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Solar Powered Smart Emergency Light with Fire Detection and Alarm System

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Abstract: This study aimed to evaluate the effectiveness of the proposed project, which is a solar-powered smart emergency light with a fire detection and alarm system. It focuses on the primary usage, functionality, applicability, workability, and safety aspects of the project, as well as how it effectively assists people through innovative means. The project is tested out of 15 respondents that has knowledge regarding electricity, enough to understand the flow of the project its material used, functions, usage and how it works.The prototype demonstrates exceptional functionality, achieving an excellent rating. This indicates a high level of effectiveness in providing illumination and alarm signal during power outages and fire situations. The device exhibits versatility with high ratings across residential and commercial settings. Its adaptability to diverse environments underscores its broad applicability.The availability of tools, expertise, and readily accessible materials contributes significantly to the overall workability of the prototype, affirming its practicality in real-world scenarios.The prototype's utilization of solar power not only makes it environmentally friendly but also offers a cost-effective alternative, potentially reducing long-term energy expenses.The absence of harmful materials and the inclusion of overload protection prioritize user safety, further bolstering the device's reliability.Overall, the findings affirm the prototype's potential to significantly enhance emergency lighting and safety measures. The integration of solar power, intelligent features, fire detection, and alarm systems places this innovation at the forefront of safety technology.

Keywords: Solar Power, Emergency Light, Fire Detection, Alarm System

I. INTRODUCTION

In recent years, fire incidents in the Philippines have become a growing concern, particularly in residential areas. According to the latest data from the Bureau of Fire Protection (2023), January 1 to April 17, 2023, there were 3,991 fire incidents that they recorded in the country. A significant number of fire incidents, totaling 2,008, were reported in residential areas. This highlights the vulnerability of homes and the urgent need for fire safety awareness and prevention measures among households. Additionally, 213 fires were recorded in mercantile areas, emphasizing the importance of fire safety protocols in commercial establishments.Emergency lighting systems have gained significant importance as essential safety components in various environments. These systems are now mandatory in many settings, including halls, ladders, garages, elevators, restaurants, and other public spaces. Their primary purpose is to provide illumination during power outages, ensuring the safety and well-being of individuals in the absence of electricity (Narasimha &Salkuti, 2020). According to Mukherjee et al. (2019), in the event of a fire, every second counts when it comes to saving lives. The rapid spread of smoke and the sudden loss of power pose significant challenges for individuals in residential and official buildings. To address this critical issue, the integration of a combined emergency light with smoke detector system, designed to show the exit route, has emerged as a potential life-saving solution. In this paper, we aim to develop a smart emergency light with fire detection and alarm system which can be use in various applications such as residential and commercial establishments.Considering all these factors, we have come up with an idea to design and develop a solar-powered smart emergency light with a fire detection and alarm system. This innovative solution aims to enable residential and commercial establishments to continue their operations during power outages, while also providing fire detection and alarm capabilities to ensure the safety of occupants in the event of a fire. This smart emergency light automatically turns on during power cuts and features a programmable timer

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for customized scheduling. Additionally, it can be conveniently controlled wirelessly, allowing for easy usability at any time.

II. REVIEW OF LITERATURE

According to Lei Zhang and Gaofeng Wang (2009), fire disasters present a substantial threat to lives and property. The integration of an automatic fire alarm system provides real-time surveillance, monitoring, and automatic alarms. This system promptly sends early alerts when a fire occurs, significantly reducing the potential fire damage.

According to Suneel Mudunuru et al. (2011), a smoke detector or smoke alarm is a device designed to detect smoke and emit an alarm to alert nearby individuals of a potential fire. These devices are capable of detecting fires in their early stages, providing valuable time for you and your family to safely evacuate your home.

A smart solar emergency lamp is a unique lighting solution that efficiently utilizes both AC and solar energy. It includes a photovoltaic solar panel, an AC power source, an LED lamp, a PIR motion detector, and a rechargeable battery. These solar lamps are commonly used for illumination in situations where centrally generated power is not readily accessible or cost-effective (Ranjan et al., 2016).

In recent decades, the design of buildings has placed significant importance on developing practical protection methods and concepts to mitigate the harmful effects of fires, which can pose a severe threat to any building throughout its lifespan. The demand for new and innovative fire protection systems has increased due to rapid technological advancements, surpassing the capabilities of conventional and traditional methods (Zahmatkesh&Memari, 2017).

Automation and security are the most important factor in our day-to-day life. This system approaches to home and industrial automation and security system design which is almost standardized now today. Everyone wants to be as much as secured as possible (Mukherjee et al., 2019).

As noted by Narasimha and Salkuti (2020), the escalating demand for electricity and frequent power cuts are posing significant challenges in various sectors, including households, domestic settings, and farms. These challenges arise from the limited power generation capacity at traditional power stations and the scarcity of non-renewable energy sources, ensuring uninterrupted power supply has emerged as a major global challenge.

