CHAPTER 1

THE PROBLEM AND SCOPE

1.1 Rationale of the Study

Drying clothes outdoors is a common practice, especially in regions where sunlight is abundant. However, unexpected rainfall often leads to inconvenience, requiring individuals to rush and retrieve their laundry or deal with re-washing due to moisture exposure. This study aims to develop an automatic outdoor clothesline integrated with an air dryer to address this issue. By combining rain sensors, photocell sensor and an automated air-drying mechanism, this system ensures that clothes remain dry even when unexpected rain occurs.

It promotes energy efficiency by utilizing an air dryer instead of traditional electric dryers, which consume significantly more electricity. Studies suggest that air drying systems, when used effectively, contribute to environmental sustainability by reducing carbon emissions associated with conventional dryers (Taylor & Kim, 2022). With smart automation becoming more prevalent, integrating rain and light detection with an alternative drying solution can enhance convenience and efficiency in household management. Moreover, many individuals face challenges due to unpredictable weather patterns, making it difficult to determine the best time to dry clothes outdoors. The proposed system offers a proactive approach by automatically responding to weather changes, ensuring that clothes remain dry without requiring human intervention. This capability is especially useful for households where occupants have limited availability to attend to outdoor laundry due to work, travel, or other responsibilities.

The development of this system is particularly beneficial for individuals with busy schedules who may not always be available to monitor the weather and retrieve their clothes manually. The integration of smart sensors and automation in home appliances is becoming a standard for modern living. The ability to remotely monitor and control home systems enhances convenience, particularly for individuals with mobility challenges or disabilities. By incorporating IoT-based monitoring and automation, this study presents a viable solution that aligns with advancements in home technology, making daily household tasks more manageable and efficient.

Beyond convenience, the study also contributes to sustainable living by reducing energy consumption. Unlike traditional dryers that rely on high electricity usage, an air dryer offers an energy-efficient alternative that maintains drying effectiveness. The system ensures that clothes are dried properly while minimizing environmental impact, making it a practical solution for eco-conscious consumers who seek to reduce their carbon footprint.

Furthermore, this innovation can inspire future developments in automated home systems by demonstrating the benefits of integrating weather-responsive automation with everyday household needs. The study presents a novel application of rain detection and airflow-based drying, setting a foundation for further research into intelligent home solutions that optimize energy efficiency and improve user convenience.

1.2 Theoretical Background

This study is anchored in automation and sensor technology theories, specifically in the fields of smart home systems and environmental sustainability. The Theory of Smart Automation (Bohn, 2024) suggests that integrating automated processes into daily routines increases efficiency and minimizes manual intervention. In this case, the rain detection system utilizes sensors that detect precipitation and trigger automated responses and also the photocell sensor is a part that can sense light, ensuring that laundry is protected from unexpected weather conditions. This theory underscores the importance of automation in modern households, where smart technology enhances daily living by improving efficiency and reducing dependency on manual efforts.

The study also applies the principles of IoT (Internet of Things) technology, as explained by (Sharma and Patel, 2021) which enables real-time weather monitoring and automated decision-making. IoT-based systems are widely used in smart homes to facilitate intelligent communication between devices, ensuring seamless integration of automation and user convenience. By incorporating IoT-enabled sensors, the system can provide timely alerts and activate the air-drying mechanism when necessary, showcasing the growing role of interconnected devices in enhancing home automation.

The Environmental Sustainability Theory (Green & Roberts, 2023) highlights the importance of reducing energy consumption in household applications. Air drying clothes, as opposed to using traditional dryers, aligns with eco-friendly practices by minimizing energy usage while still ensuring effective drying. This theory emphasizes the need for sustainable home solutions that reduce environmental impact while maintaining functionality and efficiency. The integration of rain detection with an air dryer represents an innovation in sustainable home technology, reducing dependence on electricity while enhancing user convenience. It aligns with broader sustainability goals by encouraging the adoption of energy-efficient alternatives in everyday household routines.

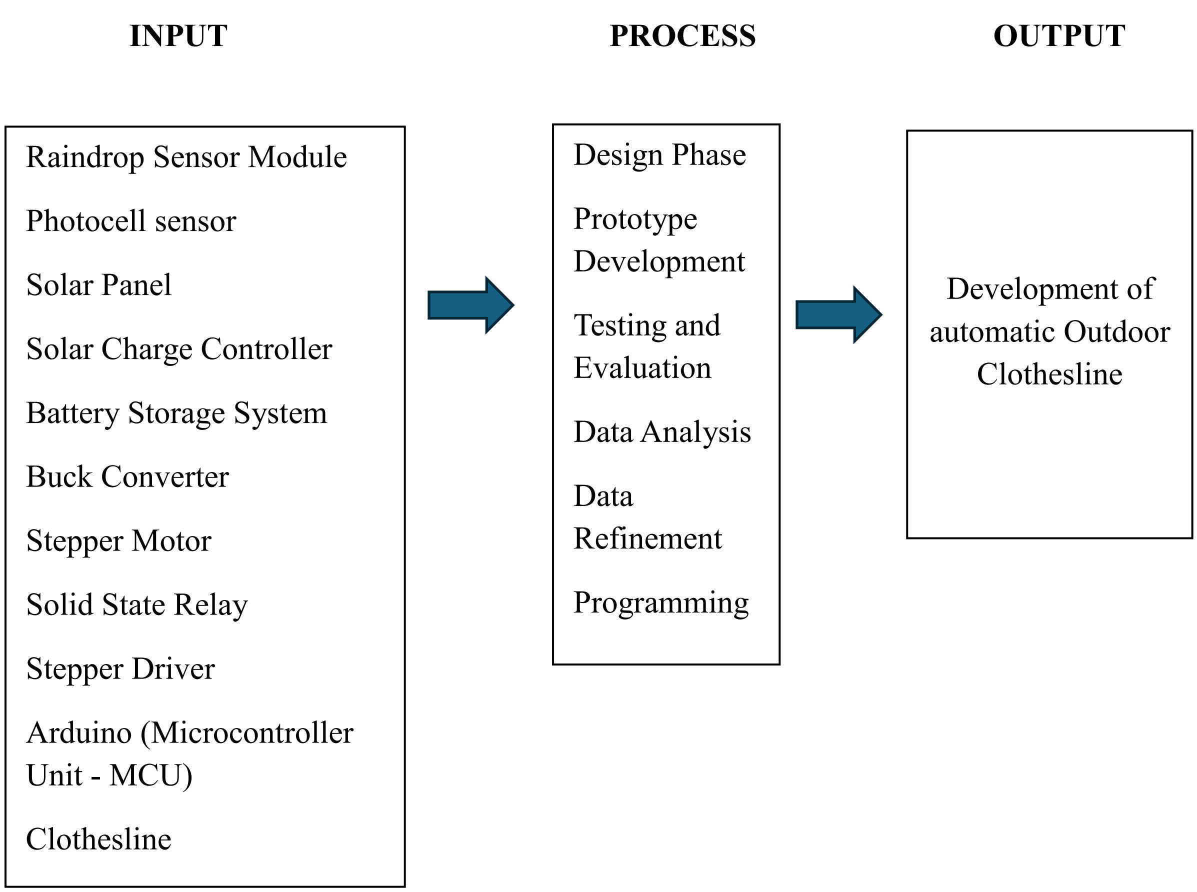
The Efficiency Theory in Engineering Design (Carter & Lee, 2023) states that automation and technological advancements should optimize resource utilization and operational performance. This principle advocates for the strategic use of technology to maximize efficiency while minimizing waste. By implementing an air-drying system in conjunction with rain and light detection, the proposed system exemplifies an efficient use of automation to solve common household problems, reducing both labor effort and energy costs. This theory supports the development of intelligent home systems that improve everyday tasks by optimizing available resources and minimizing unnecessary energy expenditure. Furthermore, research in smart home innovations suggests that integrating weather-responsive automation can enhance the adaptability of home appliances. By applying intelligent automation principles, this study aligns with the broader movement toward smart home integration, where automated processes ensure increased convenience, reduced energy consumption, and improved sustainability.

Another relevant theoretical framework is the Adaptation Theory in Technology (Miller & Zhang, 2022), which states that technological solutions should be flexible enough to adapt to changing environmental conditions and user needs. The proposed system exemplifies this principle by dynamically adjusting to rainfall conditions while maintaining an effective drying process. This adaptability ensures the system’s long-term usefulness and applicability in various climates.

Lastly, the study incorporates Human-Centered Design Theory (Norman, 2019), which emphasizes the importance of creating technology that is intuitive, accessible, and beneficial to users. The automated rain detection and drying system aims to enhance user convenience by simplifying laundry management, particularly for individuals who may have difficulty manually handling outdoor drying tasks. By prioritizing ease of use and automation, the system aligns with human-centered design principles that promote efficiency and usability in smart home technologies.

