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Design and development of solar powered water sprayer: A green technology innovation

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ABSTRACT

Philippines has many people involved in agriculture and farmers being the country's backbone strengthens community and local economy. Prioritizing farmers convenience in their agricultural activity by designing and developing an innovative sprayer is the utmost priority of this research. It is for the reason that the study entitled "Design and Development of Solar Powered Water Sprayer: A Green Technlogy Innovation" was conducted to provide opportunities for small scale local farmers by reducing production costs, decreasing labor effort while contributing to sustainability. This study provides information with theoretical basis for future practical recommendations. The result shows that the development phase incorporates four distinct construction assemblies, emphasizing both functionality and durability. Through comprehensive research and testing, it was determined that the sprayer meets specific functional requirements, utilizes appropriate materials, and offers a safe and effective operational method. By following prescribed construction procedures, the sprayer can be assembled efficiently. Evaluation based on Dr. Garvin's Eight Dimensions of Quality indicates high performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality, positioning it as an innovative project. Importantly, the production cost is lower than traditional water sprayers, and its durable construction ensures a longer lifespan. Results indicate an overall weighted mean of 3.60, signifying "Most Acceptable" quality.

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INTRODUCTION

Traditional farm workers often use hand-operated sprayers or backpack-type sprayers, which require significant human effort. Operators must continually move their hands to spray the liquid contained in the heavy backpack sprayer, which causes fatigue in the back, shoulders, and hands due to its excessive weight and repetitive manual operation (Mohan *et al.*, 2014; Tewari *et al.*, 2012). Farmers in rural areas also face challenges with access to reliable and affordable electricity to power their equipment. In many low-and middle-income countries, irrigation remains costly because of expensive and inefficient pumping systems, posing a significant barrier for small-scale farmers (Burney *et al.*, 2013; Fan and Rue, 2020).

In the agriculture sector, a lot of field work such as weeding, reaping, and sowing must be carried out. Among these, spraying plays a crucial role in crop protection and productivity. Adoption of modern spraying equipment can reduce labor costs and improve efficiency, productivity, and sustainability in farming (Gupta *et al.*, 2016). Every year, millions of hand-operated sprayers are sold worldwide, but concerns remain about their quality, efficiency, and precision. Many sprayers are poorly designed or manufactured with substandard materials, making them less effective and labor-intensive (Adisa *et al.*, 2019).

Today's growing energy demand has become a global challenge, exacerbated by the ongoing energy crisis, which has highlighted the urgent need to transition from fossil fuels to renewable sources (IRENA, 2021). To address these challenges in agriculture, researchers are developing solar-powered sprayers that can reduce labor requirements and energy dependency (Kumar *et al.*, 2016). A solar-powered sprayer charges its battery during the day, allowing farmers to irrigate and spray crops without relying on costly and unreliable electricity from the grid. This not only reduces energy costs but also minimizes the carbon footprint of farming activities, providing an environmentally sustainable option (Banna *et al.*, 2020).

For these reasons, the development of solar-powered sprayers offers a promising solution to equipment failures or emergencies where traditional sprayers may not be available, as well as in areas with limited or no access to electricity. Adoption of such innovations depends on factors such as crop type, farm size, and farmers' economic resources (World Bank, 2017).

Statement of the problem

This study aims to design and develop a solar-powered water sprayer for small-scale farmers. Specifically, it seeks to answer the following questions:

1. What are the requirements for developing the sprayer in terms of:
   i. Design, and
   ii. Materials?
2. How does the sprayer perform in terms of:
   i. Voltage,
   ii. Current, and
   iii. Battery consumption?
3. What is its level of acceptability in terms of:
   i. Performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality?
4. What is the production cost of the sprayer?
5. What user manual can be developed based on the findings?

Significance of the study

This study will benefit the following:

1. Small-Scale Farmers: Provides a cost-effective, efficient irrigation solution, enhancing productivity.
2. Agricultural Instructors: Serves as an instructional tool for agro-technology subjects and hands-on learning.
3. NGOs: Supports sustainable farming and rural development initiatives.
4. LGUs: Assists in promoting accessible farming technologies for community use.
5. HEIs: Offers affordable instructional materials and project opportunities.

6. Rural Communities: Offers irrigation solutions where electricity is limited.
7. Community & School Gardens: Promotes sustainable, eco-friendly irrigation methods.
8. Agriculture Students: Enhances knowledge and practical skills in farming technology.
9. Entrepreneurs: Opens opportunities for agricultural technology business ventures.
10. Future Researchers: Serves as a reference for related studies and innovations.

MATERIALS AND METHODS

Overview of the various methodologies which were used in gathering data and analysis which are relevant to the research. The methodologies included areas such as the location of the study, the population, research method, sampling design and data collection method and its management (Fig. 1).

First, the design and concepts are outlined. Next, is the implementation of the design followed by fabrication of the Solar powered water sprayer. Then testing was done by the researcher to meet the desired outcome. If the solar powered water sprayer would require troubleshooting if there is a negative outcome as a new feature of water sprayer, it underwent the testing process again. If the solar powered water sprayer work, it would be tested by the respondents.

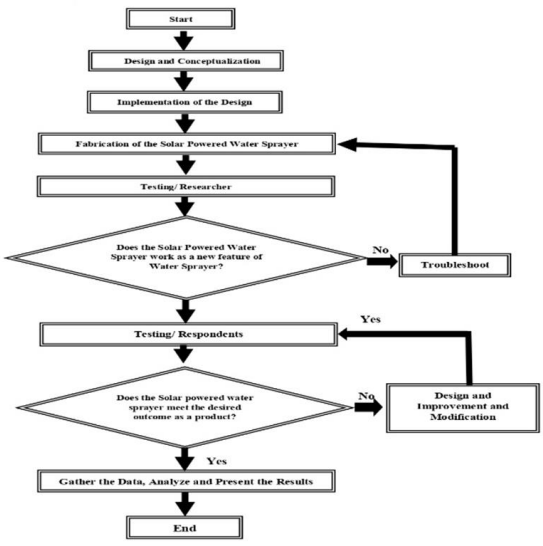

Fig. 1. Flow chart of the development process of Solar powered water sprayer

If the solar powered water sprayer does not meet the desired outcome as a product, it would go back to design improvement and modification. Solar powered water sprayer would meet the desired outcome, then the data would be gathered for analysis and presentation.

