

# SAW Method Select Type For Drying Shrimp Control System Based Microcontroller and Photovoltaic

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## ABSTRACT

This study applies the Simple Additive Weighting (SAW) method to select shrimp types in a microcontroller and solar panel-based shrimp drying control system. The aim is to enhance drying efficiency by determining the most suitable shrimp type based on multiple criteria, including moisture content, shrimp size, drying time, temperature, and humidity. The system uses sensors to monitor environmental conditions in real time and a microcontroller to automate the drying process, while solar panels provide a sustainable energy source. The SAW method evaluates each alternative by normalizing criteria values and calculating preference scores to produce a final ranking. The solar panel-based shrimp drying control system provides an efficient and sustainable solution for the drying process. By integrating sensors, a microcontroller, and automatic actuators, the system can maintain optimal temperature, humidity, and airflow. The electrical energy generated from the solar panel reaches a maximum of 90 Wh within 5 hours. Based on the SAW method calculation, the highest value is obtained by rebon shrimp (Acetes Shrimp) as Alternative 5, with a score of 18.16. Meanwhile, the lowest humidity value measured by the sensor is 10.5% RH, indicating that the drying chamber has reached optimal conditions, allowing the shrimp to dry properly without spoilage

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## 1. Introduction

Shrimp is one of the most valuable fishery commodities with high economic potential. However, the drying process of shrimp is often carried out traditionally, relying on sunlight, which is highly dependent on weather conditions and may result in inconsistent quality. In addition, selecting the appropriate shrimp type for drying is rarely based on systematic analysis, leading to suboptimal results [1]. The development of a microcontroller-based drying control system powered by solar panels offers an innovative solution to improve efficiency, consistency, and sustainability [2]. By integrating the Simple Additive Weighting

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(SAW) method, decision-making in selecting shrimp types can be optimized based on multiple criteria such as moisture content, size, drying time, temperature, and humidity. Therefore, this research aims to design an intelligent system that enhances shrimp drying performance [3].

A microcontroller based automatic clothes drying system is designed to improve drying efficiency by utilizing sensors to detect temperature and humidity. The system automatically controls heating and airflow to optimize drying conditions. It reduces dependence on weather, shortens drying time, and ensures consistent results, making it suitable for modern household and small-scale applications [1] The study by Mobile Apps-Based Decision Support System Using Simple Additive Weighting (SAW) Method develops a mobile-based decision support system using the SAW method. It evaluates alternatives through weighted criteria and ranking. The system improves decision accuracy, efficiency, and accessibility, enabling users to make objective decisions anytime and anywhere. [2]. The study by Decision Support System for Scholarship Admission Using Simple Additive Weighting (SAW) Method develops a decision support system to assist scholarship selection. It applies the SAW method to evaluate applicants based on weighted criteria, producing rankings. The system improves fairness, accuracy, and efficiency in determining eligible scholarship recipients. [4]

Conventional shrimp drying is typically done by spreading shrimp under direct sunlight. This method depends on weather conditions, requires long drying time, and often results in uneven moisture levels. It also exposes shrimp to contamination from dust, insects, and rain, reducing product quality, hygiene, and overall market value for fishermen Shrimp is a high value fishery commodity that plays an important role in improving the economic welfare of fishermen. However, many fishermen still rely on conventional drying methods, such as direct sun drying, which are highly dependent on weather conditions [11]. This traditional approach often leads to inconsistent drying results, longer processing times, and reduced product quality due to contamination from dust, insects, and unexpected rain. In addition, the lack of control over temperature and humidity during the drying process can cause uneven moisture content, affecting the shelf life and market value of dried shrimp. These limitations highlight the need for a more efficient and controlled drying system. The development of a microcontroller-based shrimp drying control system offers a modern solution by enabling automatic monitoring and regulation of environmental conditions using sensor

A shrimp drying control system using a microcontroller and solar panels offers several significant advantages[9]. It enables automatic monitoring and control of temperature and humidity, ensuring consistent and optimal drying conditions [12]. The use of solar energy reduces electricity costs and supports environmentally friendly operations. The system also shortens drying time, improves product quality, and minimizes contamination risks. Additionally, it reduces dependence on weather conditions, increases efficiency, and is suitable for small-scale fishermen due to its cost-effective and sustainable design.[13]

The Simple Additive Weighting (SAW) method offers several advantages for selecting shrimp types. It provides a simple and structured approach to evaluate multiple alternatives based on various criteria such as size, moisture content, and drying time. The method produces clear ranking results through weighted calculations, making decisions more objective and transparent. SAW is easy to implement in microcontroller-based systems, requires low computational complexity, and allows flexible adjustment of criteria weights. As a result, it helps determine the most suitable shrimp type efficiently and accurately.

