Coconut-Based Pots with LED Grow Light and Automatic Watering System: A Sustainable and Eco-Friendly Approach to Planting

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***Abstract*: This feasibility study presents the Coconut-Based Pots with LED Grow Light and Automatic Watering System (CPLAW), an eco-friendly innovation designed to reduce the use of plastic pots through the utilization of biodegradable coconut coir. The product integrates LED grow lights and an Arduino-based automatic watering system to support healthy plant growth while minimizing human effort and water waste. The study used surveys to determine market demand and product acceptability among business owners and gardening enthusiasts. Findings revealed strong interest in sustainable and automated gardening solutions. Overall, the study concluded that the product is environmentally beneficial, marketable, and financially feasible for promoting eco-smart gardening practices.**

***Keywords*: Agriculture, Arduino, automation, automatic watering system, biodegradable materials, coconut coir, coconut husk, CPLAW, eco-friendly gardening, energy-efficient lighting, indoor gardening, LED grow light, LYCS Craft, plant growth, precision farming, smart gardening, sustainable agriculture, sustainable planting, urban farming, water conservation.**

1. Introduction

Plastic is widely used worldwide for its durability, accessibility, and lightweightness. In the Philippines, plastic is used in almost every sector because of its cheap price. According to IJNRD (2024), plastics are malleable and impact-resistant, allowing them to be molded into diverse shapes while maintaining strength, though some may deform under high temperatures. Manufacturers started utilizing plastics in their sachet products, business owners in their packaging materials, food industry in their utensils and food containers, and in car parts such as dashboards, and etc. In the day to day life of the Filipinos they opt to utilize plastic made products for it is way cheaper compared to non-plastic made products.

Due to the mass production and mass use of plastics, the Philippines is now one of the countries that generate large amounts of improperly disposed plastics. A recent material flow study revealed that significant amounts of single-use plastics in Manila Bay are not properly managed, resulting in considerable accumulation along the shorelines (Garcia et al., 2025). In 2019, the Philippines contributed 36.38% of the global oceanic plastic waste. Because of the improper disposal of plastics, the environment is now compromised.

One of the contributors to these wastes are the plastic pots. Plastic pots are often made from non-biodegradable materials and chemical components. Oftentimes, these pots are discarded and thrown away after use or if it is damaged. To address this issue, a Coconut coir pot with LED grow light and automatic watering system of Arduino can be utilized as an eco-friendly solution. The use of coconut coir extracted from coconut husk can be developed into a biodegradable pot. It can be the best alternative for plastic and expensive pots. Oftentimes, coconut husks are disposed of after the juice is extracted. Despite that, the parts of the husks are useful for it has a lot of practical use. The husk contains fiber which is known as the coconut coir that is used in making ropes and the dust which is known as the peat that is commonly used as cocopeat for soil conditioning. The dust of the coconut coir has been confirmed as a reliable biofertilizer that has a vital role in the nutrient and growth of the seedlings (Chromkaew et al., 2023). In recent studies, it was shown that the coir from coconut husk can be used and developed into natural composites, construction materials, and absorbents for metals and toxins (Stelte, Reddy, Barsberg, & Sanadi, 2023). With the help of the additional coating of papaya latex on the pot, it will have a good water barrier property that could help in making the pot water resistant. After the coconut pot has served its purpose or when it is damaged, the consumers can put it into the soil for it can also be used as fertilizer and decomposer for it is made from biodegradable materials that helps in the soil enrichment. The biodegradable coconut coir pot is an excellent material for it provides business owners and individuals with a long-lasting yet sustainable alternative to plastic pots.

