Research Article

DrySense: A Smartline System with Weather API Integration

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Abstract: *The weather can be quite unpredictable with frequent typhoons between June and November in the Philippines thus, drying clothes outside is quite challenge. Despite this, most of laundry workers still prefer sun-drying since it is affordable and preserves the freshness of the clothes. However, drying clothes outside has its challenges like odors, allergens, animal droppings, and weather surprises. DrySense can predict rain and observe smoke, and it has an automated system features for retrieving garments. The results of the tests conducted on the system's performance following its installation showed positive feedback from respondents, who gave a weighted score of 3.1, indicating that users strongly agreed with the system's overall performance and its ability to lighten household chores. The respondents rated the built shelter and manual control positively, and the developed software, which suggests an algorithm for retrieving and releasing decision- making mechanisms from weather application programming interface data, was also successful in achieving its objective. The researchers concluded that the DrySense system passed ISO25010 evaluation, able to lighten household chores, and provide users with a hassle-free experience.*

Keywords: Clothesline; API; Internet of Things; Weather;

1. INTRODUCTION

In the tropical Pacific, the southwest monsoon brings with it a torrential downpour and fierce winds to the Philippines, typically lasting from June to November. The country experiences an average of 20 typhoons annually, with five of these typhoons causing destruction each year [1]. Because of the effects of global warming, weather patterns are becoming ever more unpredictable, and heavy rain could influence the traditional practice of drying clothes outdoors. Even in the face of obstacles, drying clothes outdoors remains a prevalent and suitable option for laundry people under the impression that it is a more straightforward and low-cost way of drying laundry. As a bonus, the sun-drying method has advantages over other ways of drying clothes, "sunlight is a very efficient and effective way of killing pathogens." Including viruses and bacteria [2]. The tradition of drying clothes outdoors continues to be widely practiced in the Philippines, not only as a low-cost alternative but also as a health-enhancing option. At this time, people face much greater difficulties accomplishing their day to day basic work. This is due to greater workloads and the explosion of new industries, making it difficult for many people to arrive where they intend to be at a reasonable time. Fortunately, with the advancement of technology, solutions to these problems have emerged. The latest technologies have facilitated the resolution of many seemingly arduous problems, thereby making individuals of all formats more comfortable and blither. However, despite these technological advancements, certain challenges still persist.

2. METHOD & MATERIAL

The researchers used quasi-experimental quantitative design to evaluate the quality of DrySense, a smart clothesline system, on respondents' day-to-day laundry practices. The researchers defines certain research objectives to seek relevant answers to the research questions. Quantitative research is a method of collecting and interpreting numerical data from a population regardless of how small or large. This approach emphasizes objective measurements and computational analysis, including mathematical and statistical manipulation of data from surveys, polls, and questionnaires. It seeks to evaluate the results based on a specific population.

The respondents for the study are the people who have an experience in laundry works within Arayat, Pampanga. The researchers utilized purposive sampling from non-probability sampling when researchers used their judgment in selecting samples in a given population to respond in their surveys.

The researchers in this study have identified and selected the categories of Functional Suitability, Usability, Reliability, Portability, and Maintainability from the ISO/IEC 25010 standard to guide their evaluation of the software system's quality attributes. This approach allowed the researchers to utilize a well-defined and established framework for evaluating the system's performance and quality characteristics in a structured manner.

The researchers employed a survey to gather data on the performance, dependability, and usability of DrySense, a Smart Clothesline System. The researchers ensured that ethical guidelines were followed to safeguard the privacy and confidentiality of the respondents' data, in accordance with the provisions of the Data Privacy Act of 2012 (R.A. 10173). The study's objectives and goals were clearly explained to the participants, and questionnaires were distributed to gather data on their responses. The researchers later collected the completed questionnaires used to conclude the data of this study.