Today, the saving of electricity is become popular. It is based on the principle of providing light during power outages. It involves the use of automatic charger that charges when there is a power supply. When the battery is fully charged it stops charging. In case of power failure, the LEDs glow automatically with the supply provided by the charged battery (Than et al., 2020).According to Jo et al. (2021), environmental pollution is a risk associated with various forms of energy, including fossil fuels, nuclear power plants, and thermoelectric power plants. To reduce reliance on these sources, research on eco-friendly energy is actively underway. Solar energy has emerged as a promising option due to its ability to provide clean and renewable energy. However, its output may be unstable due to factors such as weather conditions and surrounding structures.Solar energy has gained popularity in various applications, with research emphasizing the use of photovoltaic (PV) cells to convert solar radiation into electrical energy, especially with the use of solar trackers (Baballe, 2021). According to Shahabuddin et al. (2021), solar energy is a promising renewable source, with photovoltaic and concentrated solar power technologies being key methods for conversion.

III. CONCEPTUAL FRAMEWORK

In the purpose to design and develop a solar powered smart emergency light with fire detection and alarm system (FDAS). We carefully planned, designed, tested, and evaluated the inputs that we used to achieve the safety and functionality of the project.Figure 1. Represented the concept of this study. It shows the flow of the study. The first box represents the input in making the project. Such as related research that gives us idea in creating this project, knowledge and skills, supplies and equipment use in assembling, and basically the project needs methods to follow to accomplish. According to Ng KH and Peh WC (2008) a good materials and methods section will enable readers to evaluate the research performed and replicate the study, if necessary.The second box consist of the planning and designing of the circuits, then it proceeds in fabricating and assembling of the components and materials, after the assembling process, the device will go on testing and evaluation. Project evaluation is a systematic and objective assessment of an ongoing or completed project. The aim is to determine the relevance and level of achievement of project objectives, development effectiveness, efficiency, impact, and sustainability (Haque, 2019).The third box represents the output, or

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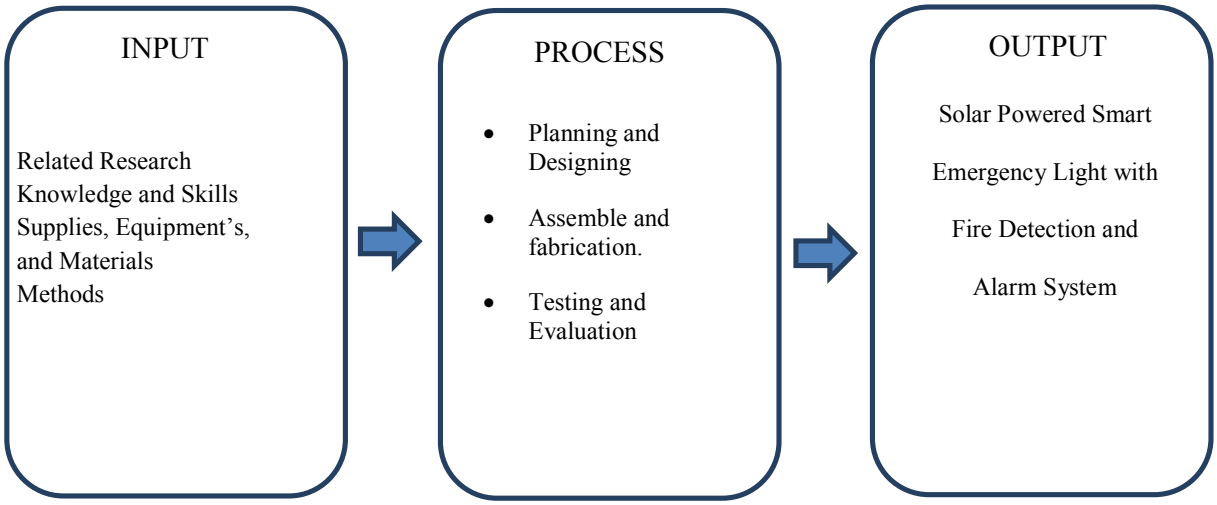
the finish product made by the team which is the Solar Powered Smart Emergency light with fire detection and alarm system.



Objectives of the Study

The main goal of this study is to design and develop a Solar Powered Smart Emergency light with fire detection and alarm system or FDAS that can be used in power outages. Additionally, we will attach a programmable timer to operate the light at a specific time and a wireless controller to operate the light at a distance.

Specifically, this study aimed to achieve the following objectives:

1) To design and develop a solar powered smart emergency light with fire detection and alarm system in residential and commercial establishments.

2) Integrate Fire Detection Sensors - Select and incorporate appropriate fire detection sensors capable of accurately detecting the presence of smoke or fire within the environment

3) Design an Alarm System - Create a reliable and effective alarm system that triggers in the event of a fire detection, ensuring prompt notification to occupants.

4) Determine the acceptability of the device in terms of:

- Functionality
- Applicability
- Workability
- Economy
- Safety

Significance of the Study

This study aims to design and develop a solar-powered emergency light with an integrated fire detection and alarm system. It specifically focuses on enhancing safety and security in residential and commercial establishments, with a particular emphasis on households, restaurants, and shops. By implementing this system, it will provide an added layer of protection for families, customers, and workers in situations such as power outages and fire emergencies.