Research method

The research used the developmental type of research as a research method that has been defined as the systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet criteria of internal consistency and effectiveness. Thereafter, fabrication of the project was be done based on the specified details.

Research respondents

The respondents to participate in this study are the small-scale local farmers. The researcher distributed a questionnaire to the local farmers in the selected community of Pagadian City wherein the researcher currently resides. Upon selection of the respondents, a non-probability sampling method was used specifically a purposive sampling which were based on the judgment of the researcher when choosing who to ask to participate. The researcher chose a representative sample or specifically approach individuals with certain characteristics (Table 1).

Table 1. Distribution of total no. of respondents

Selected municipalities	No. of respondents
Danlugan	1
Ditoray	1
Tuburan	1
Santa Cruz	1
Tawagan	1
Tiguma	1
Algeria	1
Buenavista	1
Lesson Valley	1
Macasing	1
TOTAL	10

Research instruments

In order to collect the respondent views and experiences, the researcher utilized a standardized survey questionnaire of Dr. Garvin's eight dimensions

of acceptability distributed to the 10 selected municipalities of Zamboanga Sibugay.

Data gathering procedure

The goal of data-gathering is to capture quality evidence that allows analysis to lead to the formulation of convincing and credible answers to the questions. This is essential to maintain the integrity of this study. Both the selection of appropriate data collection instruments and clearly delineated instructions for their correct use reduces the likelihood of errors occurring.

This process provides both a baseline of measurement measure and in certain cases an indication of what to improve.

To gather the data, a letter of request from the Dean of the Graduate School has been prepared which then submitted to the City Hall of Pagadian City in order to ask permission from the City Mayor, Samuel S. Co to conduct a survey. The researcher was using a standardized survey questionnaire, then the questionnaire checklist has been distributed after series of performance to evaluate the acceptability of the project. The researcher had conducted the research in a selected barangay of the city through survey.

The researcher had explained to the respondents the importance of their response to the study and clarified some terms to the respondents so that they can answer it accurately and with honesty. They were also oriented by the researcher with regards to the project's functions and operating process with procedure. With this system, the researcher can collect and measure information on target variables in an established systematic way, which then enables one to answer relevant questions and evaluate outcomes.

The researcher was utilizing a purposive sampling, wherein the sampling units were selected subjectively by the researcher. In this study since the researcher goal is to determine the acceptability of the solar powered water sprayer, the researcher believes that this method is the most appropriate in choosing the sample for the research. After the respondents answer the questionnaire, the researcher collected and tallied the data for interpretation. Then the researcher interpreted the gathered data. Based on the data the researcher came up with conclusion and recommendations for this study. A Gantt chart was provided to show timelines of the progress in realizing the project.

Research environment

In this section, the researcher provided an overview of the setting, context, and conditions under which the study is conducted. This section aims to offer readers a clear understanding of the environment in which the research is situated. This research study focuses on developing the hand operated water spraying device that is presently use by the local farmers in one of the rice producing areas in the province of Zamboanga del Sur which is Pagadian City. Zamboanga del Sur's land is highly fertile, where rice, corn, coconut and rubber are consistently produced. The production of rice, corn and root crops are the main livelihood activities in the province. Another reason why Zamboanga del Sur's economy is mostly agricultural is the fact that about 3,724.82 square meters of the total land area of the province (or about 78.67%) is composed of agricultural land. With careful consideration of its resources the place is seen as feasible and suited for agricultural farming activities with its capability to grow and manage various crops and as well as raising poultry and livestock.

Statistical treatment

The ratings on the data gathering instruments were treated statistically using the average weighted mean to determine the average mean of the acceptability of the Solar Powered Water Sprayer (Table 2). The mathematical formula is written below:

$$wx = \frac{\Sigma fw}{\Sigma f}$$

Where:

$wx =$ weighted mean

Σfw = Summation of the product of the frequency and weight

Σf = total frequency

Table 2. Weighted mean interpreted using rating scale

Weight	Range	Qualitative scale	Verbal description
4	3.26-4.0	Outstanding	Most acceptable
3	2.51-3.25	Very satisfactory	Acceptable
2	1.76-2.50	Satisfactory	Less acceptable
1	1.00-1.75	Poor	Not acceptable

Fabrication procedures

The sprayer

The following are the steps in developing the sprayer:

1.Draw the working drawing

1.1 Orthographic projection

1.2 Isometric view

1.3 Exploded view

2. Lay out the specific measurement of the flat bar as to its specific dimension.

3. Cut the lay-outed measured flat bar using angle grinder.

4. Weld the cut flat bar to form the base and foundation of the sprayer.

5. Drill the cut flat bar using hand drill

6. Mount the angle bar using rivets

7. Apply black paint to the angle bar

8. Assemble the pack bag foundation of the sprayer.

9.Mount a shelf bracket for the water gallon

10. Fasten the shelf bracket using rivets

11. Mount a shelf bracket for the solar panel

12. Fasten the shelf bracket using rivets

13. Mount a Velcro straps at the angle bar to hold the water bottle in place

14. Mount a pre-handed made backpack straps at the angle bar

15. Mount the electrical components

16. Wrap a spaghetti tube for visible electrical wiring

17. Connect all electrical wiring connection following the electrical diagram.

RESULTS AND DISCUSSION

The detailed presentation of the results of the study in textual and tabular form. Discussions of data analysis and interpretation were presented in specific headings based on the statement of the problems in the study.