Meanwhile, artificial lighting technologies such as LED grow lights have been developed to support plant growth indoors or in limited spaces. LED grow lights consume less power, have a longer lifespan, and can be scheduled to work hours thereby reducing the overall maintenance cost considerably as compared to other types of grow lights (Rahman et al., 2021). It is said that the RGB (red-green-blue) LED lighting has a big impact on plant growth, enhanced biomass accumulation, and leaf development. Automation, such as the Arduino system has also been implemented in smart farming for precision control of parameters including light intensity and time for watering plants. Arduino-based watering and climate observation setups have proven to decrease manual work while keeping the system's running properly and ensuring the output.

A Recovery Point Objective (RPO) is also considered to be utilized to ensure the consistency and reliability of the system. The RPO defines how much data can be lost before the regular saving of data is disrupted by an unexpected power outage or any other technical failure. In this project, it describes how often the Arduino system should save or back up lighting schedules, soil moisture readings, and temperature levels in its memory. With a properly set RPO, quick recovery can be made such that operations return to normal from where they were last saved. Therefore, loss of data is minimized as well as plant growth consistency maintained. Such would help perpetuate the efficiency and stability of coconut husk pot with LED grow light systems during unforeseen interruptions.

This study aims to provide an alternate product that can be utilized by busy individuals and business owners who have limited time for plant care. This innovation is a combination of convenience and sustainability without compromising the environment.

2. Methodology

A. Product Descriptions and Economic Uses

The Coconut-Based Pots with LED Grow Light and Automatic Watering System is an innovation that is made to lessen the use of plastic pots through the use of coconut coir pots made from biodegradable materials. It features a built-in light LED grow light which makes this product portable so the plants can still grow even from the indoors. In addition, it has an Arduino-based automatic watering system that is vital in the plants' photosynthesis and nutrient absorption. Basically, this product is designed to reduce manual labor in gardening through the integration of a smart and sustainable system that automates essential plant care that promotes optimal plant growth.

Furthermore, this product brings economic benefits that deliver a cost-efficient and sustainability for individuals and agripreneurs. The utilization of biodegradable coconut coir pots as a replacement to plastic pots gives benefit and support to the local coconut farmers through increased demand for their by-products of coconut coir.

The integrated LED grow light consumes less energy which reduces the electricity costs, while the Arduino-based automatic watering system ensures that no water is wasted and does not allow overwatering of the plants. This automated setup increases productivity since it allows consistent plant growth indoors or in any low-light area inside the house. This product gives opportunity for urban gardeners, plant sellers, and agripreneurs to widen their production without the need for extra labor.

Altogether, the product helps with growing plants in an eco-friendly and budget-friendly way while helping the users cut down costs.

B. Formulation of Samples

The formulation of the CPLAW product involves the combination of biodegradable coconut coir materials and electronic components for plant automation. The main materials used in the product include:

Product Name	Coconut Coir Pot with LED Grow Light and Automatic Watering System
Materials used	Coconut coir
	Cornstarch
	Vinegar
	Alcohol
	Basin
	Wooden spatula
	Container for molding
	Container for pressing
	Metal Stand
Electrical Components	LED grow light
	Arduino microcontroller
	Moisture sensor
	Mini water pump
	Power supply (adapter)
Power requirement	12 V
Dimensions for Small Pot	Length: 7 inches Width: 4 inches Height: 7inches
Dimensions for Big Pot	Length: 12 inches Width: 7 inches Height: 5 inches

Fig. 1. Product specification

C. Process and Procedures

This Standard Operating Procedure (SOP) document outlines the steps for the proper setup, operation, and maintenance of a Coconut coir pot with LED and Arduino System. This system is designed to optimize plant growth by combining three key components:

1. Coconut Coir Pot: A sustainable, biodegradable growing medium or pot and container that offers excellent aeration and water retention properties.
2. Automated Watering System: A precision mechanism that delivers water and nutrients on a scheduled or as-needed basis, ensuring consistent moisture levels and eliminating the need for manual watering.
3. LED Lighting System: An energy-efficient light

source that provides the necessary photosynthetically active radiation (PAR) spectrum, allowing for controlled and optimized growth regardless of natural light conditions.

