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SOLAR-HYDRO AUTOMATED WATER SPRINKLER

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ABSTRACT

The main objective of this study is to develop a new technology that can help individuals to lessen their task work caused by manually operated systems. Also this study aims to construct and develop an automated watering system that needs almost no human intervention. The Developmental Method of research was utilized in this study to gather information and data needed in the construction of the prototype. The researchers made use of questionnaires using the Likert Scale format; the said questionnaires were given to selected farmers, gardeners, electricians, technicians, ICT programmers, teachers and engineers. This study aims to: (1) To determine the acceptability of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of style and design, performance, cost efficiency and accessibility. (2) To determine the effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of functionality, usability, purpose and safety as evaluated by two groups of respondents, (3) To determine the significant difference on the level of acceptability and effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino as evaluated by two groups of respondents. Based on the findings, in terms of style and design, performance, cost efficiency and accessibility, the level of acceptability of Solar-Hydro Water Sprinkler acquired as an high acceptable in response to its main goal.Based on the findings, in terms of functionality, usability, purpose and safety, the level of effectiveness of Solar-Hydro Water Sprinkler acquired as an high acceptable in response to its main goal.

1. INTRODUCTION

Water is exceptionally basic. It is considered to be essential require of human being, animals, plants etc. Plants are too fundamental to human life. The food that all of the living things eat, pharmaceutical, fiber which can be manufactured to fabric and clothing can also be provided by plants. But people must consider such potential situations in watering the plants such as watering too much, too little and of course, just enough for it to sustain and maintain the plant growth. Because keeping your plant properly watered is important to its health.

And Philippines being one of the numerous agrarian lands within the world, it is important that Filipinos farm using progressed innovations because it will significantly impact not just the amount of gathered crops but moreover the time went through by the agriculturists will definitely reduce since of these technologies.

In this research, the researchers aim to develop a tool which may help people who like to plant and take care of a mini garden at home. It also helps the community to reduce their bill in electricity and lessen their work. The device will also automatically be turned off when the sensor detects if the amount of water on the soil was already enough to avoid over watering and water overconsumption. It helps gardeners to minimize the time they need to water plants every schedule. All in all, the researchers consider gardening in a convenient and fast way through this tool that helps water the plants automatically.

2 OBJECTIVES

The main objective is to design and develop Solar and Hydro Automated Water Sprinkler with Soil Moisture Sensor Using Arduino that will contribute water conservation and minimize the labor in the field of gardening.

Specifically, the study aims to:

1. To determine the acceptability of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino as evaluated by two groups of respondents in terms of:
   - 1.1 Style and design
   - 1.2 Performance
   - 1.3 Cost Efficiency and,
   - 1.4 Accessibility
2. To determine the effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino as evaluated by two groups of respondents in terms of:
   - 2.1 Functionality
   - 2.2 Usability
   - 2.3 Purpose and,
   - 2.4 Safety
3. To determine the significant difference on the level of acceptability and effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino as evaluated by two groups of respondents.

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3. METHODOLOGY

In this study, the developmental research approach for instructional technology was used, in which the research was combined in the development process (Ritchey, 1997). Throughout the study, the principles of developmental approach for research were followed (Wang &Hanafin 2005). It is a systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet criteria of internal consistency and effectiveness (Richey, 1994). Developmental research approach will be used to precisely address the procedures and processes involved in developing the designated tool or machine.

The project study gathered information through the evaluation sheet distributed to the selected respondents. The questionnaires are going to be used to gather data to know the level of acceptability in terms of effectiveness and functionality of the prototype. In general, the performance of the project design will be evaluated for this study in order to determine whether its development is effective or not. It is composed of different questions which will be answered by rating 5 being the highest and 1 being the lowest .A Likert scale is a rating scale that requires the subject to indicate his or her degree of assessment to a statement. The questionnaire structure will be used in such a way that the respondents are able to answer it easily. These options served as the quantification of the participants' perception on each question item.

The performance of the Solar and Hydro Automated Water Sprinkler with Soil Moisture Sensor Using Arduino will be evaluated in terms of the device's appearance, purpose and usability by selected farmers, gardeners, electricians, technicians, ICT programmers, teachers and engineers.

