Good
Grand Weighted Mean	**3.82**	Very Good

The table above shows the summary of assessment on the usability, safety and functionality of the Solar powered E-grass cutter by the farmers and it obtained 3.82 grand weighted mean. "Very good" is the verbal interpretation of the device meaning it exceeded all expectations and standard.

Table.21. Summary of Assessment Results on the Effectiveness, Durability and Portability of Solar powered E-grass cutter.

Descriptors	Weighted Mean	Verbal Interpretation
Effectiveness	3.80	Good
Durability	3.75	Good
3. Portability	3.80	Good
Grand Weighted Mean	**3.78**	Good

The table above shows the summary of assessment on the Effectiveness, durability and portability of the Solar powered E-grass cutter by the farmers and it obtained 3.78 grand weighted mean. "Good" is the verbal interpretation of the device meaning it reach the expectations and standard.

IV. Summary, Conclusions and Recommendations

This chapter provides a comprehensive summary of the findings obtained from the development and assessment of the Solar powered E-grass cutter, followed by the conclusions drawn from these findings and recommendations for future research and implementation.

Summary of Findings

Development Phase. The researchers successfully designed and developed the Solar powered E-grass cutter, integrating solar power technology with microcontroller systems to create a sustainable and efficient grass cutting solution for farmers.

Implementation Phase. Through rigorous monitoring and quality assurance mechanisms, the Solar powered E-grass cutter was effectively implemented, with regular check-ins and collaboration ensuring adherence to the implementation plan and maintenance of quality standards.

Evaluation Phase. Farmers and experts provided valuable feedback through a checklist questionnaire, highlighting the performance, usability, reliability, and safety of the Solar powered E-grass cutter.

Conclusions:

Based on the findings of the study, the following conclusions can be drawn:

1. The Solar powered E-grass cutter demonstrates promising potential as a cost-effective and sustainable alternative to traditional grass cutting methods, offering significant benefits for farmers in terms of operational efficiency and economic savings.
2. Integration of solar power technology and microcontroller systems enhances the functionality and usability of the grass cutter, providing precise control and automation of cutting processes while ensuring safety and reliability.
3. Feedback from the evaluation phase underscores the importance of user perspectives in refining and optimizing the design and functionality of the Solar powered E-grass cutter, emphasizing the need for ongoing collaboration and engagement with stakeholders.

Recommendations:

Based on the conclusions drawn from the study, the following recommendations are proposed for future research and implementation:

1. Further research should focus on optimizing the design and performance of the Solar powered E-grass cutter to address any identified limitations and enhance its usability and efficiency.
2. Collaboration with farmers and stakeholders should be continued to gather feedback and insights for continuous improvement and adaptation of the E grass cutter to meet evolving needs and preferences.
3. Long-term monitoring and evaluation of the Solar Charging E-grass cutter in real-world settings are recommended to assess its impact on agricultural practices and identify opportunities for scalability and expansion.
4. By incorporating these recommendations into future endeavours, researchers can continue to advance the development and adoption of sustainable technologies in agriculture, ultimately contributing to increased efficiency, productivity, and sustainability in farming communities.

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