Figure 1

Framework of the Study



1.3 Objectives of the Study

1.3.1 General Objective

The primary objective of this study is to develop an automated outdoor clothesline system with an integrated air dryer to ensure uninterrupted clothes drying and protection against sudden rainfall.

1.3.2 Specific Objectives

1. To determine the construction procedure in the development of the project.
2. To use a developed automated air dryer that helps clothes dry efficiently even during rainy weather.
3. To assess the acceptability of the project in terms of design and operation.
   a. Design
   b. Operation
4. To determine the cost of the project.

1.4 Significance of the Study

The study is significant as it provides a practical solution to a common household issue while promoting energy efficiency. Additionally, this system contributes to sustainable living by offering an energy-efficient alternative to traditional dryers, thereby reducing electricity consumption. Researchers and developers in the field of smart home automation can use this study as a reference for future innovations in household automation and environmental sustainability.

Homeowners: Benefits this project by reducing inconvenience of manually monitoring the weather and retrieving laundry.

Boarders: This research serves as a basis for advancing home automation technology by demonstrating the practical application of integrating environmental sensors with automated household systems. It can also benefit industries related to smart home development, encouraging the adoption of eco-friendly alternatives to traditional drying methods. Lastly, the findings of this study can inform policymakers and manufacturers about the benefits of energy-efficient appliances in reducing carbon footprints and promoting sustainability.

Community: The primary community that will benefit from this project includes homeowners, particularly those who rely on outdoor clothes drying and seek a more efficient and weather-responsive solution. It is especially advantageous for individuals with busy schedules, the elderly, and persons with disabilities who may struggle with manually retrieving laundry during sudden rainfall. Additionally, eco-conscious households looking for energy-efficient alternatives to traditional electric dryers can benefit from this innovation. Beyond residential users, this project can also serve as a reference for researchers, engineers, and students studying automation and smart home technologies. Furthermore, sustainability advocates and policymakers promoting energy-efficient home solutions may find value in this system, as it aligns with environmental conservation efforts by reducing electricity consumption while ensuring convenience in daily household tasks.

1.5 Scope and Limitations of the Study

Scope:

This project focuses on developing a rain detection system integrated with an automated air dryer. It covers the design, implementation, and evaluation of the system's effectiveness in protecting laundry from sudden rainfall while ensuring continuous drying. The study does not include the development of alternative drying methods such as heat-based drying] or dehumidification. Additionally, the research will be conducted under controlled environmental conditions, and external factors such as extreme weather conditions or mechanical failures are not within the scope of the study.

Limitation:

The project is limited to the efficiency of the air-drying system within a specified range of humidity and temperature conditions. The automation process is based on pre-programmed sensor triggers and does not incorporate AI-based weather prediction, which could be a potential area for future research. Furthermore, the energy consumption of the air-drying system will be evaluated in comparison to traditional electric dryers, but factors such as fabric type and drying time variability may introduce limitations in the assessment.

1.6 Definition of Terms

The following terms are defined operationally for clearer and better understanding.

Additional Load – Any extra electrical device or component connected to the system, which may consume power from the solar battery.

Air Dryer – A drying mechanism that uses airflow instead of heat to remove moisture from clothes.

Arduino (or Microcontroller Unit - MCU) – A programmable electronic board used to control the automation process by receiving sensor data and triggering system responses.

Automated Airflow System – A system that uses controlled air circulation to dry clothes efficiently without excessive heat application.

Battery Storage System – A rechargeable energy storage unit that stores electricity generated from solar panels for later use.

Buck Converter – reduces DC voltage efficiently by rapidly switching a power transistor on and off and smoothing the output with an inductor and capacitor.

Stepper Motor – A type of motor that runs on direct current (DC) electricity and is used to drive mechanical movements in automation systems.

Efficiency Theory in Engineering Design – A principle stating that automation should optimize performance and resource utilization.

Environmental Sustainability – The practice of minimizing environmental impact through energy-efficient and eco-friendly technologies.

L298N DC Driver Motor - uses an H-bridge configuration to control the direction and speed of DC motor.

Main Board – The central electronic control board that integrates different components such as sensors, relays, and microcontrollers for system automation.

Mechanical Framework – The structural support system that holds and connects the different components of the automated drying mechanism.

Power Distribution System – The wiring and circuitry that manage the flow of electricity from the solar panels, battery, and inverter to different system components.

Rain Detection System – A sensor-based system that detects precipitation and triggers automated actions.

Rainfall Sensor Module – A specific type of sensor that detects the presence of rain and sends signals to the controller to trigger automated responses.

Photocell sensor – A photocell sensor is a device that senses light, more light makes resistance go down, It uses a special material (semiconductor) that reacts lights, and the change in resistance create a signal that show bright or dark.

Solid State Relay – An electrically operated switch that allows a low-power microcontroller to control higher-power devices like motors or heating elements.

Sensor Technology – The use of devices that detect environmental changes, such as rain or humidity, to trigger automated responses.

Smart Home Automation – The integration of technology to enhance the efficiency and convenience of household activities.

Solar Charge Controller – A device that regulates the voltage and current coming from solar panels to prevent overcharging or discharging of the battery.

Solar Panel – A device that converts sunlight into electrical energy to power the system, enhancing sustainability.

Wall Mounting System – The structural setup that supports the placement of solar panels, electronic components, and mechanical parts on a vertical surface.

CHAPTER II

REVIEW OF RELATED LITERATURE AND STUDIES

2.1 Review of Related Literature

Rain detection technology has evolved significantly with the advancement of sensor-based systems and automation. According to (Smith and Johnson, 2022), modern rain sensors are commonly used in automotive applications, irrigation systems, and home automation to detect precipitation and trigger appropriate responses. These sensors work by measuring changes in electrical conductivity, optical reflection, or mechanical resistance when exposed to water droplets. The increasing demand for automated solutions in various industries has led to the continuous improvement of rain sensor accuracy, response time, and durability. Additionally, IoT-based weather monitoring has gained traction in recent years. (Sharma and Patel, 2021) discuss the implementation of smart weather stations that utilize humidity and temperature sensors, along with rain detection modules, to provide real-time weather updates. This technology is widely used in agriculture and smart city applications, ensuring efficient weather-based decision-making. The integration of real-time weather data into household management, such as automated clothes-drying solutions, can enhance convenience and efficiency by alerting users when rainfall is imminent.

The integration of rain detection systems in smart homes has been explored by various researchers. According to (Bohn, 2024), automated home systems can enhance convenience by incorporating rain detection sensors to control windows, awnings, and drying systems. These systems use microcontrollers and wireless communication to detect precipitation and respond accordingly, reducing manual intervention. Home automation companies have begun integrating smart rain detection into their products, ensuring users can receive notifications or automate home appliances based on weather conditions. Furthermore, the adoption of sensor-based automation supports environmental sustainability. Green and Roberts (2023) highlight how smart home systems contribute to reduced water wastage and energy consumption by automating weather-responsive actions. The use of rain detection systems in laundry management aligns with this principle by preventing unnecessary re-washing and reliance on electric dryers.

An additional innovation in automated drying systems is the integration of air dryers. Air dryers offer an alternative drying solution by using controlled airflow to dry clothes efficiently, even in humid or rainy conditions. According to (Taylor and Kim, 2022), air drying systems are an eco-friendly and energy-efficient alternative to conventional dryers, reducing electricity consumption while ensuring that clothes dry effectively indoors or in enclosed outdoor spaces. Incorporating air dryers into the rain detection system allows for continuous clothes drying even when rain is detected, further enhancing the efficiency and functionality of the system.

As smart home technology continues to evolve, future advancements may include AI-powered rain detection algorithms that predict precipitation with greater accuracy and reliability, combined with automated air-drying solutions for uninterrupted laundry management.

2.2 Related Studies

Several studies have been conducted on IoT-based rain detection and monitoring systems. A study by (Lee et al, 2020) developed an IoT-enabled rain sensor integrated with a mobile notification system. The research found that the system significantly improved user awareness of sudden rainfall and minimized damage to outdoor belongings. This study serves as a strong foundation for the present research, as it emphasizes real-time alerts for rain detection. The system incorporated GSM and Wi-Fi-based modules for efficient communication, ensuring that users could receive notifications regardless of their location. Similarly, a study by (Fernandez and Cruz, 2021) explored the effectiveness of an automated clothes-drying mechanism that utilizes rain sensors. Their findings revealed that an integrated system combining rain detection with motorized retractable roofs successfully protected clothes from getting wet. The study also analyzed the efficiency of different sensor types, concluding that capacitive sensors provided a faster response time compared to resistive and optical sensors. This study aligns with the present research by providing insight into the practical applications of sensor-driven rain protection solutions and guiding the selection of optimal components for implementation.