The following are the beneficiaries of the study to be conducted by the researchers:

Residential Establishment. This study will enable homes, apartments, and condominiums access renewable source of energy, enhance emergency preparedness and improved safety measures.

Commercial Establishments. This study supports commercial establishments, including offices, shops, and schools etc. by enabling them to maintain illumination, emergency response capabilities, and safety during power outages.

Future Researchers. This study serves as valuable reference for future researchers, providing insights and inspiration for new studies in the integration of solar energy systems with emergency lighting and fire detection.

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Scope and limitations

This study will be conducted in selected areas in Surigao City. The main focus of this study is to integrate the emergency light and fire detection and alarm system that is powered by solar energy. This system can be used in emergency situations such as power outages and fire scenarios, where it will serve as both a light source and an alarm to alert people in case of a fire. This research aims to explore the applicability of this system in residential and commercial establishments, not only in Surigao City but also in other regions of the Philippines. It's an innovative approach that has the potential to enhance safety and sustainability in various settings.

IV. METHODS

Below is the block diagram of the research project (Design and Development of Solar Powered Smart Emergency Light with Fire Detection and Alarm System), included the labeled parts of the research project.

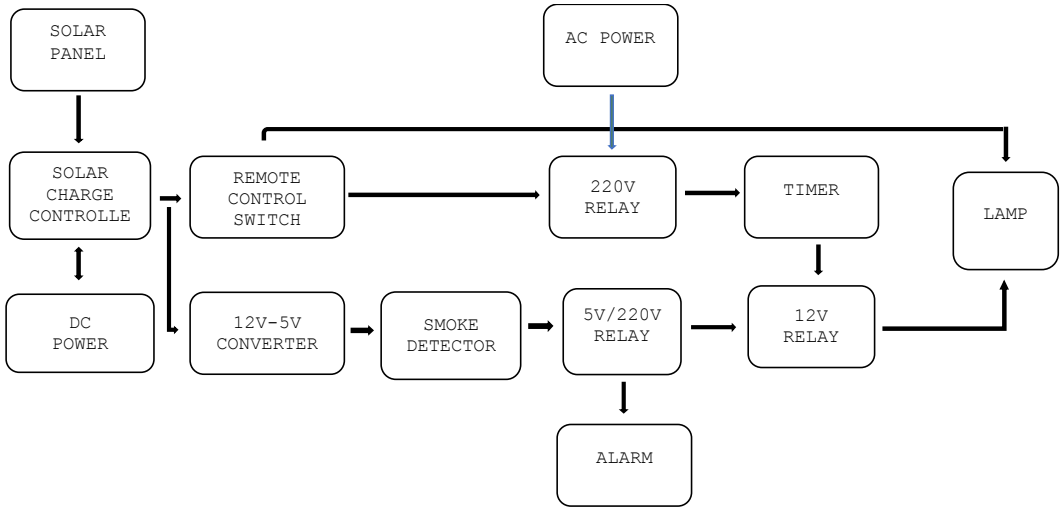

Figure 2: Block Diagram

Project Development

The steps for creating the project are listed below.
Gather all the materials required in making the project.
Check and test all the devices to be use is working and not defective.
Connect all the wirings starting from the battery to controller and controller to solar then controller down to the remote relay, 5Vport/converter down to the smoke detector, remote relay, relays, alarm, and lamp.
Review all the wiring components if it is properly connected.
After assembling all the components and checking the proper wiring connections, now the device is ready to use.

Operation Procedure

The following steps were followed in determining device performance:
1. Power On/Off Procedure:
a. To power on the system:
- Ensure the solar panels are exposed to sunlight for optimal charging.
- Press the power switch to the "ON" position.
b. To power off the system:
- Press the power switch to the "OFF" position.
2. Normal Operation:
a. Emergency Light Mode:
- In normal conditions, the system will operate in emergency light mode.

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- The lights will remain off until a power outage is detected.
b. Fire Detection System:
- The fire detection sensors continuously monitor the environment for smoke or fire.
3. Power Outage Detection:
a. When a power outage is detected:
- The emergency lights will automatically turn on to provide illumination.
4. Fire Detection and Alarm Activation:
a. When smoke or fire is detected:
- The fire detection sensors will trigger the alarm system (strobe light, siren).
b. The alarm will sound loudly to alert occupants of the potential fire hazard.
5. Resetting the System:
a. After a power outage or fire detection event:
- Once power is restored or the fire hazard is resolved, the device will automatically reset.
b. The emergency lights will turn off, and the system will resume normal operation.
6. Wireless Control:
a. The remote has the accessibility to turn ON/OFF the light anytime.
- The (A) button has the access to turn off the light. (B) button has access to turn on the emergency light mode. (C) button has the access to turn on the light anytime.
7. Maintenance and Safety Checks:
a. Regularly inspect the system for any signs of damage, wear, or malfunction.
b. Clean solar panels as needed to maintain optimal charging efficiency.
8. Troubleshooting:
a. In case of any issues or malfunctions, refer to the user manual or contact technical support for assistance.