In determining the marketability of the device in terms of its acceptability and effectiveness of the project entitled Solar and Hydro Automated Water Sprinkler with Soil Moisture Sensor Using Arduino, the weighted mean and standard deviation were used.

4. LITERATURE REVIEW

As cited by Kumar A. (2017), soil moisture sensors measure the humidity of water content in soil. Since the direct hydrometric measuring of free soil wetness needs removing, drying, and coefficient of a sample, soil wetness sensors live the meter water content indirectly by victimization in another property of the soil, like electrical phenomenon, non-conductor constant, or interaction with neutrons, as a proxy for the wetness content.

The moisture sensors measure the moisture level (water content) of the different plants. If the moisture level has gone below the desired and limited level, the moisture sensor sends the signal to the Arduino board which triggers the water pump to turn on and supply the water to the respective plant using the rotating platform/sprinkler. When the desired moisture level is reached, the system halts on its own and the water pump is turned off. Thus, the functionality of the entire system has been tested thoroughly and it is said to function successfully (Kumar A., 2017).

An automatic irrigation system using ZigBee in WSN has been proposed. They used temperature, soil moisture and the air humidity sensor to control the irrigation system. But the system is not capable of predicting the best timing of watering and also unable to measure the water level. Moreover, there is no auto notification system if there is a shortage in water supply (Abbas, Ahmed Hussein, et al, 2014).

Kansara et al. (2015) indicated that the farmers in India are suffering from the lack of rains and scarcity of water as to their serious problem on food. Whenever the surface temperature and humidity change, these sensors detect the changes and send the microcontroller an interrupt signal. Also providing an automatic irrigation system will save the farmer's time, money and power.

According to Khan, J., & Arsalan, M. H. (2016, March), the United States of America Patent No. US4827534A, (2020) invented by Alvin E. Haugen, integrated solar panels to a vest. This created a sun powered vest which can wear by a person working outdoors, which in turn allows the batteries within the vest to charge to be used for other purposes. The charging is meant to be done with an input jack attached to the rechargeable batteries.

Based on United States of America Patent No. US5969501A, (2017), a patent invented by Steven C. Glidden and Guerin G. Alker, a portable solar device is possible for use. This concept uses folding solar panels attached to trailer where it can be taken to different places as and when needed. The function of this device will allow the ability to generate electricity at any location.

According to (Bailie and McGeehee; 2015), the cost effectiveness of utilizing solar power can be attained thru the use of materials which can increase performance without heavily affecting cost.

Utilizing technology and materials that can give viability cost wise to using solar power will help in pushing this to the general public. Once it has reached the average consumer, developments of integrating solar power to usual devices will start to give its benefits to all.

5. DISCUSSION

Table 1.Level of acceptability of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Style and Design

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Statements	Farmers/ Gardeners			Engineer/ ICT Programmers/ Electricians		
	M	SD	VI	M	SD	VI
Is visually appealing to attract potential users.	4.60	0.63	HA	4.45	0.69	HA
Colour and material collaboration brings out quality and special properties of usual superior materials.	4.40	0.63	HA	4.35	0.67	HA
Parts of the prototype are made with Materials of high quality that enhance its aesthetic value.	4.67	0.62	HA	4.55	0.69	HA
Total dimensions of the product along with distances and proportions between its parts and shapes. Constitute the conventional design principles	4.40	0.63	HA	4.35	0.67	HA
Aesthetic appeal can continue to provide sensory pleasure over a long period of time.	4.60	0.63	HA	4.45	0.69	HA
Parts have their own function and purposes.	4.60	0.63	HA	4.55	0.69	HA
Equipment is arranged according to their group and function.	4.67	0.62	HA	4.55	0.69	HA
Design complements its use.	4.33	0.62	HA	4.25	0.64	HA
Weighted Mean: SD	4.53	0.62	HA	4.44	0.67	HA
Verbal Interpretation	Highly Acceptable			Highly Acceptable		

The weighted mean of farmers/gardeners 4.53 and weighted mean of engineers/ICT program mers/electricians/technicians 4.44 and with supported value of standard deviation 0.62 and standard deviation 0.67 indicated that the respondent is completely acceptable that the Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Style and Design is Highly Acceptable.