The Simple Additive Weighting (SAW) method is a decision-making technique that evaluates alternatives by normalizing criteria values and calculating weighted sums to produce rankings and determine optimal choices objectively. Solar panels provide [14] renewable energy, reduce electricity costs, and support

environmentally friendly systems. They operate independently from the grid, require low maintenance, and are suitable for sustainable, long-term applications [12].

## 2. Literature Review

### 2.1. Simple Additive Weighting (SAW) Method

The Simple Additive Weighting (SAW) method is a popular technique in Multi-Attribute Decision Making (MADM) used to evaluate and rank alternatives based on multiple criteria. In this method, each criterion is assigned a weight that reflects its importance in the decision-making process. The first step involves constructing a decision matrix that contains the performance values of each alternative for all criteria [16]. Because the criteria may have different measurement scales, a normalization process is applied to convert the values into a comparable form. Benefit criteria are maximized, while cost criteria are minimized during normalization. After that, each normalized value is multiplied by its corresponding weight. The results are then summed to produce a final score for each alternative [17].

The alternative with the highest total score is considered the best choice. The SAW method is widely used due to its simplicity, efficiency, and ease of implementation in various decision support systems [18].

### 2.2. Microcontroller

A microcontroller is a compact integrated circuit designed to perform specific control tasks within embedded systems. It consists of a processor (CPU), memory, and input/output peripherals on a single chip. Microcontrollers are widely used in electronic devices such as home appliances, industrial machines, automotive systems, and IoT applications. They can read data from sensors, process information, and control actuators based on programmed instructions. Due to their low cost, small size, and energy efficiency, microcontrollers are ideal for real-time automation and control systems. Popular examples include Arduino, PIC, and ARM-based microcontrollers used in various engineering applications [13]. The microcontroller is the most important component in this study, as can be seen in Figure 1 below.



Figure 1. Microcontroller

### 2.3. Solar Cell

A solar cell is a device that converts sunlight into electrical energy using photovoltaic (PV) cells. These cells absorb solar radiation and generate direct current (DC) electricity through the photovoltaic effect. Solar panels are a key component of renewable energy systems and are widely used in residential, industrial, and agricultural applications. They can be installed on rooftops or open land to capture maximum sunlight [10]. To ensure efficient energy usage, solar panels are often integrated with charge controllers, inverters, and battery storage systems. The charge controller regulates the flow of electricity, while the inverter converts DC into alternating current (AC) for everyday use. Batteries store excess energy for use during nighttime or cloudy conditions [10].

One of the main advantages of solar panels is their ability to produce clean and environmentally friendly energy without emitting harmful gases. They also reduce dependence on fossil fuels and help lower electricity costs over time. Additionally, solar panels require minimal maintenance and have a long operational lifespan, typically over 20 years. Therefore, solar energy is considered a sustainable and efficient solution for future energy needs [13].

A solar panel is a device that converts sunlight into electricity using photovoltaic (PV) cells made of semiconductor materials like silicon. When exposed to sunlight, these cells generate an electric current. Solar panels are commonly used in homes and industries as a clean and renewable energy source. They help reduce electricity costs and dependence on fossil fuels. With improving efficiency and durability, solar panels play an important role in sustainable energy solutions worldwide [12].