Testing Procedure

The following test procedure must be performed to ensure proper operation of all parts of the device:
System Initialization:
Ensure all components are properly connected and securely mounted.
Confirm that the battery is charged to an adequate level for testing.
Power Outage Simulation:
Temporarily disconnect the AC power plug to simulate a power outage.
Confirm that the emergency lights activate within a reasonable time frame.
Monitor the system to ensure uninterrupted operation during the simulated outage.
Fire Detection Testing:
Introduce a controlled amount of smoke or trigger the fire detection sensors using a safe and controlled method.
Verify that the fire detection sensors accurately detect the smoke.
Confirm that the alarm system is activated promptly upon detection.
Environmental Testing:
Conduct testing in various environmental conditions (different temperatures, humidity levels) to evaluate system performance.
Ensure that the system remains functional and reliable under different environmental scenarios.
Battery Life Testing:
Conduct a prolonged test to assess the battery life under continuous operation.
Record the duration the emergency lights remain operational on battery power alone.
Alarm Sound Level Testing:
Measure the sound level of the alarm to ensure it meets safety and regulatory standards.
System Reset Testing:
Simulate a scenario where the system needs to be reset after a power outage or fire detection event.

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Confirm that the system resets and resumes normal operation.
Safety Checks:
Perform a visual inspection of all components to ensure there are no signs of damage or wear.
Confirm that all safety features, such as fire detection sensors, are operational.
Documentation of Results:
Record all test results, including any observations or issues encountered during testing.
Note any adjustments or optimizations made to the system based on the testing outcomes.

Evaluation Procedure

Evaluation is a method of determining the viability of a proposed project. In our research methodology, we utilize survey as a method for collecting data. To ensure the accuracy and reliability of the collected data, we enlist the expertise of statisticians who employ rigorous computational approaches. Their involvement helps mitigate biases and ensures that the results obtained are accurate, providing a solid foundation for our research findings. Selected individuals were asked to rate the project performance. These respondents were composed of selected electrical experts in Surigao Del Norte State University. Before the actual demonstration/evaluation of the device, the researcher explained the function of the device as well as its specification of the project. The researchers discussed the evaluation sheet's content before distributing it to the respondents. After the evaluation, the data was collected and computed to determine the overall mean as well as the means for each criterion. The functionality, applicability, workability, economy, and safety serve as the main criteria for evaluation. As a result, respondents can provide their comments, suggestions, and ideas to further develop and enhance the device.

V. RESULTS AND DISCUSSIONS

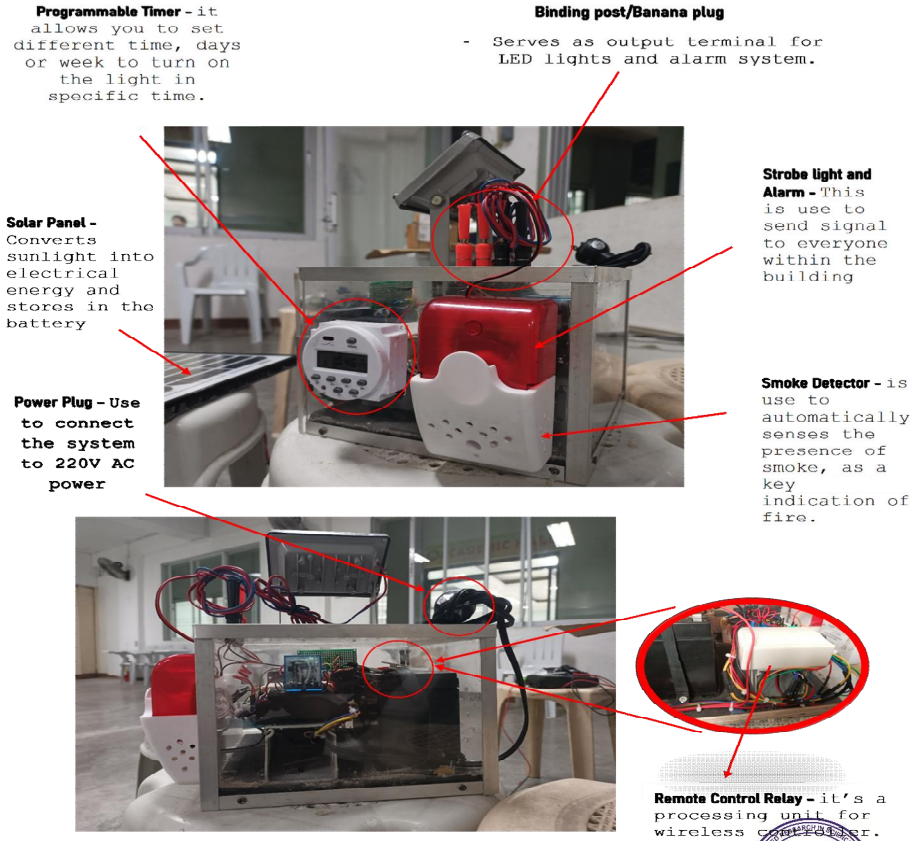

Figure 3: Components Description 1

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Project Description

Design and Development of Solar Powered Smart Emergency Light with Fire Detection and Alarm System (FDAS). The primary objective of this project is to design and develop a Solar Powered Smart Emergency Light with an integrated Fire Detection and Alarm System. This innovative system is designed to provide illumination during power outages while ensuring early detection of fires in residential and commercial settings. The proposed project is described under Figure 3.,3.1 and 4. It shows the components description and on how the proposed project being assembled and connected. It also shows the connection set up and the whole of connection diagram that described every point detail on the said project.