To analyse and evaluate the functionality and usefulness of the system, the researchers determined the frequency and weighted mean of the data collected about the respondent. Then, using the findings, descriptive evaluations adapted from the one-to-five Likert scale, or a scale of strongly agree, agree, disagree, and strongly disagree, were interpreted. The weighted mean is calculated using the formula:

$\bar{x}_{\omega} = \frac{(SA*4)+(A*3)+(D*2)+(SD*1)}{10}$ Where:

SA = Strongly Agree

A = Agree

D = Disagree

SD = Strongly Disagree

Table.1 Descriptive Evaluations Chart per Likert Scale Point used to Evaluate DrySense

Weighted Mean	Point Scale	Descriptive Interpretation
3.01- 4.00	4.00	Strongly Agree
2.01 - 3.00	3.00	Agree
1.01 - 2.00	2.00	Disagree
0.01 - 1.00	1.00	Strongly Disagree

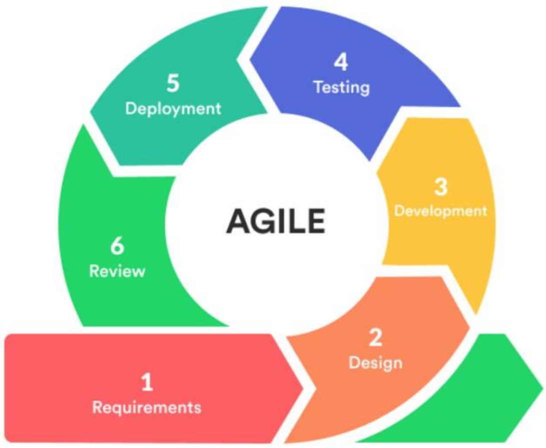

Figure 1. Agile Methodology Framework. Retrieved from: https://www.nature.com/articles/s41598-024-78613-x

Researchers used the agile development methodology which divides the activities into iterations in the software and hardware system as they develop the entire system of the DrySense Smartline System. Initially, researchers collected information that is required in the development of the system. Researchers implemented the design of the system based upon the collected information gathered. After the final development of the system, the researchers implemented the developed system to test the functionalities and to improve and maintain the found problems in the system.

The researchers identified and analyzed the functionality of the software system which is the DrySense Smartline Web Application. The researchers used different diagramming techniques to understand how the system functions.

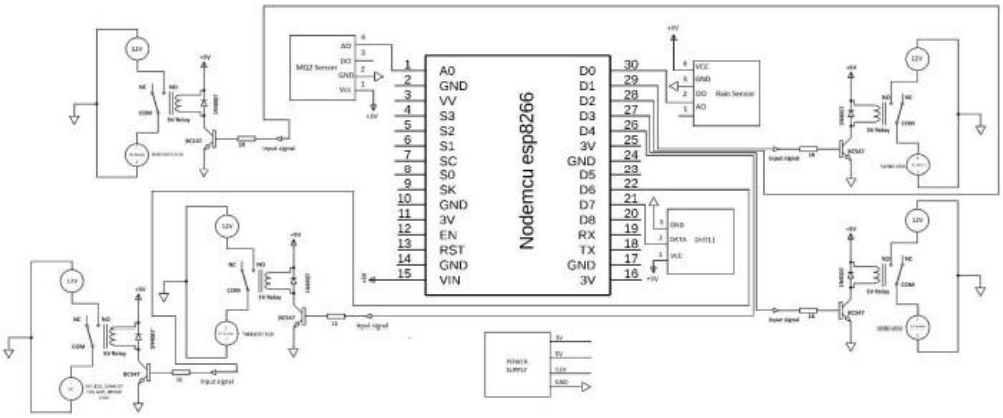

Figure 2. DrySense Schematic Diagram.

Table 2. DrySense Hardware Components.