In another relevant study, (Johnson et al, 2019) investigated the efficiency of smart weather monitoring stations in residential areas. Their research demonstrated that low-cost, sensor-based systems could accurately predict rainfall and alert users via mobile applications. The study's results suggest that similar technology can be effectively adapted for rain detection in outdoor clotheslines. Additionally, the study explored the importance of integrating machine learning models to enhance weather prediction capabilities, paving the way for more intelligent and adaptive rain detection systems. Furthermore, a study conducted by (Tanaka and Yamamoto, 2022) analyzed the accuracy and response time of different types of rain sensors. Their research concluded that capacitive-based rain sensors provided the most reliable and rapid detection of precipitation compared to traditional resistive and optical sensors. This finding supports the selection of suitable rain-sensing components for the development of the proposed system. The study also emphasized the importance of sensor placement and calibration to ensure consistent and accurate performance in varying weather conditions.

In addition, (Carter and Lee, 2023) studied the impact of air-drying technology in smart home applications, focusing on its role in energy conservation and sustainable living. Their findings suggest that integrating air dryers with automated weather detection can help maintain drying efficiency without relying on conventional electric dryers. The incorporation of such a system in rain-sensitive drying solutions can provide a more sustainable and practical approach to laundry management, particularly in regions with frequent rainfall.

Synthesis

This study integrates existing concepts of rain detection, automated drying systems, and smart home technologies to develop an innovative clothesline that responds to weather conditions. Previous literature and studies have explored rain detection using various sensor-based mechanisms and the benefits of automated home systems in enhancing convenience and efficiency. Additionally, research has highlighted the advantages of energy-efficient drying methods over conventional electric dryers in reducing environmental impact. However, while numerous studies discuss rain sensors and

IoT-based automation separately, there is a noticeable gap in integrating these technologies specifically for outdoor clothes drying.

Most existing solutions focus on either traditional retractable clotheslines that require manual operation or energy-intensive electric dryers that significantly contribute to electricity consumption. This study addresses this gap by combining a rain detection module, an automated clothesline mechanism, and an air-drying system to ensure uninterrupted drying regardless of weather conditions. By bridging the gap between sensor technology and sustainable home solutions, this project contributes to the development of intelligent household systems that prioritize convenience, energy efficiency, and environmental sustainability. It offers a novel approach to mitigating the common inconvenience of sudden rainfall while providing an eco-friendly alternative to traditional drying methods.

CHAPTER III

MATERIALS AND METHODS

3.1 Research Design

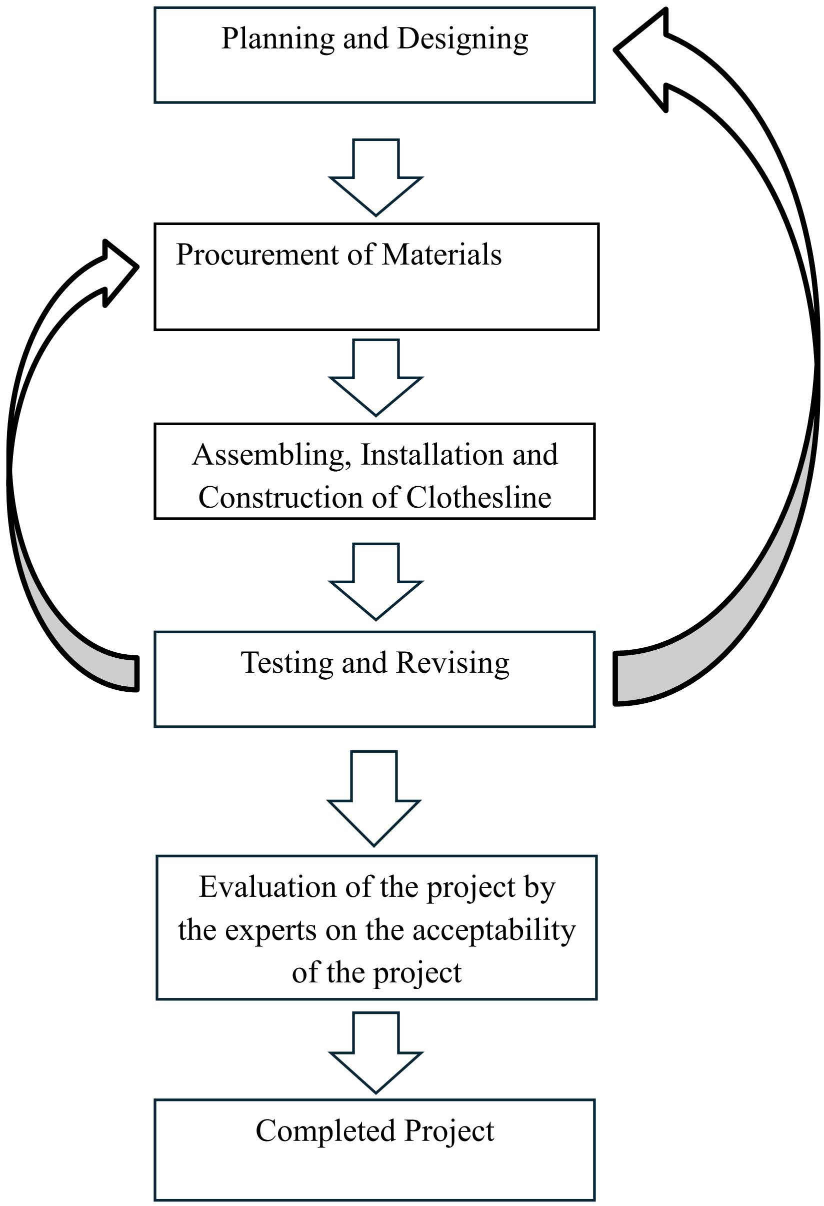
This study employs a developmental-experimental research design aimed at constructing, testing, and refining a fully functional prototype of an automated solar-powered clothesline with integrated rain detection and air-drying features. The approach is ideal for technology-driven research projects that involve building systems based on practical problems. In this case, the study addresses the inconvenience caused by sudden rainfall during outdoor clothes drying. The design process emphasizes both hardware integration and performance evaluation to ensure the reliability and functionality of the system in real-world environments. Through iterative development, the researchers ensured the effectiveness of automation by continuously testing and improving the prototype in various weather conditions.

The flow of the study is illustrated in Figure 1 and includes the following stages: identification of the problem, conceptualization of the solution, system design, prototype development, testing and refinement, and final evaluation. Each phase is essential in producing a reliable and responsive automated clothesline system that provides users with a sustainable and convenient alternative to traditional drying methods.

3.1.2 Flow of the Study

Figure 2

Flow of the study



3.2 Research Environment

This location provided suitable conditions for observing the system's response to actual weather changes, particularly in detecting rainfall. Initial testing and data gathering were conducted also in Labuyo, Tangub City, where selected community members observed the system's performance in a typical household setting. For final evaluation, the project was brought to the Engineering Technology Laboratory of the school, where controlled testing was conducted to measure the accuracy, efficiency, and overall functionality of the system. These environments provided both practical and technical settings necessary for the successful development and assessment of the prototype.

Figure 3:

Fabrication of the Site

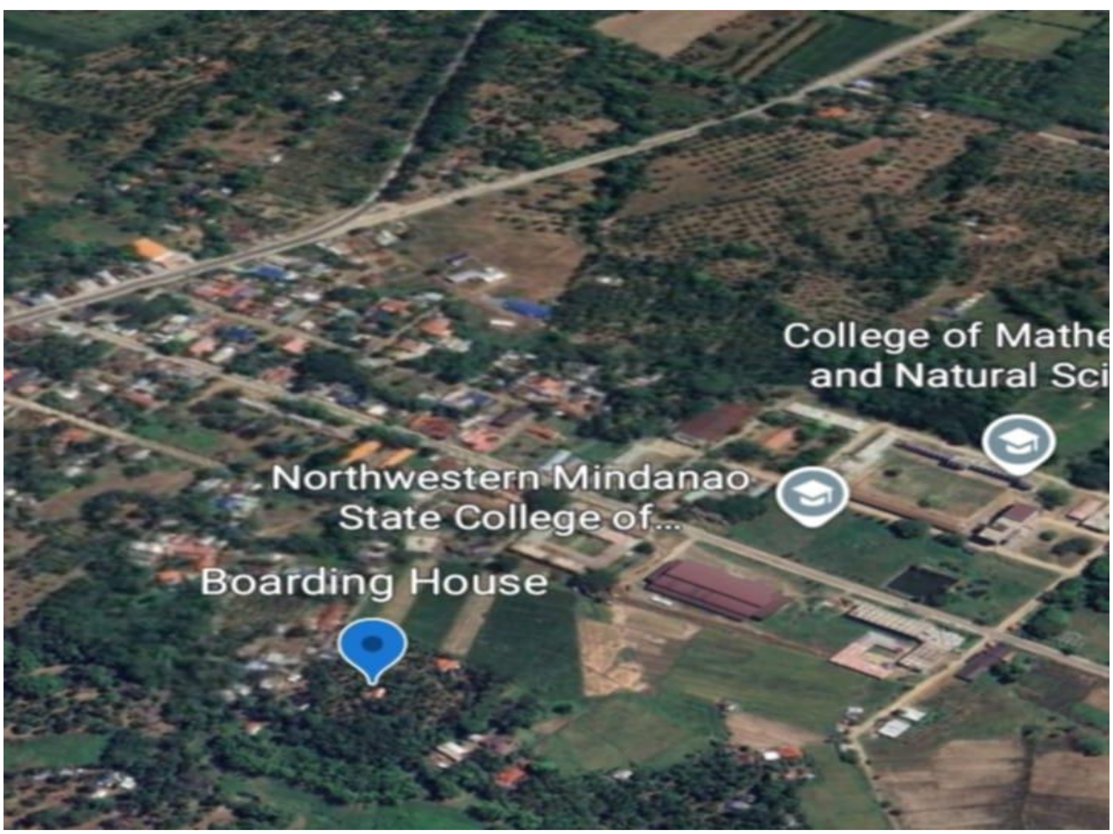


Figure 4: **NMSCST (Campus School of College of Engineering and Technology)**

The project is developed. Then the data gathering was done at Northwestern Mindanao State College of Science and Technology. The set of experts are from the School of Engineering and Technology. The experts were selected in accordance to their research respondent.

Figure 5: Northwestern Mindanao State College of Science and Technology Campus

3.3 Research Respondents

There are (5) selected experts to evaluate the design, operation of the project. They are the faculty of School of Engineering and Technology and Technology, Northwestern Mindanao State College of Science and Technology (NMSCST). These faculty members are engineers who are expert in the field of electrical engineering and are believed to possess the credibility of evaluate the developed project. Moreover, an adopted-modified questionnaire was used as tool to measure the parameters set in this study.

Table 1.

List of Experts

Groups	Number of Respondents	Percentage
Electrical Engineers (NMSCST SET Instructor)	2	40%
Electronic Engineer (NMSCST SET instructor)	1	20%
Mechanical Engineers (NMSCST SET Instructor)	2	40%
Total	5	100 %

3.4 Research Instruments

The researchers used the following instruments to evaluate the acceptability and efficiency of the completed project.

1. **Questionnaire** - as an instrument to evaluate the project. The survey questionnaire is used to determine the efficiency of the project. After it was finalized, the questionnaire was submitted and corrected by the adviser. Questionnaires were then floated to the experts which include the criteria for the proper design, operation and application of the project.
2. **The Project** - was considered as the main instrument of the study. It was evaluated by the experts in terms of design, operation, and application.

3.5 Scoring procedure

The experts were given a questionnaire with a verbal description of its range category. The weight of the range category was described as Very acceptable/Efficient for number three (3), Acceptable/Efficient for number two (2), and Not acceptable/Not efficient for Number One (1).

Researchers collated data from the responses of the experts on its assessment of acceptability and efficiency in terms of Design, Operation, and Application. Table 2 below shows the Likert scale range category and description.

Table 2

Likert Scale range category and description

WEIGHT	RANGE CATEGORY	VERBAL DESCRIPTION
3	Very Acceptable	The evaluators find the project as very satisfactory in terms of productivity and manipulation.
2	Acceptable	The evaluators find the project as satisfactory in terms of productivity and manipulation.
1	Not Acceptable	The evaluators find the project as good in terms of productivity and manipulation.

Computation of range interval

Formula

$$\mathbf{i} = \frac{\boldsymbol{HS-LS}}{\boldsymbol{HS}} \qquad i = \frac{3-1}{3} = \frac{2}{3} = 0.66$$

Where:

3= Highest Score (HS)

1= Lowest Score (LS)

i = is the rang of interval

Table 2.1

Likert Scale Average Weighted Mean and description

Range	Description
2.34 - 3.00	Very Efficient
2.67 - 2.33	Efficient
1.0 - 1.66	Not Efficient

3.6 Statistical Tool

The data gathered from the questionnaire were analyzed using descriptive statistics. The primary statistical tool used was the weighted mean to interpret the average responses for each criterion. The weighted mean helped identify which areas of the project were considered most and least evident by the respondents. This provided valuable insights for evaluating the strengths and possible areas for improvement of the system.

Average Weighted Mean Formula:

$$\bar{\mathbf{X}} = \frac{\sum \boldsymbol{fx}}{\boldsymbol{n}}$$

Where:

$\boldsymbol{X}$ - is the average weighted mean

$\boldsymbol{\Sigma fw}$ - is total weighted point

N - is the total number of respondents

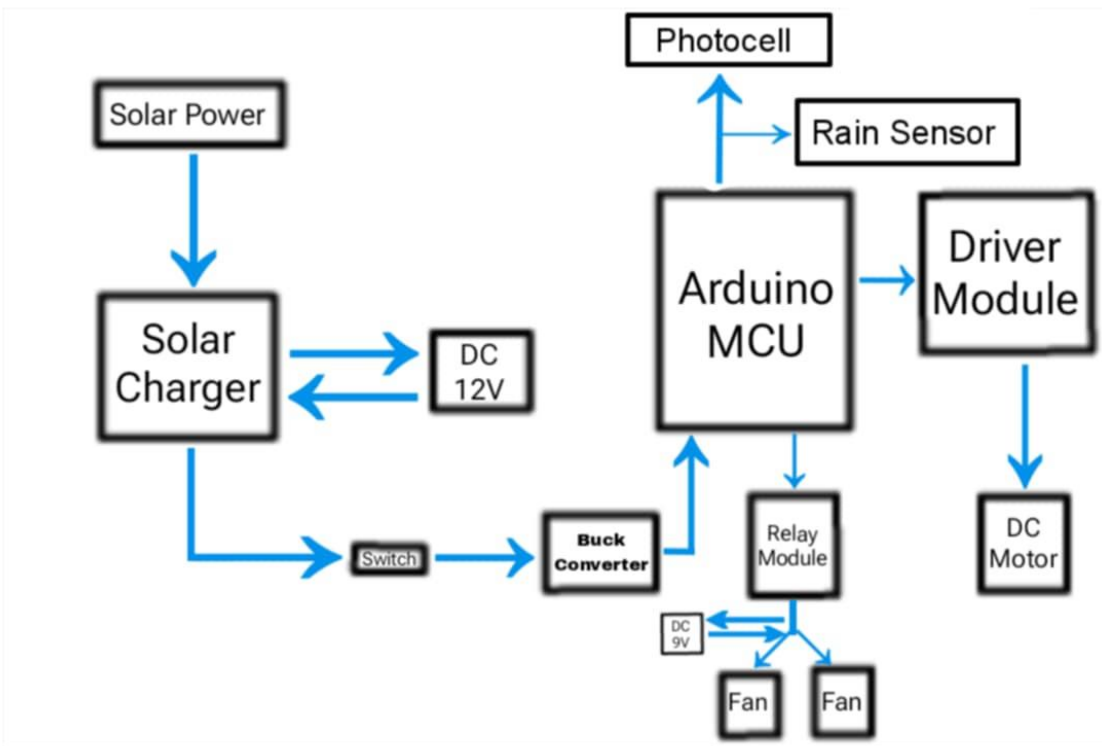
3.7 Design Requirements

This section of Chapter 3 Design requirements includes the black diagram, schematic diagram, layouts, supplies and materials, tools and equipment, and project output specifications.