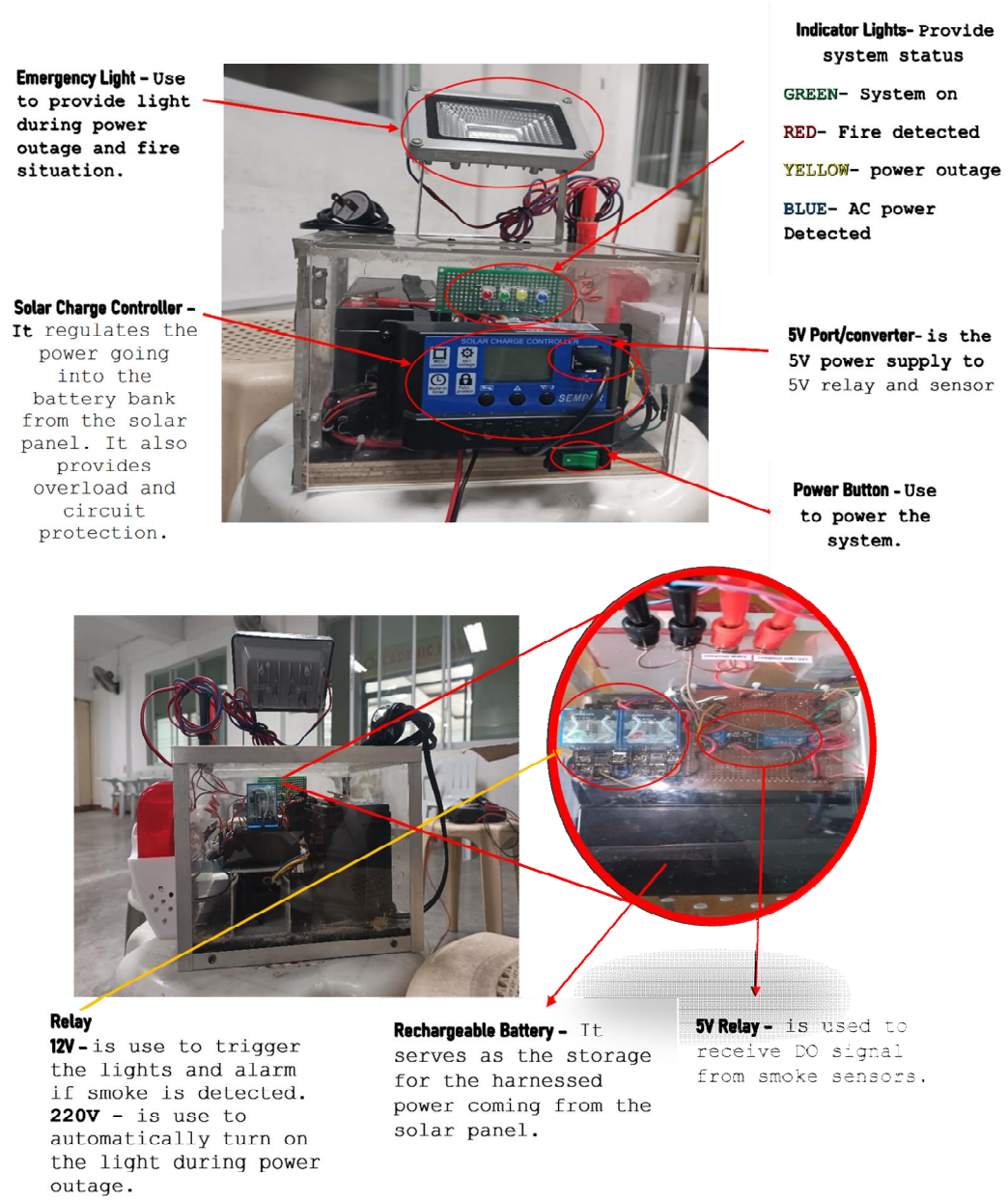

Figure 3.1 : Components Description 2

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Project Structure

This detailed structure outlines the step-by-step process from the initial planning to the completion and presentation of the project:The project structure of this design entails the process or steps in completing the project. It shows the detail process how project being done starting from the gathering of materials, tools to be use and including the desired outcome design. Below is the circuit design and the structural procedure of this project showing every step until the project completion.