Design

The design is presented using an Orthographic Drawing Pictorial Drawing, Isometric Drawing and Exploded Drawing. Each drawing presents different angles and perspectives of the various parts of the solar powered water sprayer with respective annotations and labels. Electric wiring diagram and block diagram is also presented in order to show how the sprayer operates. Table 3 presents the materials used for the water sprayer fabrication: electrical tape, gasket sealant (silicone gasket), spray paint (Pylox black no. 47), welding rod #1613, Battery Sealed Lead Acid (12V9AH/20HR) NP9 -12, Charge controller (12V /24V/ 5V Dual USB), Liquid Tank/Container (8L), Water Pump Motor (12V, 2 Amp. 3.5 L/Min), Spray Nozzle (dual) and the Solar Panel (30watts) 16 ½”x11” (Fig. 2-6).

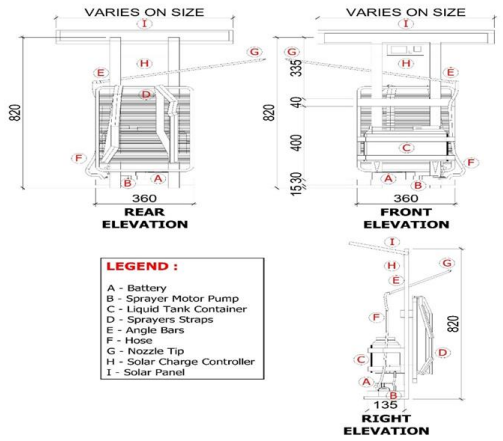

Fig. 2. Orthographic drawing

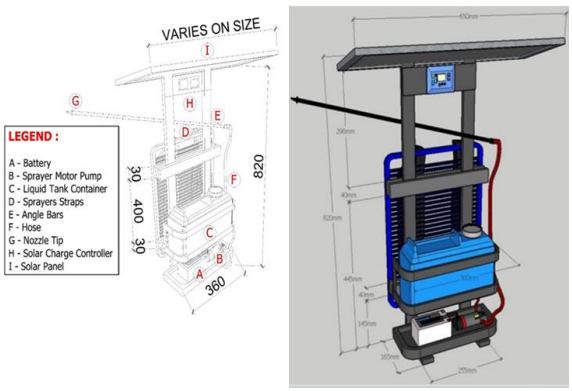

Fig. 3. Isometric drawing

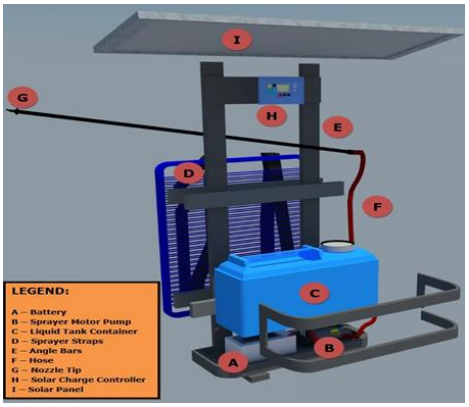

Fig. 4. Exploded drawing

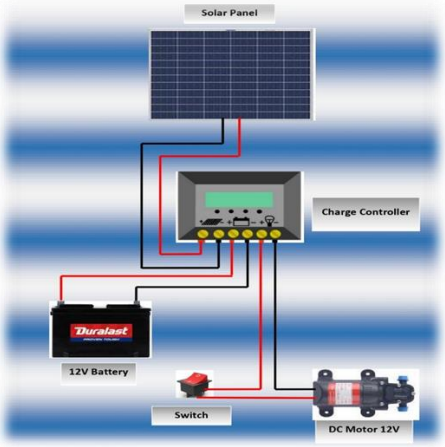

Fig. 5. Electrical wiring diagram

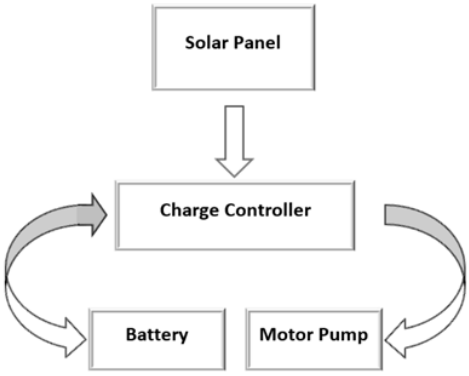

Fig. 6. Block diagram

Solar panel performance

In order to show how the Solar Powered Water Sprayer operates, the inputs and outputs of various stages, electricity and materials flow through it, a block diagram is a must to be designed. This block diagram is composed of different shapes and lines showing the components of process or system of the Solar Powered Water Sprayer that is related to and depends upon one another (Fig. 7).

Table 3. Materials

Materials
1. Electrical Tape (17mm x 20mm)
2. Gasket Sealant (silicone gasket)
3. Spray Paint (Pylox black no. 47)
4. Welding Rod #1613
5. Battery Sealed Lead Acid (12V9AH/20HR) NP9 -12
6. Charge controller (12V /24V/ 5V Dual USB)
7. Liquid Tank/Container (8L),
8. Water Pump Motor (12V, 2 Amp. 3.5 L/Min)
9. Spray Nozzle (dual)
10. Solar Panel (30watts) 16 ½”x11”

Based on the results in Fig. 7, the performance of the 30 W Solar Panel for three (3) days monitoring depicts that it produces an average of 12.2 Volts, 1.75 Amperes Current and 21.3 watts of power. Based on the recorded data using DC Multi-meter, it implies that the solar powered food cart is more advantageous over solar energy.

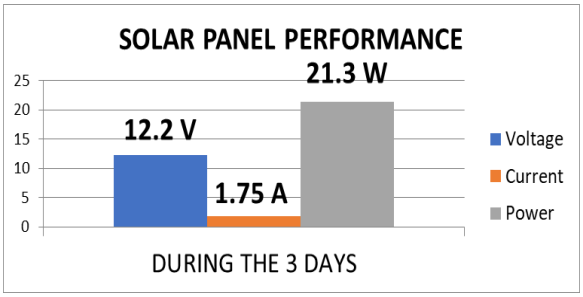

Fig. 7. Solar panel performance

Fig. 8 represents voltage level in volts (V) of the bat6ttery during the three (3) day testing. The battery takes an average of six (6) hours to fully charge using the 30W Solar Panel. It is based on the recorded data using the DC voltmeter.