Figure 5

The Black Diagram of Development of a Rain Detector for Outdoor Clothesline

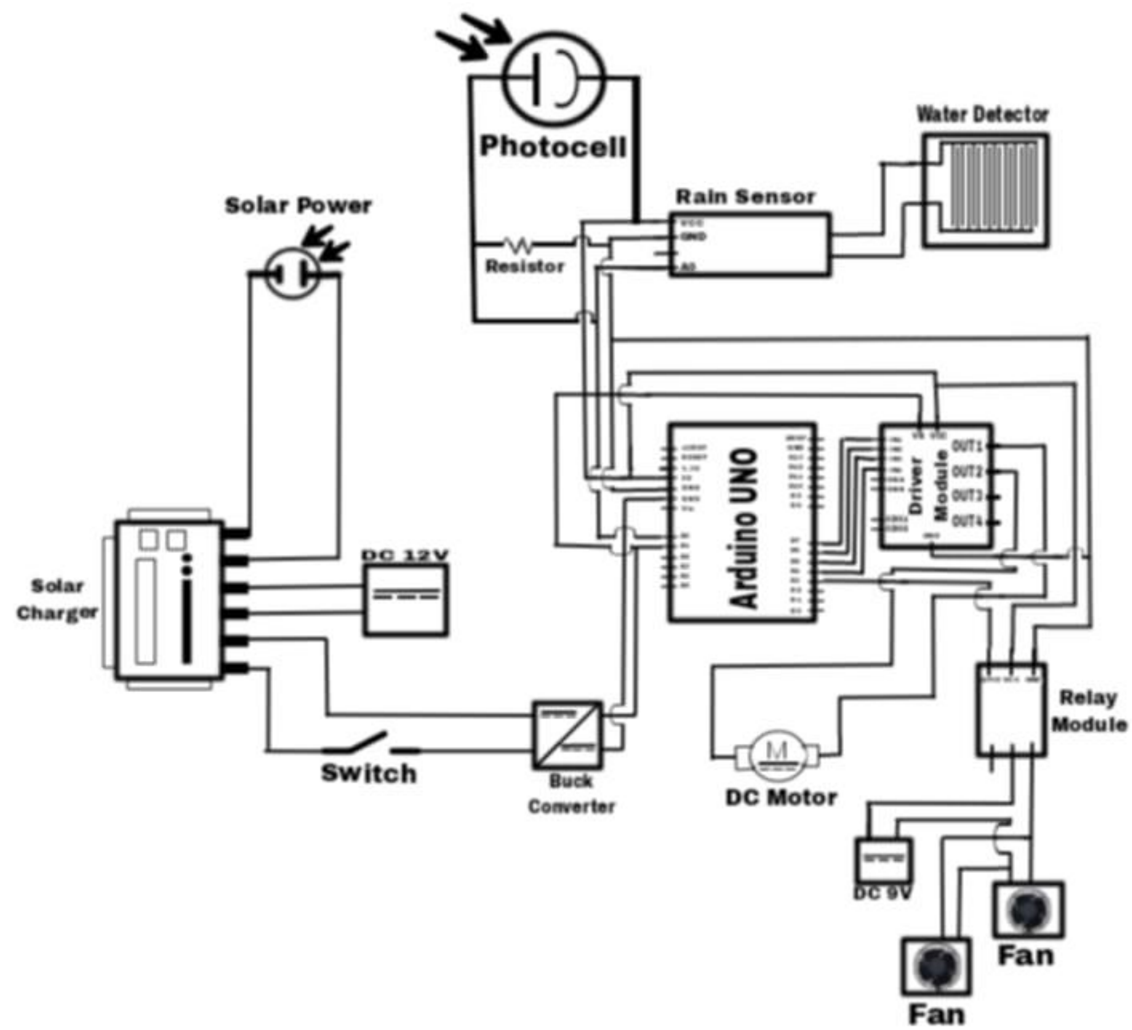
3.7.1 Block diagram



3.7.2 Schematic Diagram

Figure 6

The Schematic Diagram of the Development of a Automated Outdoor Clothesline



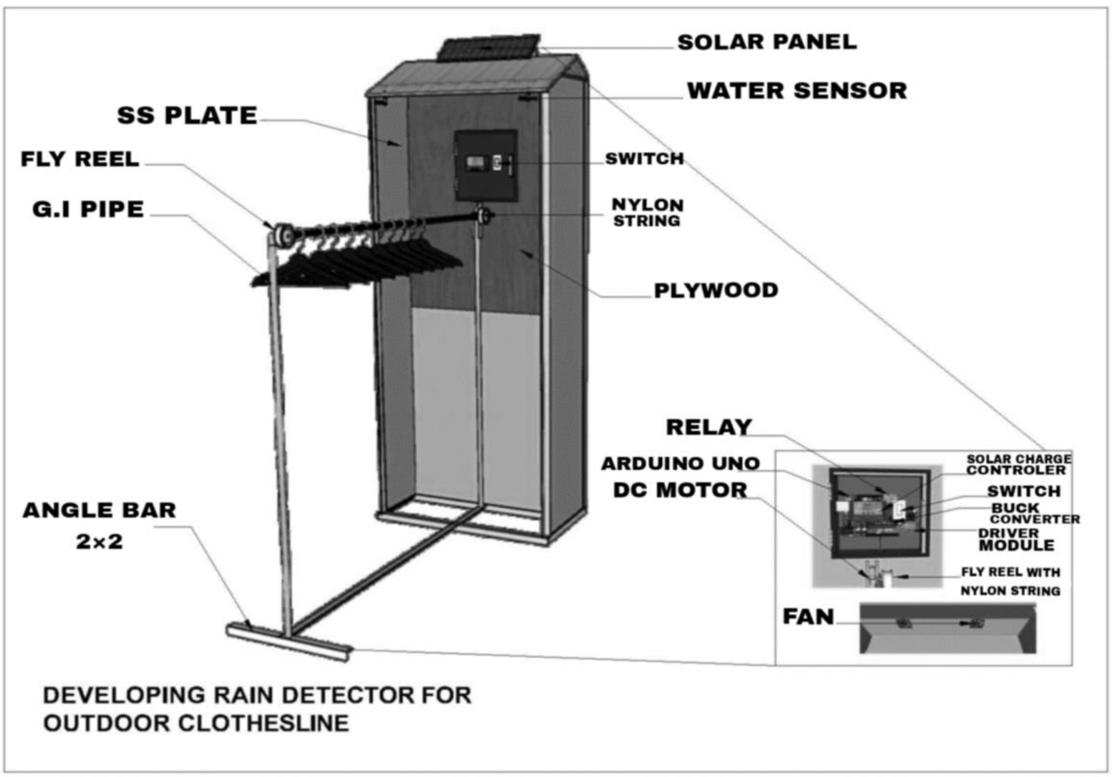
3.7.3 Layout

Perspective View

A detailed schematic illustrating a rain detector for an outdoor clothesline, highlighting components such as a solar panel, water sensor, and various electronic parts.

Figure 7

The Perspective View no the Project

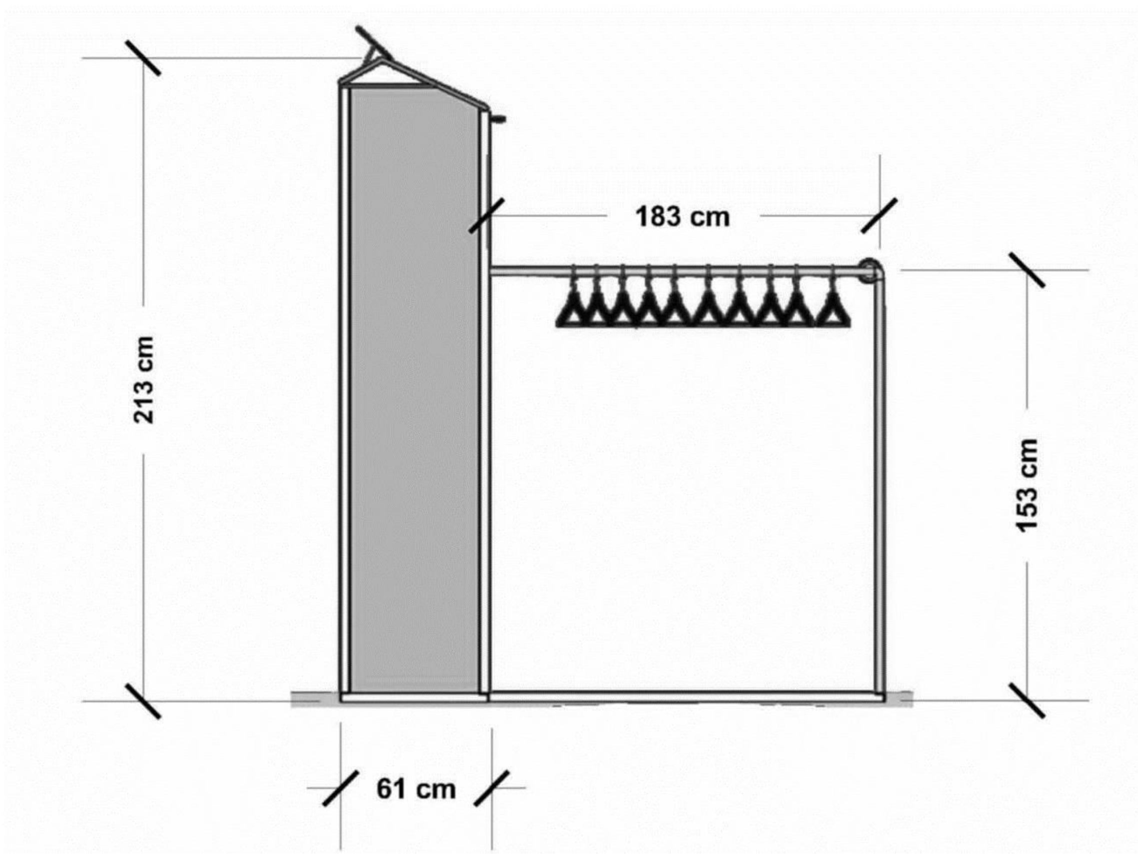


Left–side view

The left side view shows a 213 cm high vertical support structure mounted 61 cm from the wall, with a 183 cm long retractable clothesline extending horizontally at a height of 153 cm, highlighting the compact and functional alignment of the drying system components.