Table 2. Level of acceptability of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Performance

Statements	Farmers/ Gardeners			Engineer/ ICT Programmers/ Electricians		
	M	SD	VI	M	SD	VI
Is easy to manage and operate.	4.40	0.63	HA	4.35	0.67	HA
Takes an acceptable time to do the task.	4.40	0.63	HA	4.35	0.67	HA
Is easy to maintain.	4.40	0.63	HA	4.35	0.67	HA
Performs well without any malfunctions.	4.33	0.62	HA	4.25	0.64	HA
Is environmentally friendly.	4.60	0.63	HA	4.45	0.69	HA
Produces intended output with respect to quality and quantity consistently.	4.33	0.62	HA	4.25	0.64	HA
Systems, utilities and equipment operate correctly.	4.20	0.56	HA	4.15	0.59	A
As a whole performs correctly.	4.40	0.63	HA	4.35	0.67	HA
Weighted Mean: SD	4.38	0.61	HA	4.31	0.65	HA
Verbal Interpretation	Highly Acceptable			Highly Acceptable		

The weighted mean of farmers/gardeners 4.38 and weighted mean of engineers/ICT programmers/electricians/technicians 4.31 and with supported value of standard deviation 0.61 and standard deviation 0.65 indicated that the respondent is completely acceptable that the Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Performance is Highly Acceptable.

Table 3.Level of acceptability of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Cost Efficiency

Statements	Farmers/ Gardeners			Engineer/ ICT Programmers/ Electricians		
	M	SD	VI	M	SD	VI
Is a low cost machine.	4.47	0.64	HA	4.40	0.68	HA
Is reasonable for its cost.	4.40	0.83	HA	4.15	0.81	HA
Equipment used in the prototype is environmentally friendly and can't harm the environment.	4.80	0.56	HA	4.45	0.76	HA
Helps the users to lessen the consumption of electric bills.	4.87	0.52	HA	4.55	0.76	HA
Energy consumption can be supplied by alternative sources and it's cheaper than the electric bill.	4.73	0.59	HA	4.45	0.76	HA
Lessens the time and cost of money of users.	4.87	0.52	HA	4.55	0.76	HA
Did not cost too much to be sustained.	4.60	0.63	HA	4.35	0.75	HA
Consumption and sustainability of the machine, benefits less work, and enjoys more flexible production.	4.80	0.56	HA	4.50	0.76	HA
Weighted Mean: SD	4.69	0.62	HA	4.43	0.75	HA
Verbal Interpretation	Highly Acceptable			Highly Acceptable		

The weighted mean of farmers/gardeners 4.69 and weighted mean of engineers/ICT programmers/electricians/technicians 4.43 and with supported value of standard deviation 0.62 and standard deviation 0.75 indicated that the respondent is completely acceptable that the Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Cost Efficiency is Highly Acceptable.

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Table 4.Level of acceptability of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Accessibility

Statements	Farmers/ Gardeners			Engineer/ ICT Programmers/ Electricians		
	M	SD	VI	M	SD	VI
Equipment is easy to access.	4.47	0.64	HA	4.45	0.69	HA
System is easy to operate.	4.33	0.62	HA	4.35	0.67	HA
Machine actually performed upon the material being processed.	4.47	0.64	HA	4.45	0.69	HA
ICT program for arduino is easy to understand.	4.60	0.63	HA	4.55	0.69	HA
Program for arduino and indicators like LCD, LED light and buzzer used its purpose easily.	4.40	0.63	HA	4.40	0.68	HA
ICT provides all the need for the prototype.	4.60	0.63	HA	4.60	0.68	HA
Wiring and constructing the machine is easy to understand and easy to manage.	4.47	0.64	HA	4.40	0.68	HA
Overall requirements needed for the prototype are accessible.	4.20	0.77	HA	4.20	0.77	HA
Weighted Mean: SD	4.44	0.65	HA	4.43	0.69	HA
Verbal Interpretation	Highly Acceptable			Highly Acceptable		

The weighted mean of farmers/gardeners 4.44 and weighted mean of engineers/ICT programmers/electricians/technicians 4.43 and with supported value of standard deviation 0.65 and standard deviation 0.69 indicated that the respondent is completely agreed that the Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Accessibility is Highly Acceptable.