The objective of this SOP is to provide a comprehensive guide to achieve maximum efficiency, reproducibility, and sustainable plant development within this controlled environment. Adherence to these protocols ensures the longevity of the equipment and the successful cultivation of plants.

D. Research Design and Research Instrument

This study utilized a quantitative research design to determine the market acceptability and effectiveness of the Coconut Coir Pot with LED Grow Light and Automatic Watering System. The researchers used non-probability purposive sampling to gather data from selected participants including plant hobbyists, landscapers, agripreneurs, and business owners knowledgeable about gardening products and planting systems. To collect the necessary data, the researchers utilized survey questionnaires through Google Forms. Two sets of questionnaires were prepared: one for Business-to-Business (B2B) respondents and another for Business-to-Consumer (B2C) respondents. The questionnaires focused on product awareness, gardening challenges, automation preferences, sustainability, and pricing acceptance.

Procedure Title: Making a coconut coir pot	**Authored By:**	**Date:**
	Page No(s):1/1	**Revision No:**
	Reviewed By:	
Objective: To build a firm, ready to use coconut coir pot		
Outcome: Coconut Pot		
Procedure Requirements: Raw Materials: Coconut Coir, Corn Starch, 75% Alcohol Equipment: Molder, Cooking stove, Cooking Pot, Ladle, Basin, Scissors Skills:		

Person Responsible	Process Step	Time Expended (minutes)	Remarks
Yna	Prepare all raw materials and tools needed.	10	
Yna and Sofia	Cut/Trim the coconut coir using scissors.	20	
Yna	Soak the cutted/trimmed coconut coirs to the alcohol using Basin.	30	
Yna	Sun dry the coconut coirs for 30mins	30	
Yna	Prepare the cornstarch,water, and cooking pot	10	
Yna	Put the corn starch to the water	3	
Yna	Mix the corn starch and water using cooking ladle	3	
Yna	Open the cooking stove and place the cooking pot with mixed corn starch	3	
Yna	Stir the water with corn starch continuously	10	
Sofia	Prepare the dried coconut coirs, cooked corn starch. and basin	10	
Sofia	Mix the dried coconut coirs and cooked corn starch to the basin	25	
Sofia	Prepare the pot molder/tupper ware	5	
Sofia	Put the mixed corn starch and coconut coir to the molder	15	
Sofia	Carefully mold the coconut coir with corn starch to the pot molder	25	
Sofia	Put the pot to the drying section or open area where the pot can be sun dry	10	

Fig. 2. SOP of coconut coir pot

3. Results & Discussion

A. Demographic Profile of Respondents

The survey results revealed that the majority of the respondents were female, comprising 70% of the total participants, while 13.3% were male and 16.7% preferred not to disclose their gender. This indicates that women showed greater interest in plant care and sustainable gardening products.

In terms of age, most respondents belonged to the age group of 45 years old and above, accounting for 53.3% of the respondents, followed by individuals aged 35–44 years old with 33.3%. The remaining respondents were from the younger age groups below 18 and 18–24 years old. The findings suggest that adults and middle-aged individuals are more interested in gardening and eco-friendly plant care systems.

The majority of respondents also lived in small houses with limited yard space, while others resided in apartments or condominiums with indoor gardening areas only. Some respondents had no gardening space but still expressed interest in starting indoor gardening. These findings indicate a growing demand for compact and space-efficient gardening solutions suitable for urban living environments.