Figure 8

Left-side view of the project

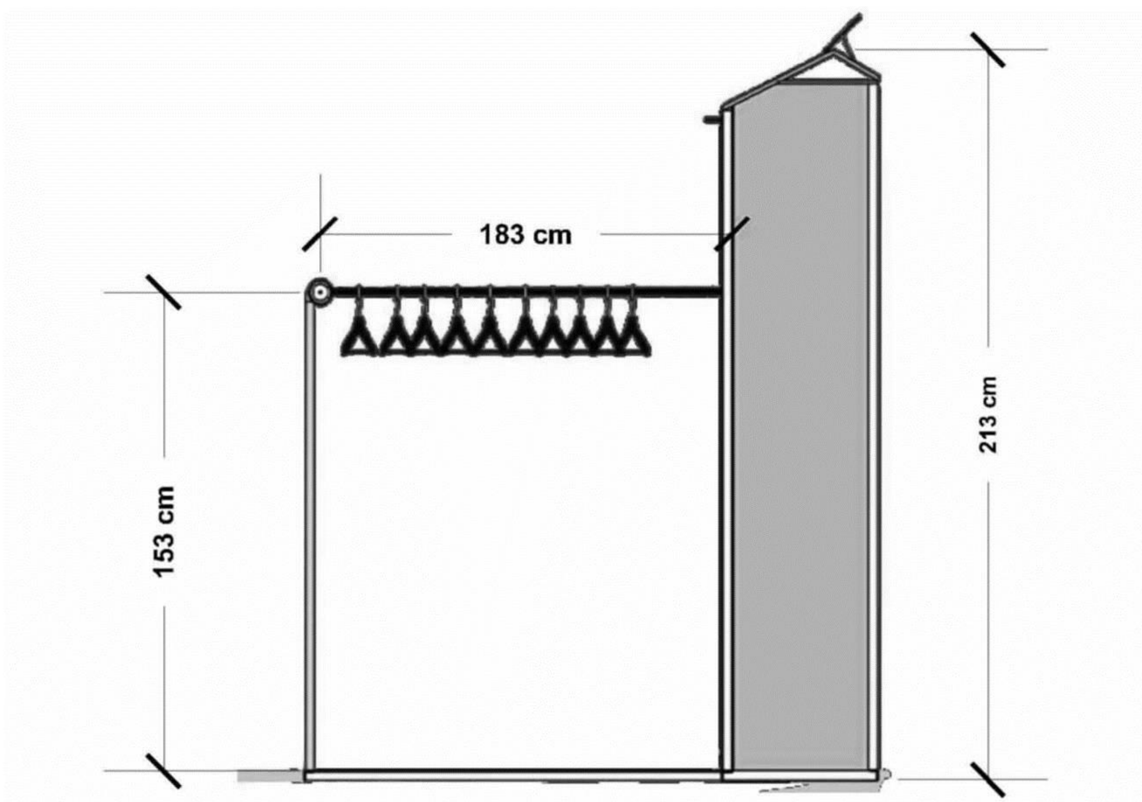


Right– side view

The right side view drawing illustrates the height of the object at 213 cm and a width of 183 cm, featuring a hanging arrangement and large vertical surface.

Figure 9

Right-side view of the project

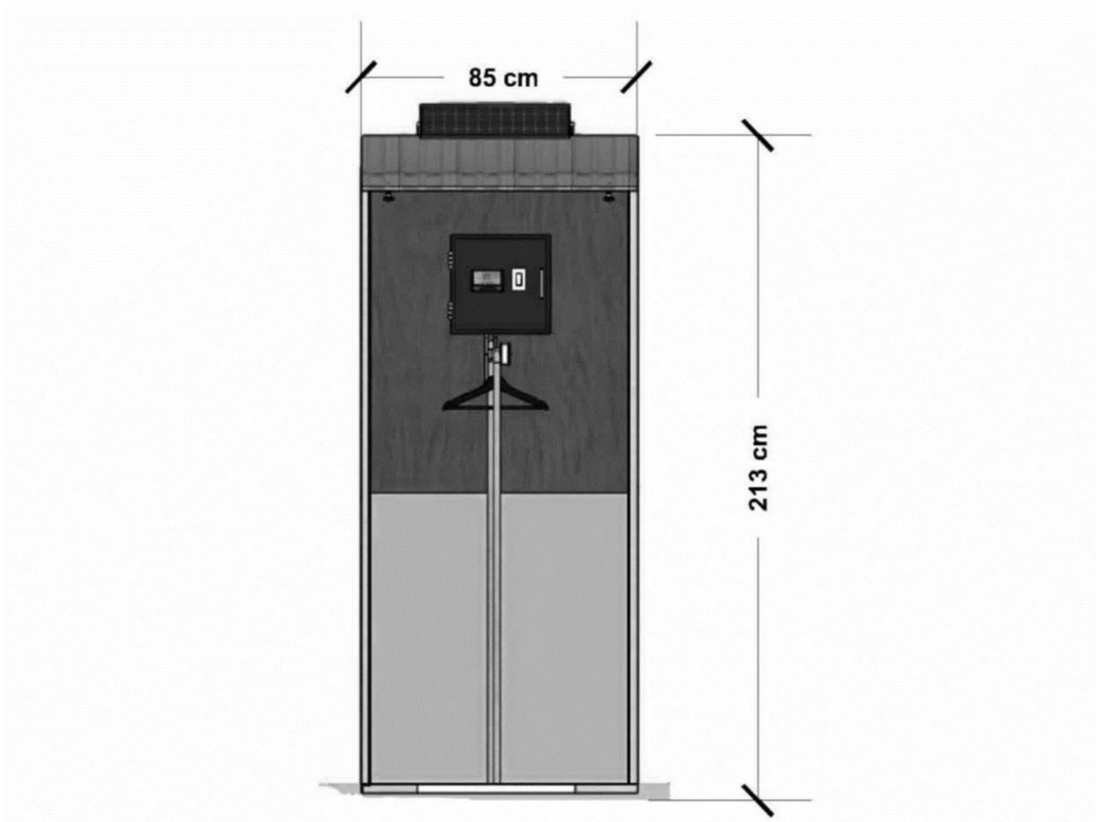


Front view

This front view illustration displays a vertical structure with a height of 213 cm and a width of 85 cm, showcasing a control panel and hanging rod.

Figure 10

The Front view of the project

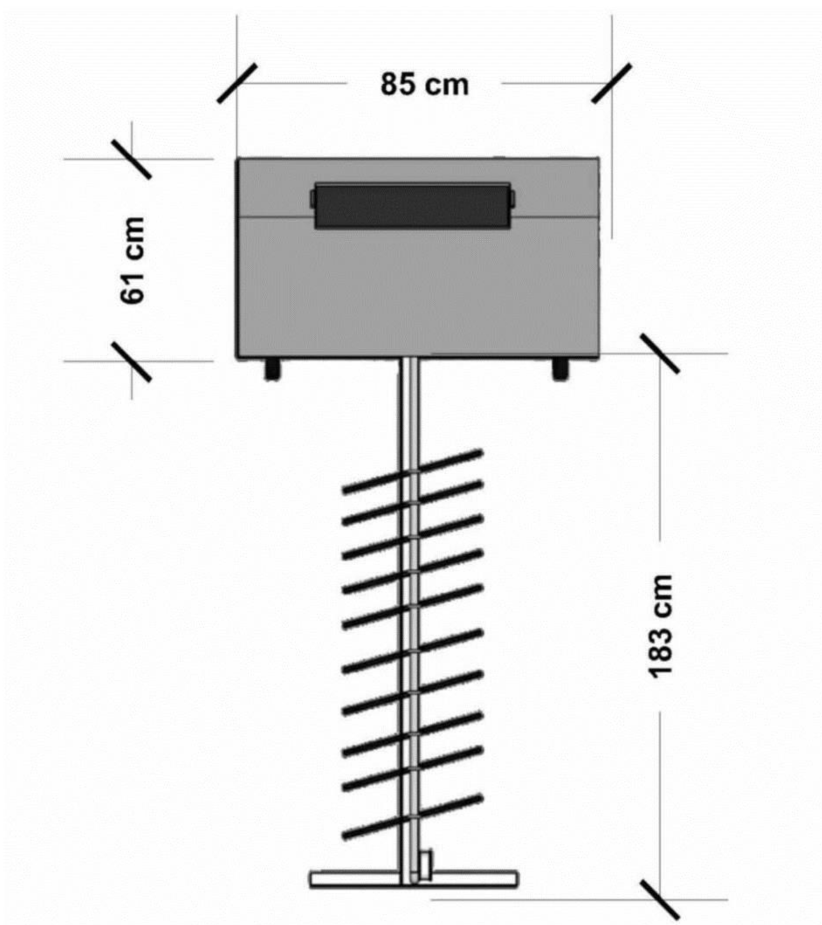


TOP VIEW

This top view depiction shows the layout of the object, measuring 183 cm in length and 85 cm in width, featuring a series of rods extending outward.