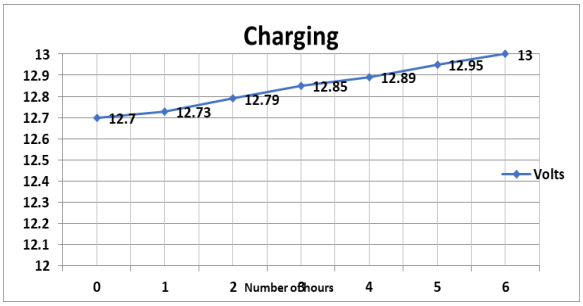

Fig. 8. Charging

The load current of the total loads is displayed Amperes (A) in this chart. It is predicated on the data that was captured using DC ammeter (Fig. 9).

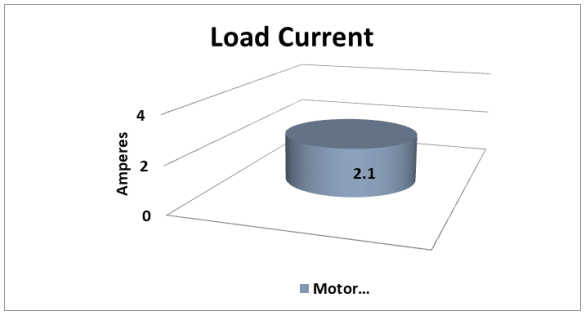

Fig. 9. Load current

This chart shows the battery consumption with an average of six (6) hours a day, it is found out that the device can last up to four (4) days with the average usage of six (6) hours a day without charging. It is based on the recorded data using the Battery Analyzer (Fig. 10).

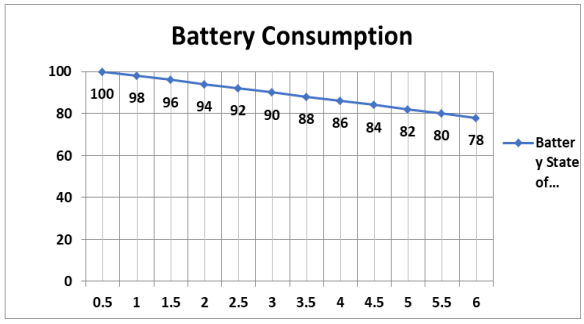

Fig. 10. Battery consumption

The chart shows the battery's voltage level in volts (V) over the course of one-day test, with an average time of six (6) hours. It is predicated on the data using the DC voltmeter while the solar panel is unplugged (Fig. 11).

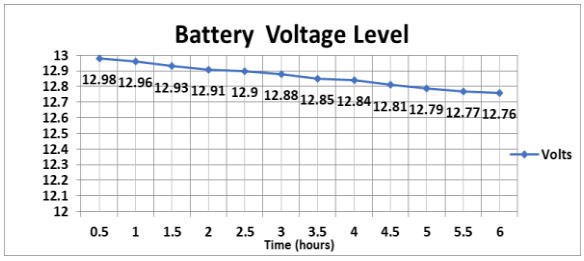

Fig. 11. Battery voltage level

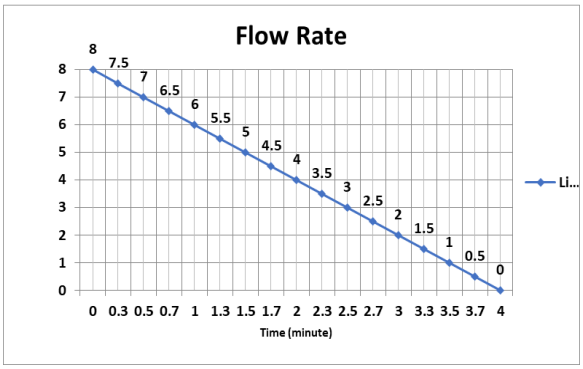

Fig. 12. Flow rate

This dataset assumes a linear relationship between time and volume transferred, where one liter is transferred each minute. With this data, the x-axis represents time in minutes and the y-axis represents the volume transferred in liters (Fig. 12).

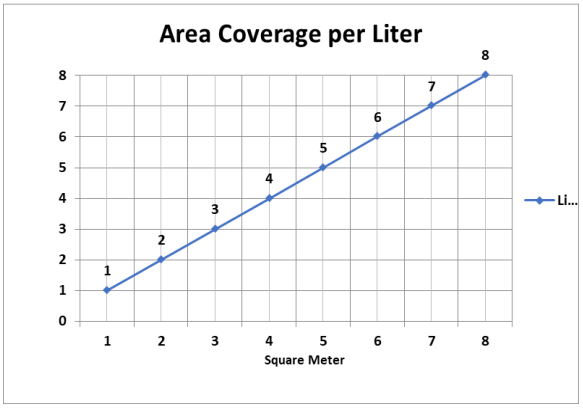

Fig. 13. Area coverage per liter

The graph shows relationship between sprayer and square meter coverage, x-axis indicate the liter of sprayer and square meter coverage on the y-axis. As the spray per liter increases the square meter coverage is increase as well. The graph shows a positive correlation (Fig. 13).

Level of acceptability

Presents the level of adaptability along performance. A look at the table revealed that the solar powered water sprayer was easy to operate and portable with the average weighted value of 3.80 falls on the most acceptable level. This means that the solar powered water sprayer can be moved and easy to carry from one place to other places (Table 4).

Table 4. Level of acceptability of the solar powered water sprayer along performance

Items	AWV	D
1. Easy to operate and portable	3.80	MA
2. Solar power supply	3.56	MA
3. Sufficient electricity supply	3.72	MA
Mean	3.69	MA

The solar power supply and sufficient electricity supply were rated by the respondents as 3.56 and 3.72 respectively. These average weighted values fall under the most acceptable category. This means that the solar power and electricity supply are evidently observed in the water sprayer.