Circuit Design

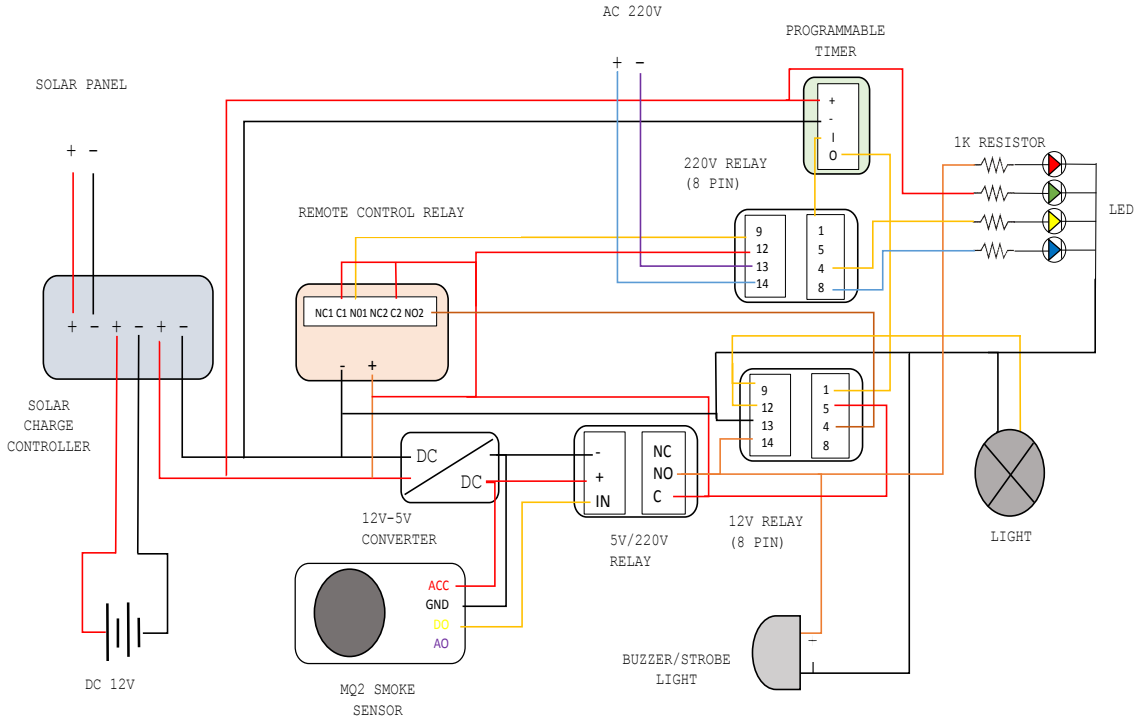

Figure 4: Circuit Design

Project Capabilities and Limitations

Capabilities:

Objectives: The primary goal of this project is to design and develop a solar-powered smart emergency light equipped with a fire detection and alarm system.

Limitations:

- **Scalability Constraints:**While additional sensors can be integrated, there may be limitations on the number of sensors the relay and battery can handle efficiently. In this project we only designed one sensor, one alarm, and light, if we add more sensor and lights, we need to upgrade its battery, solar panel, and add another channel of 5v relay.
- **Performance:** Response time for fire detection and alarm activation may vary based on environmental conditions and sensor accuracy.
- **Maintenance:**Regular cleaning and inspection of the solar panel are required for optimal performance.
- **Cost Considerations:**The cost of components, especially high-quality sensors and solar panels may influence the overall project cost.
- **User Support:**A user manual and troubleshooting guide will be provided, while technical support is limited.

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Advantages:

- **Energy Efficiency:**Utilizing solar power makes the emergency light environmentally friendly and reduces dependence on conventional power sources.
- **Cost-Effectiveness:**Over time, the use of solar power can lead to cost savings as it eliminates the need for continuous grid electricity.
- **Environmental Impact:**Reduces carbon footprint by using clean, renewable energy from the sun.
- **Automation and Reliability:**Solar power ensures continuous operation even during power outages or in areas with unreliable electrical grids.
- **Enhanced Safety:**The integration of fire detection and alarm system adds an important safety feature, providing early warning in case of a fire.
- **Versatility:** The system can be deployed in various settings in residential and commercial establishment including homes, offices, and commercial spaces, contributing to improved safety standards.
- **Smart Integration:**The incorporation of smart technology allows for remote monitoring and control, enhancing convenience and user experience.
- **Low Maintenance:**Solar panels generally require minimal maintenance, reducing operational costs over the lifespan of the system.

Disadvantages:

- **Limited Sunlight Dependency:**The system's effectiveness is dependent on the availability of sunlight. In regions with extended periods of low light or cloudy weather, performance may be compromised.
- **Complexity of Development:**The integration of solar power, fire detection, and smart technology requires a higher level of technical expertise, potentially leading to longer development times.
- **Sensor Accuracy:**The accuracy and reliability of the fire detection system may be influenced by environmental factors and the quality of the sensors used.
- **Regulatory Compliance:**Ensuring compliance with safety and regulatory standards may require additional testing and certification, potentially adding to development costs.
- **Maintenance of Smart Features:**The smart features of the system, including wireless control, may require periodic checking and maintenance.