### 3. Methodology

#### 3.1. Research Method

This research has a research method. The following research methods have been implemented, which can be seen in

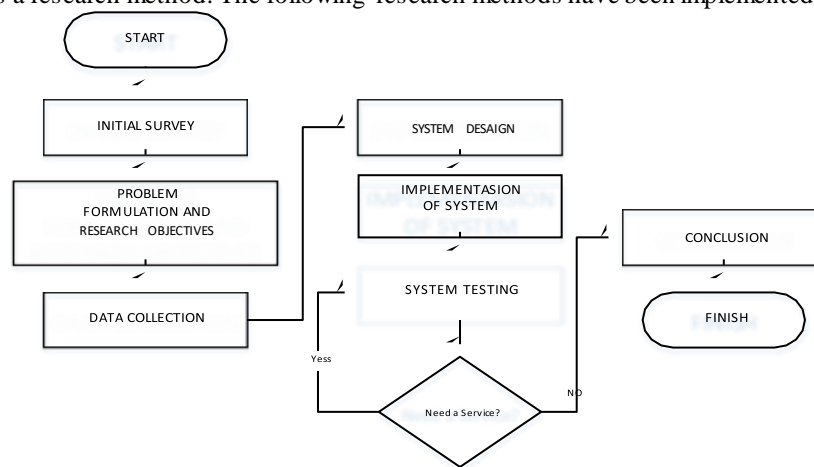


Figure 2. Research Methods

The research process begins with an initial survey to identify problems and gather relevant information. Based on the findings, the research objectives and problem statements are formulated. The next steps include data collection, system design, implementation, and system testing. During the testing phase, the system is evaluated to ensure it functions properly and meets the desired objectives. If any issues or improvements are identified, revisions are made, and the system is tested again. This iterative process continues until the system performs optimally. Once no further improvements are needed, the research proceeds to the conclusion stage, where final results are presented.

#### 3.2. System Flow

This research has a system flow of shrimp drying. The following research methods have been implemented, which can be seen in Figure 2.

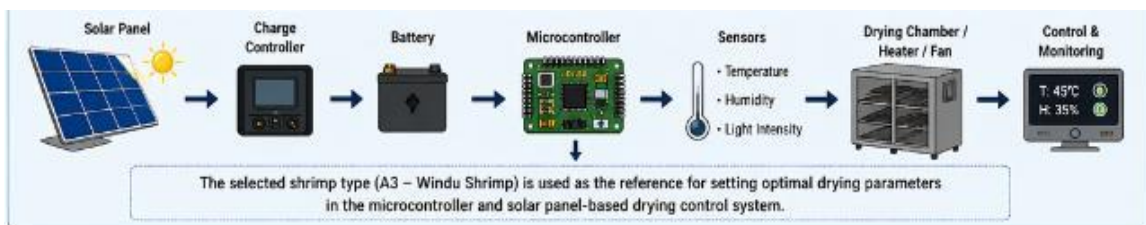


Figure 2. System Flow Shrimp Drying

The system flow begins with identifying the available shrimp alternatives and determining the relevant decision criteria, such as moisture content, drying time, nutritional value, market price, and availability. Each criterion is assigned a specific weight based on its importance in the decision-making process. After that, the system collects performance data for each shrimp type and organizes it into a decision matrix.

Next, a normalization process is applied to the matrix to convert different data scales into comparable values. Benefit criteria are maximized, while cost criteria are minimized during this stage. Once normalized, each value is multiplied by its corresponding weight to produce the weighted normalized matrix. The system then calculates the preference value for each alternative by summing all weighted scores.

After obtaining the preference values, the system ranks all shrimp types from highest to lowest score. The alternative with the highest value is selected as the best shrimp type. This selected result is then used as a reference by the microcontroller to control the drying process. Finally, the microcontroller, supported by sensors and powered by a solar panel system, regulates temperature, humidity, and airflow in the drying chamber to achieve optimal drying performance based on the selected shrimp type.

## 4. Results and Discussion

### 4.1. Result Of Simple Additive Weighting (SAW)

This research has the results of calculations using the SAW method. The SAW method must consist of decision criteria, alternatives, the weight values of each criterion for every available alternative, the normalized values of each alternative, and finally the ranking values. This will be explained in the description Table 1 below :

Table 1. The Criteria of Calculation of the SAW method

Code	Criteria
C1	Size Shrimp
C2	Fat Content
C3	Moisture Content
C4	Texture
C5	Crunchiness
C6	Shrimp Freshness

This method has preference value. The value are : {4, 2, 5, 1, 5, 4} or {W1, W2, W3, W4, W5, W6}. This reference value consists of five numbers based on the decision criteria. The preference value is from fisherman. The weight values are derived from the standard weighting of the SAW method.

The weight values in the SAW method calculation are determined by the type of shrimp. This can be seen in Table 2 below.