As a whole, the mean of 3.69 signifies that the performance of solar powered water sprayer was very adaptable. This means that the performance of the solar powered water sprayer is satisfactory.

The solar-powered sprayer industry has recorded a steady growth rate of 9.9% since 2018. Known for their easy usability in watering gardens and rice fields, cost-effective water sprayers are increasingly becoming solar-powered to meet both agricultural and business energy needs (NCC, 2022).

Table 5. Level of acceptability of the solar powered water sprayer along features

Items	AWV	D
1. Breaks liquid into droplets of effective size	3.78	MA
2. High flow rate	3.62	MA
3. Zero carbon emission	3.59	MA
Mean	3.66	MA

Table 5 presents the level of acceptability of the solar powered water sprayer along features. As seen in the table revealed that the water sprayer powered by solar panel was found to be very adaptable to the public. This bears the mean of 3.78, this means that the solar powered watered sprayer contained breaks liquid into droplets of effective size with high flow rate and zero carbon emission that might cause pollution in the environment.

The findings implied that the solar powered water sprayer can help people especially those who are engaging the business and agriculture al products due to its very acceptable features to the clienteles.

A solar-powered water sprayer promotes quick delivery services to customers engaged in agricultural activities. It is also an excellent option for entrepreneurs who wish to start a business but have limited capital for a traditional brick-and-mortar establishment (AsiaLink Finance, 2023).

Table 6. Level of acceptability of the solar powered water sprayer on reliability

Items	AWD	D
1. Rigid design	3.22	A
2. Stable during Operation	3.48	MA
3. Efficient in controlling pests	3.45	MA
Mean	3.38	MA

Table 6 reflects the level of acceptability of the solar powered water sprayer long reliability. The mean of 3.38 manifests that the newly fabricated solar powered water sprayer was very acceptable to the customers. It has rigid design that attracts costumers with stable operations and efficient in controlling pests. This means that in terms of reliability of the solar powered water sprayer had a very good impact to the customers.

The solar-powered water sprayer cart business is considered one of the most successful small enterprises in the Philippines. This type of business is gaining popularity among entrepreneurs because it is easily manageable, requires minimal capital, is simple to set up, and carries a relatively low risk of business failure (Subong Espina, 2021).

Table 7 shows the level of acceptability of the solar powered water sprayer along conformance. As shown, a presence of variability of renewable energy resources has an average weighted value of 3.52, falls on the most acceptable category. This means newly developed products by the researchers, a renewable energy sources that are needed in the full operation of the business.

Table 7. Extent of adaptability of the solar powered water spray along conformance

Items	AWV	D
1. A variability of renewable energy source	3.52	MA
2. User friendly	3. 62	MA
3. Environmental friendly	3. 62	MA
Mean	3.59	MA

The rest of the items were rated as most acceptable with the average weighted value of 3.62 and 3.62 respectively. This means that the solar powered water sprayers was user and environmental friendly so that no one would be damaged on the chemicals placed in the sprayers. This is observed in the business like this solar powered performance water sprayer.

This environmentally friendly solar power sprayer is a requirement of the city like Pagadian to maintain clean and sanitized environment to avoid harm and damages to the constituents.

As a whole the mean of 3.59 was described as most acceptable. This means that the developed solar powered water sprayer was following the standard of a business. It bears the capability to conform the highest standards of the services in the city that is understudy.

Table 8. Extent of adaptability of the solar powered water sprayer along durability

Items	AWV	D
1. Materials are in good condition	3.52	MA
2. Well-built and designed	3.55	MA
3. Free from defects	3.58	MA
Mean	3.55	MA

Safety and standards authority is mandated with disseminating evidence-based standards in conformance with standard for business industry and matters connected to best result of the solar powered water sprayer. Hence this study was conducted to ascertain the conformance of the farmers who are using the product (Subong Espina, 2021).

Table 8 presented the solar powered water sprayer along durability. The computed mean was 3.55 falls on the most acceptable category. This means that the newly developed solar powered that the newly powered water sprayer was found to be much durable due to the materials which are in good conditions, well-built designed and free from defects.

This implied that developing solar powered water sprayer must consider its standard so that the users and clienteles must be hassled free. The strengths for the business might include a unique product offering, strong customer loyalty and a durable solar powered water sprayer with well-established brand reputation (Subong Espina, 2021) further, unlike traditional water sprayer that are limited to a specific location, solar power have the advantage to move to different areas and places. This allows them to reach a wider customer based and take advantage of new opportunities.

Table 9. Extent of adaptability of the solar powered water sprayer along serviceability

Items	AWV	D
1. Ease of repair	3.62	MA
2. Materials are available locally	3.89	MA
3. Maintenance is simple	3.91	MA
Mean	3.81	MA

Table 9 presents the adaptability of the solar powered water sprayer along serviceability. It was found out that the computed mean was 3.81 belonged to the most acceptable categories. This means that solar powered water sprayer is easy to repair and materials are available locally. It is implied further that the newly developed solar powered product is much serviceable.

Serviceability can be seen in the durability with which the product can be put into service when it breaks down, as well as the competence and the behavior of the service person.

Besides, a product which is considered serviceable is of good quality being able to provide good service. It is a fact that the new developed solar powered water sprayer be usable (Subong Espino, 2021).

Table 10 shows the level of acceptability of the solar powered water sprayer along aesthetic. As shown in

the table revealed that all items were rated as very acceptable. This was supported with the mean of 3.35 which described as most acceptable.

Table 10. Extent of adaptability of the solar powered water sprayer along aesthetics

Items	AWV	D
1. Comes with different type of nozzles	3.55	MA
2. Well – crafted	3.48	MA
3. Less vibration	3.01	A
Mean	3.35	MA

This finding implied that the newly developed solar powered water sprayer comes with different type of nozzles, well-crafted and less vibration. Therefore, this solar powered water sprayer as to aesthetics was outstanding.