V. EVALUATION RESULT

Table 1. Acceptability of the device in terms of Functionality

Functionality	Median	Rank	Description	Interpretation
1. The light is bright enough to provide illumination	4	3	Very Good	Highly Attainable
2. The smoke sensor performs effectively	5	1	Excellent	Very Highly Attainable
3. The alarm sound is loud enough to provide warning	5	1	Excellent	Very Highly Attainable

Legend:5-Excellent, 4-Very Good, 3-Good, 2-Fair, 1-Poor

Table 1 assesses the acceptability of the device in terms of functionality, focusing on specific aspects related to its performance. The brightness of the light is rated as "Very Good," indicating that it provides illumination at a level that is considered very acceptable. However, the ranking suggests that there may be some room for improvement, possibly in terms of making the light even brighter for more effective illumination.The effectiveness of the smoke sensor is rated as "Excellent," indicating that it performs exceptionally well. This is a highly positive assessment, suggesting that the device reliably detects smoke, a crucial function for safety devices.The loudness of the alarm sound is rated as "Excellent," indicating that it provides a warning at a level considered highly acceptable. This is a crucial aspect of safety devices, ensuring that users are promptly alerted in case of a potential threat.In summary, Table 1 suggests that the device is generally acceptable in terms of functionality, with specific areas performing exceptionally well. The

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effectiveness of the smoke sensor and the loudness of the alarm sound are rated as "Excellent," indicating a high level of performance in critical safety functions. While the brightness of the light is rated as "Very Good," there may be some room for improvement, as suggested by its lower rank. Overall, the device appears to be well-suited for its intended functionality with strong performance in key areas.

Table 2. Acceptability of the device in terms of Applicability

Applicability	Median	Rank	Description	Interpretation
1. Residential, Industrial and commercial applicability	4	3	Very Good	Highly Attainable
2. The device accommodates the specific needs of its users	5	1	Excellent	Very Highly Attainable
3. The device meets the safety standard	5	1	Excellent	Very Highly Attainable

Legend:5-Excellent, 4-Very Good, 3-Good, 2-Fair, 1-Poor

Table 2 assesses the acceptability of the device in terms of applicability, focusing on aspects related to its suitability for various settings, accommodation of user needs, and adherence to safety standards. The applicability of the device to residential, industrial, and commercial settings is rated as "Very Good." This suggests that the device is well-suited for a variety of environments, but there may be some room for improvement, possibly to make it even more versatile or tailored to specific settings.The device's accommodation of the specific needs of its users is rated as "Excellent." This indicates that the device is designed with user requirements in mind, ensuring that it meets the unique needs and preferences of its intended users. This is a positive indicator of user-centered design.The rating of "Excellent" for meeting safety standards indicates that the device adheres to or exceeds established safety standards. This is a crucial aspect, especially for safety devices, as it ensures that the device is reliable and safe for use in various settings.In summary, Table 2 suggests that the device is highly acceptable in terms of applicability. While there may be some areas for improvement in its applicability to different settings, the device excels in accommodating the specific needs of users and meets or exceeds safety standards. The "Excellent" ratings in the latter two categories indicate a strong alignment between the device's design and user requirements, as well as a commitment to safety, making it a versatile and reliable choice across various environments.

Table 3. Acceptability of the device in terms of Workability

Legend:5-Excellent, 4-Very Good, 3-Good, 2-Fair, 1-Poor

Workability	Median	Rank	Description	Interpretation
Availability of tools and equipment	4	2	Very Good	Highly Attainable
Availability of expertise	4	2	Very Good	Highly Attainable
Materials readily available	5	1	Excellent	Very Highly Attainable

Table 3 assesses the acceptability of the device in terms of workability, focusing on factors related to the availability of tools and equipment, expertise, and materials.The availability of tools and equipment is rated as "Very Good." This suggests that the necessary tools and equipment for working with the device are generally accessible, indicating a good level of workability. However, there may be some room for improvement or refinement.The availability of expertise is also rated as "Very Good." This implies that the knowledge and skills required for the development, operation, or maintenance of the device are readily accessible. A "Very Good" rating indicates a positive level of workability but leaves room for potential enhancements.The rating of "Excellent" for materials' availability suggests that the necessary materials for the device are readily accessible. This is a positive indicator for workability, ensuring that the device can be produced or maintained without significant hurdles related to material availability.In summary, Table 3 indicates that the device is generally acceptable in terms of workability. The availability of tools, equipment, and expertise is rated as "Very Good," indicating a positive but improvable state. The "Excellent" rating for the availability of materials is particularly positive, as it ensures that the necessary resources for production and maintenance are easily obtainable. Overall, the device appears to have a good level of workability, with potential areas for improvement in certain aspects of tools, equipment, and expertise accessibility.

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Economy	Median	Rank	Description	Interpretation
The device is environmentally friendly	4	2	Very Good	Highly Attainable
The device utilizing Free Energy	5	1	Excellent	Very Highly Attainable
Affordable materials costs	4	2	Very Good	Highly Attainable

Table 4. Acceptability of the device in terms of Economy

Legnd:5-Excellent, 4-Very Good, 3-Good, 2-Fair, 1-Poor

Table 4 evaluates the acceptability of the device in terms of economy, focusing on aspects related to environmental impact, energy utilization, and material costs. The device's environmental friendliness is rated as "Very Good." This suggests that the device has positive environmental attributes, but there may still be opportunities for improvement. The rating indicates a relatively good performance in terms of environmental considerations.The device's utilization of free energy is rated as "Excellent." This implies that the device is designed to harness energy from renewable sources or in a way that minimizes its reliance on traditional power sources. An "Excellent" rating in this category is a positive indicator of sustainability and efficiency.The affordability of materials costs is rated as "Very Good." This suggests that the device is constructed with materials that are cost-effective, contributing to its economic viability. While very good, there may still be room for improvement.In summary, Table 4 indicates that the device is generally acceptable in terms of economy. The "Excellent" rating for utilizing free energy suggests a strong commitment to sustainability and efficiency, contributing positively to economic considerations. The "Very Good" ratings for environmental friendliness and affordable materials costs indicate that the device performs well in these aspects but may have some room for improvement. Overall, the device appears to have positive economic attributes, with a particularly strong emphasis on the utilization of free energy.