Table 2. The Alternative of Calculation of the SAW method

Code	Alternative
A1	Vaname Shrimp
A2	Tiger Shrimp
A3	White Shrimp
A4	Giant Freshwater Prawn Shrimp
A5	Acetes Shrimp
A6	Mantis Shrimp

After determining the criteria and alternatives, the next step is to assign weight values to all criteria for each available alternative. these weights are applied consistently to all alternatives. This means every alternative is evaluated using the same set of criteria, but the impact of each criterion depends on its assigned weight. This can be seen in Table 3.

Table 3. The Alternatif of Calculation of the SAW method

Code Of Criteria	Name Of Criteria	Code Of Alternative					
		A1	A2	A3	A4	A5	A6
C1	Small Size Shrimp	3	1	5	1	5	4
C2	Low Fat Content	4	2	3	1	4	3
C3	Low Moisture Content	4	3	5	2	5	2
C4	Texture	4	3	5	2	5	3
C5	Crunchiness Shrimp	2	4	5	1	5	3
C6	Shrimp Freshness	2	3	5	3	5	4

Before calculating the final score, the values of each alternative must be normalized. This process ensures that all criteria are comparable, especially when they have different measurement scales, In SAW. After that, a matrix is constructed from the weighted values of the criteria for each alternative.

$$X = \begin{bmatrix} 3 & 1 & 5 & 1 & 5 & 4 \\ 4 & 2 & 3 & 1 & 4 & 3 \\ 4 & 3 & 5 & 2 & 5 & 2 \\ 4 & 3 & 5 & 2 & 4 & 3 \\ 2 & 4 & 5 & 1 & 5 & 3 \\ 2 & 3 & 5 & 3 & 5 & 4 \end{bmatrix}$$

After make the matrix value, next step is making the normalization of matrix X. Below are the results of the normalization calculation of matrix X.

$$R_{11} = \frac{3}{\text{Max}\{3;4;4;2;2\}} = \frac{3}{4} = 0.75$$

$$R_{21} = \frac{4}{\text{Max}\{3;4;4;2;2\}} = \frac{4}{4} = 1$$

$$R_{31} = \frac{4}{\text{Max}\{3;4;4;2;2\}} = \frac{4}{4} = 1$$

$$R_{41} = \frac{4}{\text{Max}\{3;4;4;2;2\}} = \frac{4}{4} = 1$$

$$R_{51} = \frac{2}{\text{Max}\{3;4;4;2;2\}} = \frac{2}{4} = 0.5$$

$$R_{61} = \frac{2}{\text{Max}\{3;4;4;2;2\}} = \frac{2}{4} = 0.5$$

$$R_{12} = \frac{1}{\text{Max}\{1;2;3;3;4;3\}} = \frac{1}{4} = 0.25$$

$$R_{22} = \frac{2}{\text{Max}\{1;2;3;3;4;3\}} = \frac{2}{4} = 0.5$$

$$R_{32} = \frac{3}{\text{Max}\{1;2;3;3;4;3\}} = \frac{3}{4} = 0.75$$

$$R_{42} = \frac{3}{\text{Max}\{1;2;3;3;4;3\}} = \frac{3}{4} = 0.75$$

$$R_{52} = \frac{4}{\text{Max}\{1,2,3,3,4,3\}} = \frac{4}{4} = 1$$

$$R_{62} = \frac{3}{\text{Max}\{1,2,3,3,4,3\}} = \frac{3}{4} = 0.75$$

After normalization, next step is making a matrix value. Matrix value is consisting of normalization value, this is X Matrix value of Normalization

$$X = \begin{bmatrix} 0.75 & 0.25 & 1 & 0.3 & 1 & 1 \\ 1 & 0.5 & 0.6 & 0.3 & 0.8 & 0.75 \\ 1 & 0.75 & 1 & 0.66 & 1 & 0.5 \\ 1 & 0.75 & 1 & 0.66 & 0.8 & 0.75 \\ 0.5 & 1 & 1 & 0.3 & 1 & 0.75 \\ 0.5 & 0.75 & 1 & 1 & 1 & 1 \end{bmatrix}$$