Aesthetics is a love design principle that defines a design pleasing qualities. In visual terms aesthetics include factors such as balance, color movement, pattern scale, shape and visual weight. Designers use aesthetics to complement their designs usability, and so enhance functionality with attractive layouts (Subong Espina, 2021).

Table 11. Extent of adaptability of the solar powered sprayer along perceived quality

Items	AWV	D
1. Skillfully constructed	3.60	MA
2. Durable	3.78	MA
3. Easy to assemble and disassemble	3.90	MA
Mean	3.52	MA

Table 11 presents the level of acceptability of solar powered water sprayer along perceived quality. It can be seen in the table the computed mean was 3.52 indicated that the perceived quality of the products was very acceptable to the public especially the homes owners the farmers, planters, etc. This means that product was designed professionally, skillfully constructed, durable and easy to assemble and disassemble.

Perceived quality is the quality of a product service according to the customers perception. It is a subjective criterion and does not have to coincide with actual or objective quality, which is based on tangible data such as raw materials, manufacturing process, warranty or after-sales service. Further, perceived quality of a product or service based on individual experiences and expectations. It is a critical aspect of product development and is important to the competitive products industry. Overall, it is a subjective evaluation that plays crucial role in the success of product design and customer satisfaction. This can vary among different individuals and it is influenced by the factors such as durability designs, materials and new technologies.

Extent of acceptability

Table 12 shows the summary on the level of acceptability of the solar powered water sprayers. As shown all indicators were rated by the respondents as most acceptable. It bears a general mean of 3.60 describes as most acceptable. This means that the newly developed solar powered water sprayer was very acceptable to the customers of Pagadian City.

Table 12. Summary table on the extent of acceptability of solar powered water sprayer

Indicators	Mean	**D**
Performance	3.69	MA
Features	3.66	MA
Reliability	3.38	MA
Conformance	3.59	MA
Durability	3.55	MA
Serviceability	3.81	MA
Aesthetic	3.35	MA
Perceived Quality	3.76	MA
Gen. Mean	3.60	MA

Garces (2016) emphasized that evaluating and improving product acceptability is an important step to minimize the risks associated with new products not being accepted in the market. Existing approaches often fail to integrate key features of acceptability. The proposed method highlights evaluation based on users' concept perception, considering factors such as performance, features, reliability, conformance, durability, aesthetics, and serviceability of the products.

Production cost

The cost of the materials in the fabrication of the Solar Powered Water Sprayer was based on the actual

expenditures spent, for the supplies and materials a total of Php 3,403.00, and for the labor cost, which was twenty percent (20%) of the total cost of supplies and materials, Php. 608.60, and miscellaneous charges, which accounted for 5% of the total cost of supplies and materials, totaled Php. 170.15, and the total cost of fabrication was PHP. 4,253.75 (Table 13).

Table 13. Production cost

Source of cost	Cost per source
Supplies and Materials	Php. 3,403.00
Labor Cost (20% of the total cost of supplies and materials)	Php. 680.60
Miscellaneous expenses (5% of the total cost of supplies and materials)	Php. 170.15
Total Cost of Production	Php. 4,253.75

User manual of the solar powered water sprayer

Capabilities

Solar-powered operation: The water sprayer is equipped with a solar panel that harnesses sunlight to power its operation. This feature ensures eco-friendly and sustainable usage without relying on conventional electricity sources.

Portability and mobility: This design allows for easy carrying on the user's back, enabling mobility and flexibility during watering tasks. This feature is particularly advantageous for large gardens, agricultural fields, or landscaped areas where flexibility is essential.

Easy to install: The compact and lightweight design of the sprayer makes it easy to install and move around as needed. Whether it's for a backyard garden, a greenhouse, or a landscaping project, users can set up the sprayer with ease.

Water conservation: With its precise watering capabilities, the sprayer helps conserve water by delivering the right amount directly to the root zone of plants, minimizing wastage and promoting efficient water usage.

Low maintenance: Solar-powered water sprayers typically require minimal maintenance, thanks to their durable construction and efficient design. Regular cleaning and occasional battery checks (if applicable) are usually all that's needed to keep the device running smoothly.

Adjustable pressure control: Some models may include adjustable pressure control settings, allowing users to regulate the spray pressure based on the type of vegetation or surface being watered. This feature ensures precise water delivery and minimizes water wastage.

Adjustable spray nozzles: The sprayer is equipped with adjustable spray nozzles, allowing users to customize the spray pattern and intensity according to specific watering requirements. Whether it's a fine mist for delicate plants or a concentrated stream for thorough irrigation, the knapsack sprayer offers versatility in application

Durable and Weather-Resistant Construction: Solar water sprayers are often constructed from durable materials such as metals, ensuring longevity and reliability in various weather conditions. This well-built quality makes them suitable for outdoor use in harsh environments.

Adequate capacity: Typically, this water sprayers feature a sizable water reservoir capacity, enabling extended operation without the need for frequent refills. This capability is beneficial for covering plenty areas or completing intensive watering tasks without interruptions.

Environmentally friendly: By harnessing solar energy for operation and promoting water conservation, the sprayer aligns with eco-friendly practices, contributing to a greener and more sustainable environment.

Versatile applications: Apart from watering plants, the sprayer can be used for various other applications such as cleaning outdoor surfaces, controlling dust, or even as a misting system for cooling purposes.

Hands-free operation: The hands-free design of the knapsack sprayer allows users to carry out other tasks

while watering, providing convenience and efficiency during operation. This feature is especially useful for agricultural professionals or gardeners managing multiple tasks simultaneously.

Integrated filtration system: This filtration mechanism helps maintain optimal performance and prolongs the lifespan of the sprayer.

User-friendly controls: The sprayer typically features user-friendly controls and indicators for easy operation and monitoring. This includes buttons or knobs for adjusting spray settings, battery level indicators, and solar charging status indicators for efficient management.

Multi-purpose functionality: In addition to watering plants or crops, the knapsack water sprayer can be used for various applications such as pesticide or herbicide application, foliar feeding, or general cleaning tasks in agricultural, horticultural, or industrial settings.