Component	Technical Description
Tubular steel	Tubular steel is a type of steel formed into a hollow shape, commonly used in the construction and manufacturing of the DrySense chassis. It is used in the system to allow the sprockets to rotate, enabling the actuator to move either upwards or downwards.
Sprockets and Chain	Sprockets and chains are components used in DrySense to transfer power from one rotating shaft to another. A sprocket is a toothed wheel that meshes with a chain, which consists of a series of interconnected links.
Polycarbonate	A material known for its excellent heat resistance and ability to withstand extreme weather conditions, making it a popular choice for outdoor applications. It can be easily molded into different shapes and is available in a variety of colors and finishes. Polycarbonate is a versatile material valued for its strength, transparency, and durability.
Power supply	A device is used to deliver 12V 5A of electricity to the system.
UV LED	UV LEDs are utilized to disinfect garments and are more environmentally friendly, as they do not contain harmful mercury, do not produce ozone, and consume less energy.
Fans	Fans are used to draw cooler air into the case from the outside, expel warm air from inside and move air across a heat sink to cool the clothes inside the shelter.
CH340 microcontroller	The main controller of the system collects and transmits signals from the software to the corresponding hardware output.
Relay	The module's primary purpose is to regulate the power input to the DrySense motors based on the output signal from the CH340.

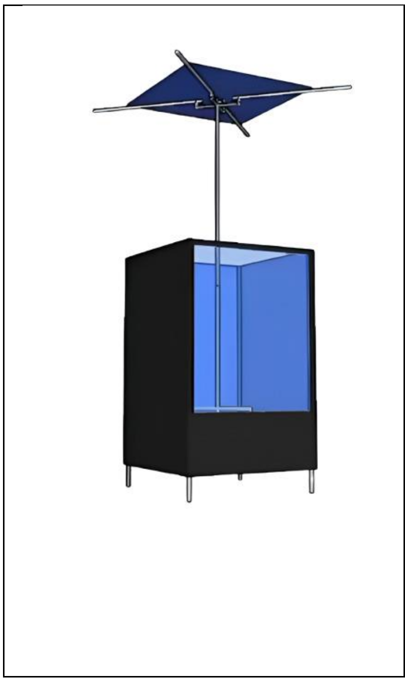

Figure 3.a

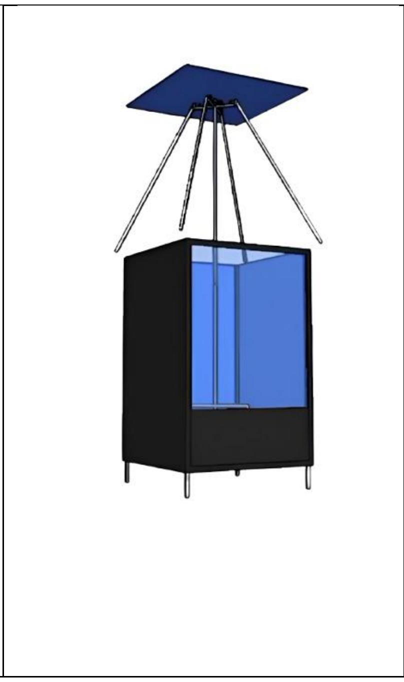

Figure 3.b

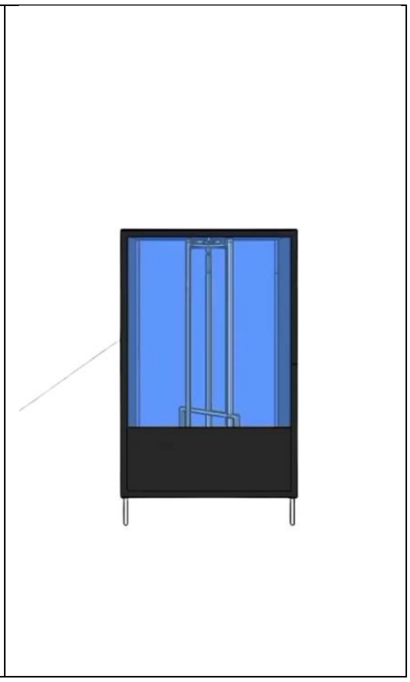

Figure 3.c

Figure 3. DrySense Hardware Prototype Design.