Figure 11

The Top view of the project

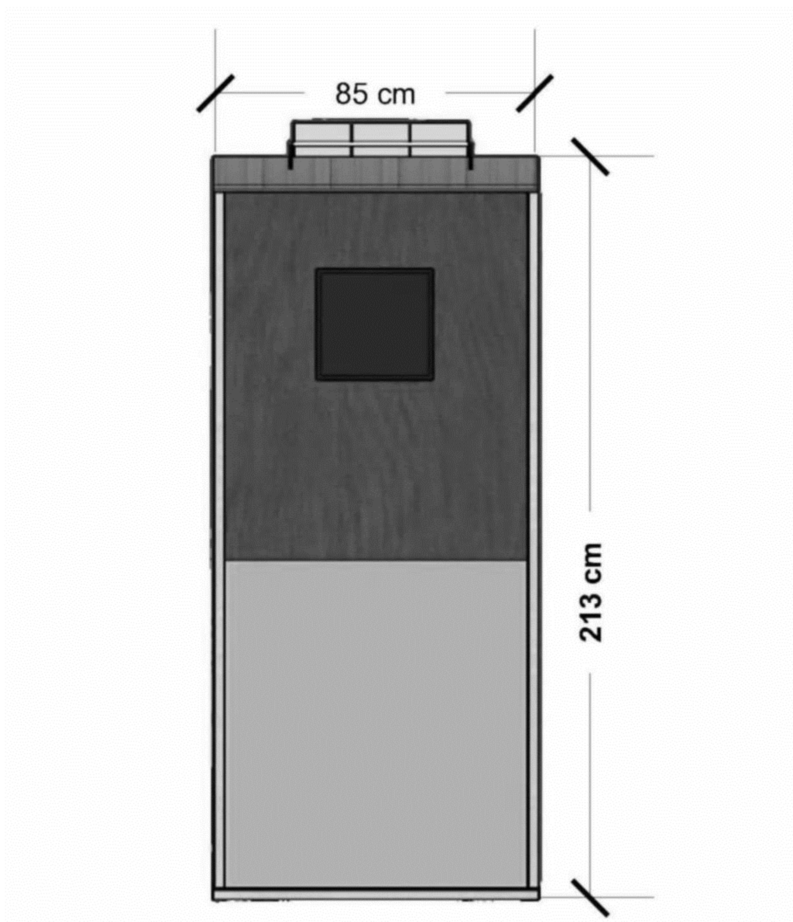


REAR VIEW

The rear view diagram presents a structure that is 213 cm long and 85 cm wide, with a simplified layout highlighting the back area.

Figure 12

Rear view of the project

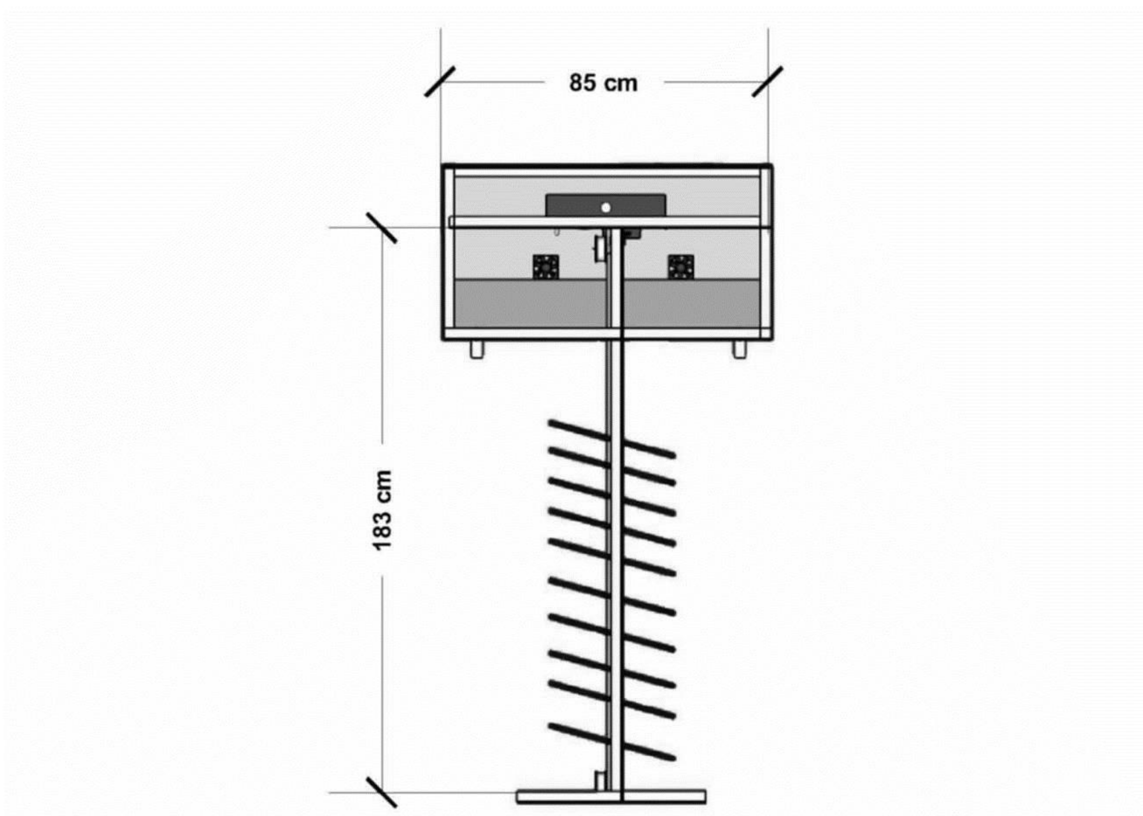


Bottom view

This is a technical drawing showing the bottom view of a structure measuring 85 cm wide and 183 cm tall, featuring a central support with multiple horizontal rods.

Figure 13

Bottom view of the project



3.7.4 Supplies and Materials

The supplies and materials needed to complete the project are available at the fabrication site. Materials, unit, quantity, unit cost, and total cost are all provided.

Table 3 Supplies and Materials

Materials	Unit Price	Quantity	Unit Cost(₱)
Angle Bar	169.00	1 length	169.00
Wood Screw	144.00	1 pack	144.00
Cutting Disc	80.00	5 pieces	400.00
Grinding Disc	156.00	1 piece	156.00
Drill Bit	200.00	1pack	200.00
Paint Brush	140.00	2 inches	280.00
Electrical Tape	140.00	1 piece	140.00
Paint	124.00	1 piece	124.00
Plywood	610.00	1 piece	610.00
PVC Pipe	216.00	2 pieces	216.00
Roof	184.00	1 piece	184.00
Welding Rod	139.00	1 Box	139.00
Arduino Uno	330.00	1 piece	330.00
Square Bar	300.00	1 length	300.00
Solar Panel	1,885.00	1 piece	1,885.00
Plastic Molding	55.00	1 length	55.00
Metal Faring	95.00	2 pieces	190.00
Solid state relay (12v)	39.00	2 pieces	78.00
DC Fan (12v)	220.00	2 pieces	440.00
Buck Converter	142.00	2 pieces	284.00
Stepper Motor (12v)	236.00	1 piece	236.00
L298N Motor Driver Controller	100.00	1piece	100.00
Photocell	55.00	1piece	55.00
Total			**₱ 6,815.00**

The table displays the summary of expenditure incurred during the production of the project which includes the cost of materials, the labor cost, travel expenses as well as the total cost spent. It can be noted that the total cost of the project was only P6,760.00

which can be considered affordable. This was since most of the raw materials used in assembling the project were recycled and were locally available. The project then can also be considered as cost-beneficial and can be utilized affordably by the community.