Battery: By directly connecting the battery to the battery terminals of the charge controller, it would be charged by the solar panel.

Battery type: The SPS-300 is equipped with a 12V, 9Ah sealed lead-acid battery.

Battery capacity: The battery has a capacity of 9Ah (ampere-hours), providing sufficient power for extended operation between charges.

Charging: The battery is charged using the integrated solar panel. Ensure that the solar panel receives direct sunlight for optimal charging efficiency. A full charge typically takes 8-10 hours under direct sunlight.

Charging indicator: During charging, a LED indicator light would illuminate to indicate the charging process. Once fully charged, the LED light would turn off automatically.

Battery life: With proper care, the battery can provide reliable performance for several years. However, it's essential to monitor battery health periodically. If you notice a significant decrease in battery capacity or performance, it may be time to replace the battery.

Storage: If the sprayer would not be used for an extended period, store it in a cool, dry place. Before storing, ensure the battery is fully charged. Periodically check the battery charge during storage and recharge as needed to maintain optimal performance.

Environmental considerations: Sealed lead-acid batteries should be disposed of properly according to local regulations. Do not incinerate or expose the battery to extreme heat, as this may cause it to rupture or leak hazardous chemicals.

Safety precautions: Avoid overcharging: Do not leave the sprayer connected to the solar panel for extended periods once the battery is fully charged. Overcharging may reduce the battery's lifespan.

Do not disassemble: Do not attempt to disassemble the sprayer or remove the battery unless instructed by authorized personnel. Disassembling the unit may result in damage or injury.

Keep away from water: While the sprayer is designed for outdoor use, avoid exposing the battery to water or moisture. Water damage can lead to malfunction or electrical hazards.

Children and pets: Keep the sprayer and its components out of reach of children and pets. The battery and other small parts may pose a choking hazard.

Troubleshooting

Battery not charging: If the battery is not charging, ensure that the solar panel is exposed to direct sunlight. Check for any obstructions that may be blocking sunlight. If the issue persists, contact customer support for assistance.

Reduced battery life: If you notice a significant decrease in battery life, it may indicate that the battery needs replacement. Contact customer support for information on purchasing a replacement battery.

Battery overheating: If the battery becomes hot to the touch during charging or operation, immediately disconnect the sprayer from the solar panel and allow it to cool down. Overheating may indicate a malfunction and should be addressed promptly.

Operating procedure of the solar powered water sprayer

In order to maintain the effectiveness of the Solar Powered Water Sprayer and prevent injuries during its operation, procedure and instruction should be carefully followed.

The following steps and procedures are to be carefully observed:

1. Initial setup

a. Assembly: Assemble the components of the sprayer according to the instructions provided in the assembly manual.

b. Solar Panel Placement: Position the solar panel in an area that receives ample sunlight throughout the day. Ensure there are no obstructions blocking sunlight from reaching the panel.

2. Charging

a. Sunlight Exposure: Place the sprayer in an outdoor location where the solar panel can receive direct sunlight.

b. Charging Indicator: Monitor the LED charging indicator light on the sprayer. It illuminates during charging and turns off automatically when the battery is fully charged.

c. Charging Time: Allow the sprayer to charge for 6-8 hours under direct sunlight for optimal performance.

3. Filling the tank

a. Water Source: Fill the sprayer tank with clean water from a suitable source such as a tap or hose.

b. Optional Additives: If desired, add gardening or cleaning additives to the water according to the manufacturer's instructions.

4. Operation

a. Power On: Switch on the sprayer using the power button or switch located on the control panel.

b. Adjust Settings (if applicable): Depending on the model, adjust the spray pattern, pressure, or other settings to suit your specific needs.

c. Spraying: Direct the spray nozzle towards the area you wish to water or clean. Press the trigger or activate the spray mechanism as per the sprayer's design to initiate spraying.

5. Post-operation

a. Power Off: Once you have finished using the sprayer, switch it off using the power button or switch.

b. Cleaning: Rinse the tank and spray nozzle with clean water to remove any remaining liquid or residue. Ensure the sprayer is clean and free from debris before storage.

6. Maintenance

a. Battery Care: Monitor the battery charge regularly and recharge as needed to maintain optimal performance. Avoid overcharging the battery.

b. Cleaning and Inspection: Periodically clean the solar panel to remove dust or debris that may obstruct sunlight. Inspect the sprayer for any signs of damage or wear and address any issues promptly.

7. Storage

a. Dry Storage: Store the sprayer in a cool, dry place when not in use to prevent damage from moisture or extreme temperatures.

b. Battery Maintenance: If storing for an extended period, ensure the battery is fully charged before storage and periodically check the charge level during storage.

8. Safety precautions

a. Children and Pets: Keep the sprayer and its components out of reach of children and pets to prevent accidents or injury.

b. Water Safety: Avoid spraying water directly onto electrical components or outlets to prevent electrical hazards.

c. Proper Use: Use the sprayer only for its intended purpose as outlined in the user manual. Do not modify or tamper with the sprayer's components.

Maintenance

In order to maximize the full performance of the Solar Powered Water Sprayer.

The following steps should be strictly observed.

1. Regular cleaning

After each use, clean the sprayer thoroughly with clean water to remove any dirt, debris, or residues that may accumulate. Pay particular attention to the tank, nozzle, hose, and filter.

2. Inspect for damage

Periodically inspect all components of the sprayer for signs of wear, damage, or leaks. Check the tank, hose, connections, and spray nozzle for cracks, punctures, or deterioration. Replace any damaged parts promptly.

3. Battery maintenance

Monitor the battery regularly to ensure it is adequately charged for operation. Avoid overcharging the battery and keep it clean and dry. If storing the sprayer for an extended period, fully charge the battery before storage and disconnect it from the system if possible.

4. Solar panel care

Keep the solar panel clean and free from dust, dirt, or debris that may hinder sunlight absorption. Regularly wipe the solar panel with a clean, damp cloth to maintain optimal charging efficiency.