The figure presents in three distinct illustrations (3.a, 3.b, and 3.c), each of which focuses on a different aspect or configuration of the device. Figure 3.a shows the prototype in completely assembled state, with its main rectangular enclosure on four legs and a higher roof-superstructure belonging to it, all supported centrally on one pole. The interior of the enclosure is visible, with the walls being semi-transparent. Figure 3.b then shows an alternative configuration, here with the roof-like structure being raised or removed from the main body, now propped on several inclined struts, in retracting state, or an operational mode with the roof raised. Finally, figure 3.c shows a close-up of the fully enclosed rectangular enclosure, providing a layer of protection against the external elements that may affect the drying process of the garments.

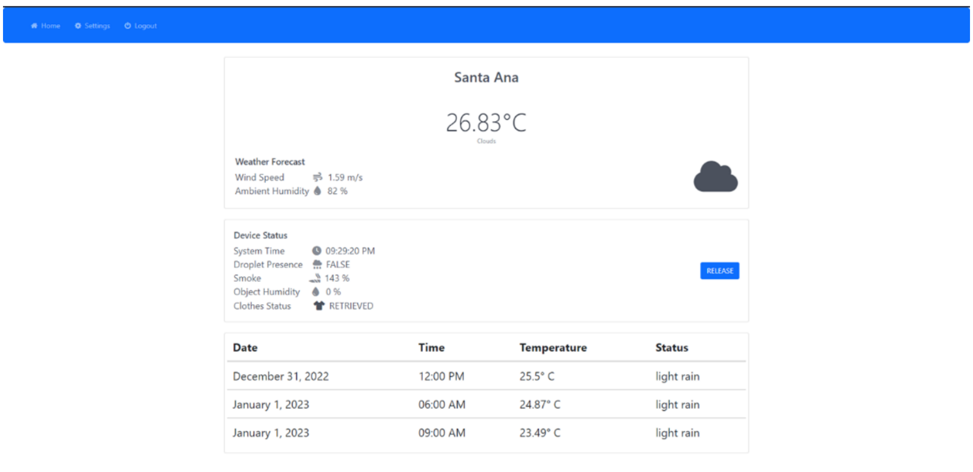

Figure 4. DrySense Web Portal.

Figure 6 depicts the design of the homepage user interface where the user can see the weather forecast in the place that the user chose, device status and the button where the user can manually retrieve or release the clothes. The image on the right shows if the toggle menu is pressed.