Procedure Title: Assembling of Automated Plant Watering and Lighting System (using Arduino System).	**Authored By:**	**Date:**
	Page No(s):1/1	**Revision No:**
	Reviewed By:	
Objective: To build the Automated Plant Watering and Lighting System through an Arduino System.		
Outcome: Automated Plant Watering and Lighting System		
Procedure Requirements: Raw Materials: Arduino, 2 Relays, RTC, Pump, Moist Sensor, Light sensor Equipment: Soldering iron, glue gun, wire strippers, portable drill Skills: Assembling Skills, Computer Engineering Skills, Programming Skills		

Person Responsible	Process Step	Time Expended (mins)	Remarks
Lian	Checking of components	5	
Lian	Marking the locations on the box lid for the Toggle Switch, LED indicator, and on the side for the cable exit slot.	10	
Lian	Drill holes for the switch and LED. Cut/file the slot on the side of the box for the external cables (Pump, 12V power, LED Strip).	25	
Lian	Insert the Toggle Switch and LED sensor into the lid. Use hot glue on the underside to secure them firmly. Glue the Moisture Sensor Driver board to the lid.	15	
Lian	Strip the main 12V DC adapter wires. Create a "Y-split" to send power to two places: (1) The Arduino VIN/DC Jack and (2) The Relay COM ports.	20	
Lian	Solder a resistor to the Blue LED. Solder wires to the Switch and Sensor Driver board (VCC, GND, Data).	20	

Lian	Connect the Pump positive wire to Relay 1. Connect LED Strip positive wire to Relay 2. Connect the incoming 12V positive to the COM ports of both relays.	25	
Lian	Apply hot glue to the Arduino, Relay Module, and RTC Module to the base of the box.	15	
Lian	Connect logic wires (jumper cables) from the modules (Relay IN pins, RTC SDA/SCL, Sensor Analog Out) to the specific Arduino pins.	20	
Lian	Use electrical tape to bundle loose wires. Ensure no bare metal touches the Arduino board (short circuit risk).	10	
Creed	Open Arduino IDE. Install necessary libraries	10	
Creed	Upload the "DS1307/DS3231 Set Time" example sketch to sync the RTC module with your computer's current time.	5	
Creed	Upload a test sketch to read the Moisture Sensor. Note the value for "Dry Air" vs "Cup of Water." Update these values in your main code.	15	
Creed	Write/Copy the main automation logic and upload it to the Arduino.	20	
Creed	With the box open, power on the system. Manually touch the moisture probe to simulate wet/dry soil and watch if the Relay clicks and Pump activates.	10	
Creed	Close the lid carefully (don't pinch wires). Screw it shut.	5	

Fig. 3. SOP of arduino and LED

B. *Gardening Challenges of Respondents*

The study identified several common challenges experienced by respondents in maintaining plants and gardens. Most respondents reported lack of time as their primary challenge in plant care. Other major concerns included forgetting to water plants, insufficient natural light, pest control, and messiness caused by soil and water spills.

Additionally, the findings showed that most respondents preferred low-maintenance gardening systems, with nearly half of them willing to spend only 1–15 minutes daily for plant care. These results emphasize the importance of automation and convenience in modern gardening products, especially for busy individuals and urban residents.

The respondents also showed strong interest in growing edible plants and ornamental houseplants despite their limited gardening space. This demonstrates the increasing popularity of indoor and sustainable gardening practices among consumers.

C. *Acceptability of Automated Watering and LED System*

The survey findings showed that most respondents were not currently using any automated watering system for their plants. This indicates a potential opportunity for introducing innovative gardening technologies such as the CPLAW system in the market.

Most respondents also considered the integrated LED grow light system highly valuable, especially for indoor gardening and areas with limited access to sunlight. The LED grow light was viewed as an effective solution for supporting healthy plant growth while minimizing dependence on natural lighting conditions.