Table 4

Components

No.	Items	Cost(₱)
1	Cost of materials	6,760.00
2	Labor (30% of Cost of Materials)	1,328.00
3	Travel Expenses	2,000.00
	Total Cost	**₱10,088.00**

Table 5

List of Tools and Equipment

Tools	**Functions**
SCREWDRIVERS ● Philip Screws ● Flat Screws	● Use for driving screws
PLIERS ● Needle nose/Long Nose ● Diagonal/Side cutting plier ● Combination plier	 ● Use for gripping, bending, and ● Use for cutting wires ● A multipurpose tool
Hand Riveter ● Scissor	● Hand-operated tool to install blind rivets ● Use to cut
Heating Tool ● Butane Torch Flame Gun ● Soldering iron	 ● Used to melt the PVC pipe. ● Use for melting solder that is to be joined.
● Open Wrench	● Use for tightening the volts

• Saw	• Use for cutting woods
EQUIPMENT	**FUNCTIONS**
• Welding Machine	• Use to join the frames
• Tape Measure	• Use to measure the frame size
• Grinder	• Use to cut the PVC, angle, and flat bar
• Hand drill	• Use to holes
PERSONAL PROTECTIVE EQUIPMENT	**FUNCTION**
• Working Gloves	• To protect hands while making the
• Welding Gloves	• Project
• Welding Helmet/Mask	• To protect eyes from sparks and
• Goggles	• potentially vision damage.
	• To protect your eyes
• Industrial Suit	• To protect your skin from sparks
	• and sharp metals
• Shoes/Boots	• Footwear that protects your feet
• Steeltoe	• from sharp metal and sparks that

	● can damage your feet.

3.7.6 Specification of the Project

1. Power Source: 10W Solar Panel with 12V Battery Backup
2. Control Unit: Arduino Uno
3. Sensor: Rain Sensor Module, Photo cell sensor , Limit Switch
4. Actuation: Stepper Motor for clothesline movement, 12V Fan for air dryer
5. Automation: Trigger-based system using Solid State Relay (SSR)
6. Application Area: Residential outdoor clothesline
7. Mounting: Wall-based structure with protective enclosure for electronics

3.8 Functional Decomposition of the Project

1. ***Sensing and Input Layer***

Rain Detection

Raindrop Sensor detects precipitation.

Sends signal to Arduino when rain is detected.

Light Detection

When light increase, it's resistance decrease.

Send signal to Arduino when light/dark is detected

Environmental Power Input

Solar Panel collects energy from sunlight.

Charge Controller regulates voltage.

Battery stores energy for use during cloudy or night-time conditions

2. Control Layer (Processing/Decision-Making)

Microcontroller Operations (Arduino UNO)

Processes signal from rain sensor.

Decides whether to activate motor or dryer.

Programming Logic

Conditional logic: If rain is detected → retract clothesline and activate air dryer.

Controls based on real-time sensor data.

3. ***Output & Actuation Layer***

Clothesline Retraction

Stepper Motor pulls the clothesline inward when rain is detected.

Stepper Motor Driver controls direction and speed.

Drying System Activation

Air Dryer (12V fan) turns on to maintain drying despite rainfall.

Power Regulation

Buck Converter steps down voltage to suitable levels for Arduino and control electronics.

Solid State Relay

Serve as switches to activate high-power components from low-power signals.

4. Support & Structural Layer

Mechanical Framework

Provides physical support for motor, dryer, solar panel, clothesline, and wiring.

Mounting & Protection

Main Enclosure Box houses sensitive electronics.

Wall mounting system stabilizes the unit in outdoor conditions.

5. User Interaction and Feedback

Automation

No manual input required once system is active.

System automatically handles drying process based on rain detection.

User Output

Physical movement of clothesline and fan activation serve as indicators of system function.

Simplified interaction for users (especially elderly or disabled).

3.8.1 Project's Essential Integral Components with Functions

The following are the project's essential integral parts and major components along with their respective functions:

- **Arduino Microcontroller** – Serves as the central control unit that processes sensor input and manages automated system responses.
- **Rain Sensor Module** – Detects the presence of rainfall and sends a signal to the microcontroller to initiate automatic retraction and drying.
- **Photocell** – Photocell sensor senses light and changes its resistance, witch creat a signal that shows how bright or dark.
- **Switch** – Used to control the power flow manually.
- **Stepper Motor** – Mechanically retracts or extends the clothesline based on commands from the control unit.
- **Air Dryer (12V Fan)** – Provides airflow to continue drying clothes during rain or low sunlight conditions.
- **Solid State Relay** – Controls high-power components (Stepper motor and dryer) based on low-power signals from the microcontroller.
- **Solar Panel** – Converts sunlight into electrical energy to power the system sustainably.

- **Charge Controller** – Regulates the charging of the battery to prevent overcharging and ensure system stability.
- **Battery (12V)** – Stores energy from the solar panel and powers the system during cloudy or night-time conditions.
- **Mechanical Framework** – Serves as the support structure for the clothesline, sensors, and motor, and provides stability and durability.
- **Main Enclosure Box** – Houses all critical electronics, protecting them from environmental exposure and ensuring safety and accessibility.
- **Wiring and Electrical Circuitry** – Interconnects components, allowing for the transmission of data and electrical signals throughout the system.
- **Buck Converter –** Step down the voltage to levels suitable for Arduino and other components.

References

Alahmer, A., & Al-Dabbas, M. (2014).*Design and construction of a passive solar power clothing dryer.*Research Journal of Applied Sciences, Engineering and Technology, 7(4), 2785–2792.https://www.researchgate.net/publication/261877051.

Ahmed, A. G. (2013).*Prototype design and performance analysis of solar clothes dryer.* ARME Journal, 2(3), 45–52. https://armejournal.org/index.php/arme/article/view/2325

Kulkarni, P. D., Kulkarni, R. S., Patil, A. M., & Patil, P. A. (2021). *Design and implementation of IoT-based weather monitoring and forecasting system*. International Journal of Engineering Research & Technology (IJERT), 10(06), 412–416.https://www.ijert.org/design-and-implementation-of-iot-based-weather-monitoring-and-forecasting-system

Mai, R., & Swe, A. (2011).*Solar powered electric clothes dryer.* California Polytechnic State University, Senior Projects. https://digitalcommons.calpoly.edu/eesp/127/

Peng, G., Deng, S., Sharshir, S. W., Ma, D., Kabeel, A. E., & Yang, N. (2018). *High efficient solar evaporation by airing multifunctional textile.* arXiv preprint arXiv:1812.02417.https://arxiv.org/abs/1812.02417.

Rahman, M. F. S. A., Pramod, R. K., Asad, M. H., & Rafique, W. (2022, October).*Design and implementation of an automated clothes drying system with rain detection*. In

2022 IEEE International Conference on Smart Electronics and Communication (ICOSEC) (pp. 1–6). IEEE.https://doi.org/10.1109/ICOSEC55439.2022.9934222

Romero, R. V., & Romero, N. V. (2021).*Drying of washed clothing utilizing solar powered dryer.*Bulletin of Scientific Research, 2(11), 32–40.https://doi.org/10.34256/bsr2114

Shaikh, J., Shaikh, M., Mulla, M., & Shaikh, R. (2018).*Home automation system using IoT and Arduino*. International Journal of Engineering and Techniques, 5(2), 5–8.https://www.ijetjournal.org/index.php/ijet/article/view/471

Sharma, M., & Gupta, R. (2020).*Design of a solar-powered clothes dryer*.Renewable Energy and Sustainable Development, 6(2), 34–39.https://doi.org/10.21608/jesd.2020.96842

Sirsat, A. S., & Borse, R. R. (2016).*Design and development of rainwater detection system*.International Journal of Computer Applications, 140(10), 25–29.https://doi.org/10.5120/ijca2016909303

DEVELOPMENT OF AN AUTOMATIC OUTDOOR CLOTHESLINE

An Undergraduate Thesis Proposal

Presented to

The Faculty of the College of Engineering Technology
Northwestern Mindanao State College of Science and Technology
Labuyo, Tangub City

In Partial Fulfillment of the Requirement for the Degree
Bachelor of Science in Industrial Technology
Major in Electrical Technology

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APPROVAL SHEET

This Undergraduate Thesis Project entitled "**DEVELOPING RAIN DETECTOR FOR OUTDOOR CLOTHESLINE"** prepared and submitted by **Mark Saintgin Lino G. Macion et al. 2024** in partial fulfillment of the requirements for the degree of **Bachelor of Science in Industrial Technology** major in **Electrical Technology has** been examined and recommended for acceptance and approval.

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