Table 5.Level of effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Functionality

Statements	Farmers/ Gardeners			Engineer/ ICT Programmers/ Electricians		
	M	SD	VI	M	SD	VI
Demonstrates the system/equipment function as expected.	4.53	0.64	HE	4.45	0.69	HE
Measures the level of function and ability to perform functional tasks.	4.53	0.64	HE	4.45	0.69	HE
Can be easily operated automatically.	4.53	0.64	HE	4.45	0.69	HE
Different parts of the machine can be easily maintained.	4.73	0.59	HE	4.65	0.67	HE
Can be operated in any weather condition.	4.27	0.59	HE	4.25	0.64	HE
All the parts of the machine are purposeful and suited for varied functions.	4.47	0.64	HE	4.45	0.69	HE
Functions effectively.	4.53	0.64	HE	4.45	0.69	HE
Meets the needs of the users of the automated sprinkler.	4.40	0.63	HE	4.35	0.67	HE
Weighted Mean: SD	4.50	0.62	HE	4.44	0.67	HE
Verbal Interpretation	Highly Effective			Highly Effective		

The weighted mean of farmers/gardeners 4.50 and weighted mean of engineers/ICT programmers/electricians/technicians 4.44 and with supported value of standard deviation 0.62 and standard deviation 0.67 indicated that the respondent is strongly agreed that the Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Functionality is Highly Effective.

Table 6.Level of effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Usability

Statements	Farmers/ Gardeners			Engineer/ ICT Programmers/ Electricians		
	M	SD	VI	M	SD	VI
Is user-friendly and does not contribute to the physical discomfort of the user.	4.67	0.62	HE	4.45	0.69	HE
Is functional and fits for its uses.	4.60	0.63	HE	4.55	0.69	HE
Cost of the machine is reasonable.	4.73	0.59	HE	4.65	0.67	HE
Materials used in the prototype are long lasting.	4.60	0.63	HE	4.55	0.69	HE
Parts and components of the machine can be changed or replaced easily.	4.67	0.62	HE	4.55	0.69	HE
Price of the parts and components are at a reasonable price.	4.67	0.62	HE	4.55	0.69	HE
Parts and components of the machine are available and can easily be bought in the market.	4.53	0.64	HE	4.45	0.69	HE
Machine achieves its purpose.	4.47	0.64	HE	4.40	0.68	HE
Weighted Mean: SD	4.62	0.61	HE	4.53	0.67	HE
Verbal Interpretation	Highly Effective			Highly Effective		

The weighted mean of farmers/gardeners 4.62 and weighted mean of engineers/ICT programers/electricians/technicians 4.53 and with supported value of standard deviation 0.61 and standard deviation 0.67 indicated that the respondent is strongly agreed that the Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Usability is Highly Effective.

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Table 7Level of effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Purpose

Statements	Farmers/ Gardeners			Engineer/ ICT Programmers/ Electricians		
	M	SD	VI	M	SD	VI
Proposes new innovation on the machine.	4.27	0.59	HE	4.25	0.64	HE
Is able to serve the function it is intended for.	4.47	0.64	HE	4.45	0.69	HE
Serves as a viable solution to an existing problem.	4.53	0.64	HE	4.45	0.69	HE
Developed is more beneficial as compared to existing similar products in the market	4.47	0.64	HE	4.35	0.67	HE
is environmentally friendly	4.33	0.62	HE	4.25	0.64	HE
Operates the machine as per proposed procedure.	4.60	0.63	HE	4.55	0.69	HE
Maintained its qualification requirement for the machine.	4.53	0.64	HE	4.45	0.69	HE
Serves as a guide in constructing and developing new technology.	4.47	0.64	HE	4.45	0.69	HE
Weighted Mean: SD	4.46	0.62	HE	4.40	0.67	HE
Verbal Interpretation	Highly Effective			Highly Effective		

The weighted mean of farmers/gardeners 4.46 and weighted mean of engineers/ICT programmers/electricians/technicians 4.40 and with supported value of standard deviation 0.62 and standard deviation 0.67 indicated that the respondent is strongly agreed that the Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Purpose is Highly Effective.