Furthermore, respondents stated that the automatic watering system could significantly reduce their stress related to plant care and maintenance. The majority believed that automation is the most important benefit of the product because it minimizes manual effort and allows plants to receive proper care even when users are busy or unavailable. These findings indicate strong acceptance of automated gardening technologies among consumers and support the feasibility of integrating Arduino-based automation syste*ms into sustainable gardening products.*

Table 1
Pot ingredients

Items	**Unit Cost**	**Quantity**	**Total Cost**
Basin	₱ 130.00	5pcs	₱ 650.00
Ladle	₱ 150.00	5pcs	₱ 750.00
Molder	₱ 299.00	20 pcs	₱ 5,980.00
Molder	₱ 176.00	100 pcs	₱ 17,600.00
Drying rack	₱ 687.00	5pcs	₱ 3,435.00
Cooking Stove	₱ 1,095.00	1 pcs	₱ 2,719.00
LPG	₱ 1,051.00	1 pcs	₱ 1,051.00
Cooking Pot	₱ 199.00	2pcs	₱ 398.00
Scissors	₱ 45.00	5pcs	₱ 225.00
Soldering iron	₱ 125.00	2pcs	₱ 250.00
Soldering lid	₱ 79.00	4 pcs	₱ 320.00
Soldering pump	₱ 75.00	2pcs	₱ 150.00
Airtight container	₱ 175.00	2 pcs	₱ 350.00
Total			= 33,878.00

Table 2
Arduino components

Items	**Unit Cost**	**Quantity**	**Total Cost**
Arduino Uno	₱ 194.00	130 pcs	₱ 25,220.00
Led Strip RGB(3m)	₱ 74.00	130 pcs	₱ 9,620.00
RTC Module	₱ 53.00	130 pcs	₱ 6,890.00
Soil Moisture Sensor	₱ 60.00	130 pcs	₱7,800.00
Dual Channel Relay	₱ 75.00	130 pcs	₱9,750.00
LDR Module	₱ 18.00	130 pcs	₱ 2,430.00
Toggle Switch	₱ 40.00	130 pcs	₱ 5,200.00
12V Power Supply Adapter	₱ 44.00	130 pcs	₱ 5,720.00
12V Water Pump	₱ 82.00	130 pcs	₱ 10,660.00
AWG 20 or 19 Red & Black(3m)	₱ 112.00	130 pcs	₱ 14,560.00
Waterproof Box	₱ 124.00	130 pcs	₱ 16,120.00
Rack	₱ 415.00	130 pcs	₱ 53,950.00
	1291	130 pcs	= ₱ 167,830.00

D. Consumer Preference and Pricing

The respondents expressed positive interest toward the combined features of the coconut coir pot, LED grow light, and automatic watering system. Most participants identified the combination of the biodegradable coconut coir pot and automation system as the most appealing aspect of the product.

In terms of pricing, the survey results revealed that the majority of respondents considered ₱3,500 as a reasonable and acceptable price for the complete product package. This suggests that consumers are willing to invest in eco-friendly and technology-driven gardening products that provide convenience and sustainability benefits.

The pricing strategy of the product was computed based on material costs, labor costs, and markup percentage. The LED and Arduino system with casing obtained a projected selling price of approximately ₱2,799.00, making it competitive and aligned with consumer expectations.

4. Estimated Costs in the CPLAW Production

A. Computation for Coconut Pot Cost

Table 1
Pot ingredients

Items		Supplier	Unit Cost	Quantity	Total Cost
Coconut Coir		Coconut Vendor	₱ 200.00	156 pcs (5kg)	₱ 31,200.00
Ethyl Alcohol		Shopee	₱ 165.00	78 pcs(1 gal)	₱ 12,870.00
Cornstarch		Shopee	₱ 1,230.00	14 pcs (25 kg)	₱ 17,220.00
Papaya Latex		Shopee	₱ 24.00	42 pcs (500g)	₱ 1,008.00
	TOTAL				= ₱ 62,298.00