5. Pump lubrication (if applicable)

If your sprayer includes a pump mechanism, lubricate it according to the developer's recommendations. Use a suitable lubricant to ensure smooth operation and prevent friction-related wear.

6. Filter maintenance

Clean or replace the sprayer's filter regularly to prevent clogs and ensure consistent water flow. Remove any debris or sediment that may have accumulated in the filter.

7. Storage preparation

Before storing the sprayer for an extended period, clean and dry it thoroughly. Store the sprayer in a cool, dry place away from direct sunlight and extreme temperatures. Consider removing the battery and storing it separately in a cool, dry location.

8. Periodic testing

Conduct regular functionality tests to ensure all components of the sprayer are functioning correctly. Test the battery charge, pump operation, spray nozzle, and any other relevant features.

9. Guidelines

Refer to the instructions and guidelines provided with the sprayer for specific maintenance recommendations. Adhere to these guidelines diligently to ensure proper care and maintenance.

10. Seasonal check-up

Before the start of each season, perform a thorough check-up of the sprayer to ensure it is in good working condition. Clean any dirt or debris that may have accumulated during storage and check for any signs of wear or damage.

Contraindications

Maintenance requirements: While solar-powered sprayers generally require less maintenance compared to fuel-powered sprayers, they still require

regular upkeep. This includes cleaning the solar panel, checking the battery, and ensuring all components are in good working condition. Farmers who are unable to dedicate time to maintenance may find this challenging.

Sunlight dependence: Solar-powered sprayers rely on sunlight to charge their batteries. Therefore, their effectiveness may be limited on cloudy days or in areas with limited sunlight. Farmers operating in regions with frequent cloud cover or during the rainy season may not fully benefit from the solar-powered functionality.

Battery lifespan: The lifespan of the battery in a solar-powered sprayer is finite and may degrade over time with repeated charging cycles. Replacing the battery can be an additional expense for farmers, especially if it needs to be done frequently.

Limited capacity: Knapsack sprayers typically have limited tank capacity compared to larger, tractor-mounted sprayers. This means that farmers may need to refill the tank more frequently, which can be time-consuming and inefficient, especially for larger farms.

Skill and training: Operating a knapsack solar-powered water sprayer requires some level of skill and training. Farmers who are unfamiliar with the technology may require training to ensure they use the sprayer correctly and efficiently.

Not suitable for all crops: While knapsack sprayers are versatile and can be used for various crops, they may not be suitable for all types of crops or farming practices. Certain crops or farming methods may require specialized equipment that a knapsack sprayer cannot provide.

Limited reach: Knapsack sprayers have a limited reach compared to larger, tractor-mounted sprayers. This means they may not be suitable for large-scale farming operations or for crops that are planted over vast areas.

Risk of theft or damage: Solar-powered equipment may be at risk of theft or damage, especially if left unattended in remote or insecure areas. Farmers need to take appropriate measures to secure their equipment when not in use.

Safety measures: Implementing safety measures for a solar-powered water sprayer is crucial to ensure user protection and efficient operation. Here are some key safety measures to consider:

Training and instructions: Comprehensive training to users on how to operate the sprayer safely is a must. This includes assembly, charging, refilling, and maintenance procedures.

Protective gear: Users should wear appropriate protective gear such as gloves, goggles, and long-sleeved clothing to prevent contact with chemicals, sun exposure, and potential debris.

Chemical handling: If the sprayer is used for applying chemicals, ensure users understand the proper handling and storage of chemicals. Clear instructions on dilution ratios, compatible chemicals, and safety precautions when handling pesticides or other substances should be provided.

Solar panel safety: Educate users on the safe handling and maintenance of the solar panel. Advise against tampering with the panel or exposing it to excessive force or extreme weather conditions that could cause damage.

Water source safety: Ensure that users only fill the sprayer with clean water from a safe source. Discourage the use of contaminated or untreated water to prevent health risks.

Leak detection: Promptly repair any leaks to prevent chemical spills or damage to the equipment.

Emergency response plan: Provide users with access to emergency contact numbers and first aid supplies so as procedures on how to handle accidents, spills or injuries related to the sprayer.

Regular maintenance: Schedule regular inspections and maintenance checks for the sprayer to identify and address any potential safety hazards or mechanical issues promptly.

Child safety: If the sprayer is accessible to children, storing the sprayer in a secure location out of reach of children.

Weather consideration: Farmers should avoid operating the sprayer in adverse weather conditions such as strong winds or lightning storms, which could compromise safety and effectiveness.

By incorporating these safety measures into the design, operation, and maintenance of the solar-powered water sprayer, it can help minimize risks and ensure safe and effective use.

Conclusion

The project is innovated and improved from the water sprayer in Pagadian City through its features and designs. Based on the requirements in developing the solar powered water sprayer, it was concluded that: It features specific functions and demonstrates full functionality. It is well equipped in terms of materials needed. It provides a safe and effective method of demonstrating the operating principles. The solar powered water sprayer can be developed through assembling of all the materials needed, following the required construction procedure. All Dr. Garvin's Eight Dimensions of Quality shown in the findings are present in the solar powered water sprayer and are very acceptable in terms of performance, features, reliability, conformance, durability, serviceability, aesthetic and perceived quality as innovation project. The production cost of solar powered water sprayer is lower than the ordinary commercialized water sprayer. It would last longer because of their material used that makes it durable.

RECOMMENDATIONS

The following recommendations were made based on the results of the study:

1. The administration or the Local Government of Pagadian should be encouraged to allocate funds to mass produce this project so that other small scale local farmers specifically in Pagadian City can avail of its usefulness.

2. The solar powered water sprayer must be improved continuously through enhancing its features and design to attain durability and better quality.

3. It is strongly recommended that the Eight Dimensions of Quality by Dr. Garvin would be followed strictly when using the solar powered water sprayer to attain its acceptability.

4. Windshield washing motor can be an alternative motor to be used.

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