Table 5. Acceptability of the device in terms of Safety

Legend:5-Excellent, 4-Very Good, 3-Good, 2-Fair, 1-Poor

Safety	Median	Rank	Description	Interpretation
User's safety	5	1	Excellent	Very Highly Attainable
Absence of harmful materials	4	3	Very Good	Highly Attainable
Overload/Short circuit protection are applied	5	1	Excellent	Very Highly Attainable

Table 5 assesses the acceptability of the device in terms of safety, focusing on aspects related to user safety, the absence of harmful materials, and the application of overload/short circuit protection. The user's safety is rated as "Excellent." This suggests that the device is designed with a high level of consideration for user safety, ensuring that users are protected during operation. An "Excellent" rating in this category is a strong indicator of a safe and reliable device.The absence of harmful materials is rated as "Very Good." This indicates that the device is designed with materials that pose a low risk of harm to users. While very good, there may be some room for improvement or refinement in terms of material safety.Interpretation: The application of overload/short circuit protection is rated as "Excellent." This suggests that the device incorporates protective measures to prevent overloads and short circuits, enhancing its safety. An "Excellent" rating in this category is a positive indicator of robust safety features.In summary, Table 5 indicates that the device performs exceptionally well in terms of safety. The "Excellent" ratings for user's safety and overload/short circuit protection indicate a strong commitment to ensuring the safety of users during operation. The "Very Good" rating for the absence of harmful materials suggests that while the device is generally safe, there may be areas for improvement in terms of material safety. Overall, the device appears to be highly acceptable and safe for use, with a focus on protecting users from potential hazards.

VI. SUMMARY

This study aimed to evaluate the effectiveness of the proposed project, which is a solar-powered smart emergency light with a fire detection and alarm system. It focuses on the primary usage, functionality, applicability, workability, and

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safety aspects of the project, as well as how it effectively assists people through innovative means. The project is tested out of 15 respondents that has knowledge regarding electricity, enough to understand the flow of the project its material used, functions, usage and how it works.

VII. FINDINGS

Based on the comprehensive evaluation of the "Solar Powered Smart Emergency Light with Fire Detection and Alarm System," the following key findings have emerged:

1. Functionality Excellence:The prototype demonstrates exceptional functionality, achieving an excellent rating. This indicates a high level of effectiveness in providing illumination and alarm signal during power outages and fire situations.
2. Applicability Across Diverse Settings:The device exhibits versatility with high ratings across residential and commercial settings. Its adaptability to diverse environments underscores its broad applicability.
3. Workability and Accessibility:The availability of tools, expertise, and readily accessible materials contributes significantly to the overall workability of the prototype, affirming its practicality in real-world scenarios.
4. Economic and Environmental Advantages:The prototype's utilization of solar power not only makes it environmentally friendly but also offers a cost-effective alternative, potentially reducing long-term energy expenses.
5. User Safety and Material Considerations:The absence of harmful materials and the inclusion of overload protection prioritize user safety, further bolstering the device's reliability.

Overall, the findings affirm the prototype's potential to significantly enhance emergency lighting and safety measures. The integration of solar power, intelligent features, fire detection, and alarm systems places this innovation at the forefront of safety technology.

VIII. CONCLUSION

Certainly, based on the data and evaluations provided, the research on the "Solar Powered Smart Emergency Light with Fire Detection and Alarm System" has yielded highly promising results. The prototype's exceptional performance across various criteria, including functionality, applicability, workability, economy, and safety showcases its potential as an innovative and effective emergency lighting solution.The integration of solar power, intelligent features, fire detection, and alarm systems represents a significant advancement in emergency preparedness and safety technology. This combination not only enhances the device's sustainability and efficiency but also provides crucial safety features for users in critical situations.The consistently high ratings indicate an overall level of excellence, further reinforcing the viability and acceptability of this prototype. It stands poised to make a meaningful contribution to the field of emergency lighting systems, offering a sustainable, intelligent, and safety-centric solution.In conclusion, the "Solar Powered Smart Emergency Light with Fire Detection and Alarm System" holds great promise as a cutting-edge solution for emergency lighting needs in residential and commercial setting. Its outstanding performance and multifaceted capabilities position it as a potential game-changer in the realm of safety and emergency preparedness.

Further development and refinement could lead to widespread adoption and meaningful contributions to safety and sustainability efforts.

Recommendations

1. Residential and Commercial establishment: This device can provide cost-effective, environmentally friendly smart emergency lights and fire security features during power outages and fire scenarios.
2. Future Researchers: They are encouraged to conduct studies similar to this idea for further improvements.

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