B. Computation for Production Material Cost

Table 3 Production material

Items	Unit Cost	Quantity	Total Cost
Basin	₱ 130.00	5pcs	₱ 650.00
Ladle	₱ 150.00	5pcs	₱ 750.00
Molder	₱ 299.00	20 pcs	₱ 5,980.00
Molder	₱ 176.00	100 pcs	₱ 17,600.00
Drying rack	₱ 687.00	5pcs	₱ 3,435.00
Cooking Stove	₱ 1,095.00	1 pcs	₱ 2,719.00
LPG	₱ 1,051.00	1 pcs	₱ 1,051.00
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Scissors	₱ 45.00	5pcs	₱ 225.00
Soldering iron	₱ 125.00	2pcs	₱ 250.00
Soldering lid	₱ 79.00	4 pcs	₱ 320.00
Soldering pump	₱ 75.00	2pcs	₱ 150.00
Airtight container	₱ 175.00	2 pcs	₱ 350.00
Total			**= 33,878.00**

C. Computation for Machinery Cost

Table 4
Machinery

Items	Unit Cost	Quantity	Total Cost
Coconut Husk Decorticator	₱ 51,800.00	1 pc	₱ 71,800.00
Generator	₱ 20,000	1pc	₱ 20,000
Chaff Cutter	₱18,076.00	1 pc	₱18,076.00
Industrial hot air blower dryer	₱16,616.00	1 pc	₱16,616.00
Total			= ₱ 106,492.00

D. Computation for Office Supplies Cost

Table 5
Office supplies

Items	Unit Cost	Quantity	Total Cost
Computer	₱18,500.00	2pc	₱37,000.00
Air Conditioner	₱18,995.00	2pcs	₱37,990.00
Office Chair	₱ 370.00	4 pcs	₱ 1,480.00
Office Table	₱ 289.5	4 pcs	₱ 1,158.00
CCTV	₱ 940.00	4 pcs	₱ 3,760.00
Printer	₱ 3,818.00	1 pc	₱ 3,818.00
Water Dispenser	₱ 1,003.00	1 pc	₱ 1,003.00
Fire Extinguisher	₱ 598.00	7 pcs	₱ 1,596.00
Total			= ₱ 87,805.00

E. Computation for Total Project Cost

Table 6
Total project cost

Type of Cost	Cost
Annual Expense	₱ 3,831,216.00
Production Material	₱ 33,878.00
Machinery	₱ 106,492.00
Office Equipment	₱ 87,805.00
TOTAL	= ₱ 4,059,391.00

Table 7
Monthly expenses

Type of Cost	Cost
Pot Ingredients	₱ 62,298.00
Arduino Component	₱ 167,830.00
Stationery and Supplies Used	₱ 817.00
Miscellaneous Expenses	₱ 1,361.00
Rent	₱ 15,000.00
Electricity	₱7,000.00
Water Expense	₱1,000.00
Internet	₱ 1,000.00
Traveling Expenses	₱ 1,500.00
Freight Expenses	₱ 1,500.00
Salaries and Wages	₱ 59,280.00
Others	₱ 682.00
TOTAL	= ₱ 319,268.00

The estimated cost computation for the CPLAW Production presents the projected expenses needed for the development, production, and operation of the project. It includes the costs of pot ingredients, Arduino components, production materials, machinery, office equipment, and other monthly operational expenses. These computations were carefully prepared to determine the financial requirements of the project and to ensure that all necessary materials, tools, and resources are properly allocated. Through this cost estimation, the researchers can evaluate the feasibility, sustainability, and overall budget management of the CPLAW Production.

5. Conclusion

The Project Team has confirmed that his Sustainable Product utilizes eco-friendly nature combined with functionality by utilizing a biodegradable coconut coir container as an alternative to plastic containers. Utilizing coconut coir in order to produce the product utilizing environmentally friendly manufacturing processes and minimize plastic waste disposal. The system enables eco smart gardening while solving environmental problems and delivering sustainable answers that create economic and social and environmental advantages for Filipino people. With the addition of the LED Grow Light and Arduino system, the pot provides a consistent environment for plants to grow, eliminates some manual labor, and is convenient for people who are short on time or space such as businesses, gardeners, etc.

This feasibility study shows that the Coconut Coir Pot with LED Grow Light and Automatic Watering System maintain durability while being affordable and using minimal resources.

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