Table 8.Level of effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Safety

Statements	Farmers/ Gardeners			Engineer/ ICT Programmers/ Electricians		
	M	SD	VI	M	SD	VI
Safety of the user is guaranteed.	4.60	0.63	HE	4.55	0.69	HE
User feels comfortable using the machine.	4.60	0.63	HE	4.55	0.69	HE
Machine is equipped with proper equipment.	4.33	0.82	HE	4.25	0.79	HE
Machine is able to deal with safety properly and efficiently.	4.67	0.62	HE	4.55	0.69	HE
Program of the arduino installed in proper and functional condition.	4.33	0.62	HE	4.25	0.64	HE
Energy source (solar power and hydro power) is placed in a safe and convenient place in the machine.	4.40	0.63	HE	4.35	0.67	HE
Wiring is properly located and it does not affect the performance of the machine.	4.40	0.63	HE	4.35	0.67	HE
Location of the energy storage (battery) is guaranteed safe.	4.67	0.62	HE	4.55	0.69	HE
Weighted Mean	4.50	0.65	HE	4.43	0.69	HE
Verbal Interpretation	Highly Effective			Highly Effective		

The weighted mean of farmers/gardeners 4.50 and weighted mean of engineers/ICT programmers/electricians/technicians 4.43 and with supported value of standard deviation 0.65 and standard deviation 0.69 indicated that the respondent is strongly agreed that the Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino in terms of Safety is Highly Effective.

Table 9. Difference on the level of acceptability and effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino as evaluated by two groups of respondents

Acceptability	t-value	t-critical	p-value	Analysis
Style and Design	0.4838	1.6939	0.3159	*Not Significant*
Performance	0.3746	1.6955	0.3553	*Not Significant*
Efficiency	1.3181	1.6924	0.0983	*Not Significant*
Accessibility	0.0827	1.6955	0.4673	*Not Significant*
Effectiveness				
Functionality	0.3189	1.6939	0.3759	*Not Significant*
Usability	0.2990	1.6955	0.3835	*Not Significant*
Purpose	0.4047	1.6939	0.3442	*Not Significant*
Safety	0.4280	1.6939	0.3357	*Not Significant*

Based on the data, it is shown that there is a significant difference between the Acceptability and effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino at 0.05 level of significance. It shows that the null hypothesis stating that "There is no significant difference between the Acceptability and effectiveness of Solar and Hydro Automated Water Sprinkler with soil moisture sensor using Arduino" is rejected; it can infer that there is "significant" difference between them.

6. CONCLUSION

After completing the project entitled Solar-Hydro Automated Water Sprinkler, it can be concluded that the systems and the whole prototype works perfectly as planned. Based on the preceding findings, with the given aspects, such as style and design, performance, cost efficiency, and accessibility were acceptable and for functionality, usability, purpose and safety were effective as rated by two groups of respondents. It was concluded that the prototype has a high acceptability and effectiveness rate. The programming part of the system has been established and tested. From the simulation result, the program is correct and no error found.

7. RECOMMENDATION

This prototype has its own potential for improvement and adaptation. Therefore, several recommendations would like to be

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proposed as part of future work.

1. It is recommended to go over the design and function to see any potential improvement on the acceptability and effectiveness of the prototype.
2. It is recommended to gather data such size, height, changes observe on the plants being used in the machine.
3. The program of the prototype is still under progress and any problem related to the program needs to be verified quickly.
4. Adding more sensors to improve the monitoring process. It is important to have another sensor to help to improve the monitoring process.
5. Integrate the web server with weather forecast. Having to know the current weather updates would certainly help the user in monitoring their garden.
6. Future researchers may create an opening and closing gate for the waterline to make sure that the water is securely stopped when the soil reaches its desired moisture.
7. For further improvement, there might be a need for the system to have an alert to remind the user that their water storage is getting low and this might need another sensor to be added to measure the water level in the water container.
8. The researcher recommended adding and mixing fertilizer to water which may flow in every plot that can help the plants grow faster.
9. Expanding the system and study the implementation of the system in a large scale plantation.
10. The researcher recommends including the machine in school purpose like school project, feeding program, etc.

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