3. FINDINGS

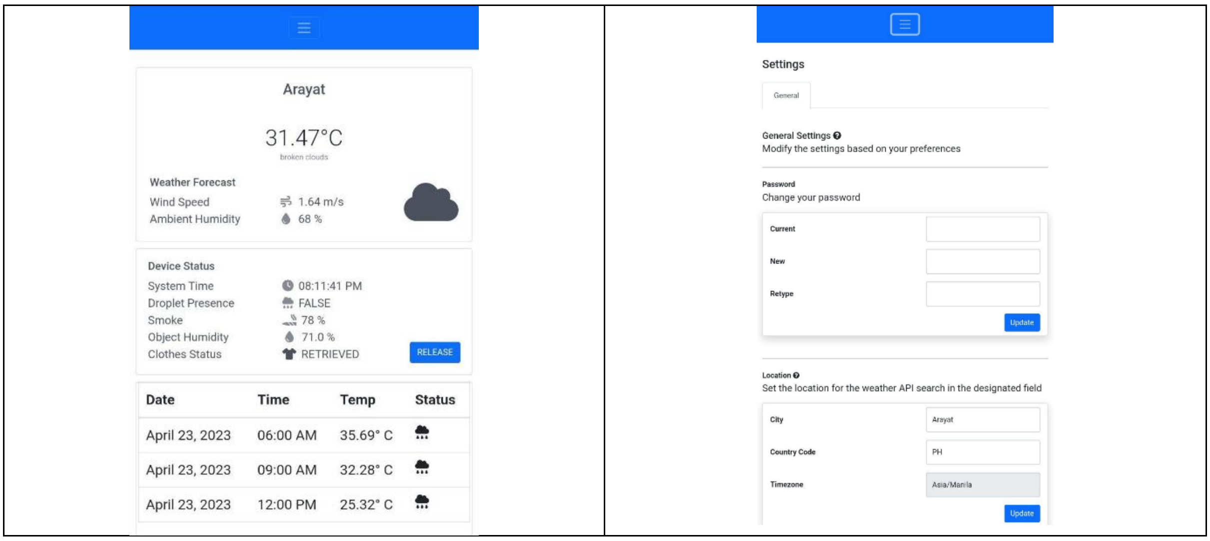

Figure 5.a **Figure 5.b**

Figure 5. Drysense Web Application User Interface.

The Figure 5 of the DrySense Web Application User Interface illustrates the visual design of the DrySense software. Figure 5.a captures the home page, which contains key information, including the weather forecast with basic information like the temperature, wind speed, and ambient humidity, device status including the system time, droplet still present, smoke detected, object humidity, and clothing status (for example, "RETRIEVED"), and a "RELEASE" button for the user to control the system manually. Additionally, a weather forecast for specific dates and times, with the weather temperature and status. Figure 5.b demonstrates the settings interface of the DrySense web application, where the user can modify various parameters. These parameters include general settings to change passwords, location settings to specify the city, country code (for example, PH, which is Philippines), and timezone so the weather api can access accurate climatic search results, and developer settings (modifying "Time Left Allowable Release" and "Retrieval of Clothes Before Forecast DateTime" in hours). The design allows the users to configure the way the system behaves according to the user's preferences and local situation.

Figure 6. Drysense Hardware.

Figure 6 depicts the final development of DrySense system where the clothes can be stored. Inside this shelter, there are UV LEDs and fans that will disinfect the clothes.

Table 3. Summary of the System Evaluation based on adapted ISO25010 Instrument.

Criteria	Weighted Mean	Descriptive Interpretation
Functionality	3.10	Strongly Agree
Usability	3.42	Strongly Agree
Portability	2.90	Agree
Maintainability	3.30	Strongly Agree
Reliability	3.15	Strongly Agree
Overall Weighted Mean	3.20	Strongly Agree

The researchers computed the weighted means of the data gathered from the participants and used a four-point Likert scale to interpret the results. This approach aimed to determine if the respondents found the developed system acceptable, helpful, and recommended for use. The results of the system evaluation, based on the survey questionnaire adapted from the ISO/IEC 25010 standard, are presented in this section. The **Table 3** provides a descriptive interpretation of the functionality, usability, portability, maintainability and reliability of the designed system.

4. DISCUSSION

The results show with 3.18 being the overall weighted mean, proving the users strongly believed that the system was working, user-friendly, and achieved its purpose. These are a weighted average of functional suitability, usability, maintainability, and reliable criteria based on ISO25010 standard, which corresponds to an interpretation of strongly agree. Thus, the accuracy of weather forecasting, efficiency of the smoke and rain detection sensors, ease of learning and use of the user interface, and overall system performance were things of impressive to the respondents. It indicated that while the system would have some inconvenience associated with installation and relocation, it would be easier than other aspects of the system.

5. CONCLUSION

The results of the tests conducted on the system's performance following its installation showed positive feedback from respondents, who gave a weighted score of 3.1, indicating that users strongly agreed with the system's overall performance and its ability to lighten household chores. The respondents rated the built shelter and manual control positively, and the developed software, which employs an algorithm for retrieving and releasing decision- making mechanisms from weather API data, was also successful in achieving its objective. The researchers concluded that the DrySense system is efficient and reliable, able to lighten household chores, and provide users with a hassle-free experience.

In conclusion, the DrySense Smartline System provided an innovative solution to a longstanding problem and demonstrated the potential of technology in improving traditional practices. The system's efficiency and reliability can help alleviate the burden of household chores and promote sustainable living. The researchers' contribution to the field of laundry drying technology opens opportunities for future research and development of smart home systems that can further improve the quality of life of people

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