After obtaining the normalized decision matrix, each value is multiplied by the corresponding criterion weight. This step reflects the importance level of each criterion in the evaluation process. Next, the weighted values for each alternative are summed to produce a final preference score. This score represents the overall performance of each alternative across all criteria. The process is below

$$A1 = (4)(0.75) + (2)(0.25) + (5)(1) + (1)(0.3) + (5)(1) + (4)(1) = 17.8$$

$$A2 = (4)(1) + (2)(0.5) + (5)(0.6) + (1)(0.3) + (5)(0.8) + (4)(0.75) = 15.3$$

$$A3 = (4)(1) + (2)(0.75) + (5)(1) + (1)(0.66) + (5)(1) + (4)(0.5) = 16.15$$

$$A4 = (4)(1) + (2)(0.75) + (5)(1) + (1)(0.66) + (5)(0.8) + (4)(0.75) = 14.75$$

$$A5 = (4)(0.5) + (2)(1) + (5)(1) + (1)(0.3) + (5)(1) + (4)(0.75) = 18.16$$

$$A6 = (4)(0.5) + (2)(0.75) + (5)(1) + (1)(1) + (5)(1) + (4)(1) = 18.5$$

The result of the SAW method calculation shows that the 5th alternative, Acetes shrimp, has the highest ranking value of 18.16. This ranking score is the highest compared to the other alternatives. Rebon Shrimp (Acetes) is a very small shrimp species that typically grows only 1–3 cm in length. Characteristics: It has a micro size and is often found in large quantities along coastal areas. Advantages: Despite its small size, it has a very strong savory taste. Uses: Commonly used as the main ingredient for shrimp paste (terasi), shrimp crackers, or rempeyek.

#### 4.2. Result Of Control System

The test results of the temperature sensor. Minimum temperature: around 40–45°C. At this temperature, the water in the shrimp begins to evaporate steadily without damaging its texture and nutritional content. If the temperature is too low (<40°C), the drying process becomes very slow and increases the risk of spoilage [20]. This can be demonstrated in Table 4 below

Tabel 4. Test Result Temperature Sensor

No	Date	Low Temperature	High Temperature	Temperature Value	Description
1	15 March 2026		✓	60 °C	Drying Normal
2	16 March 2026		✓	65 °C	Drying Normal
3	18 March 2026		✓	63.5 °C	Drying Normal
4	19 March 2026	✓		20.5 °C	Drying Abnormal
5	20 March 2026	✓		25.3 °C	Drying Abnormal

6	21 March 2026	✓	62 °C	Drying Normal
7	22 March 2026	✓	66 °C	Drying Normal
8	23 March 2026	✓	61.2 °C	Drying Normal
9	24 March 2026	✓	55 °C	Drying Abnormal
10	25 March 2026	✓	58 °C	Drying Abnormal
11	26 March 2026	✓	62.2 °C	Drying Normal

This result is obtained from the humidity sensor. The air humidity sensor is typically integrated into the DHT11 Temperature and Humidity Sensor or DHT22 to measure humidity levels during the drying process. The maximum air humidity for effective drying is around  $\leq 60\%$  RH. Ideally, it should be lower, about 40–50% RH, to allow faster evaporation. If the air humidity is too high ( $>60\%$  RH), the air becomes saturated and cannot effectively absorb moisture from the shrimp [21]. It can seen in Table 5 below.

Tabel 5. Test Result Humidity Sensor

No	Date	Low Humidity	High Humidity	Relative Humidity (%RH) Value	Description
1	15 March 2026	✓		30% RH	Drying Normal
2	16 March 2026	✓		22.4% RH	Drying Normal
3	18 March 2026		✓	68% RH	Drying Abnormal
4	19 March 2026	✓		24% RH	Drying Normal
5	20 March 2026	✓		20% RH	Drying Normal
6	21 March 2026		✓	80% RH	Drying Abnormal
7	22 March 2026	✓		32.5% RH	Drying Normal
8	23 March 2026	✓		25.2% RH	Drying Normal
9	24 March 2026	✓		10.5% RH	Drying Normal
10	25 March 2026		✓	69.2% RH	Drying Abnormal
11	26 March 2026	✓		33.3% RH	Drying Normal

The results in Table 6 represent the completion of system operations of the microcontroller- and solar panel-based shrimp drying device. There is a delay notificatiob because error signal of internet, with alerts sent to fishermen via Telegram to proceed with shrimp drying. This device can also be monitored remotely. The system was tested for 11 days. This can be seen in Table 6 below.

Tabel 6. Test Result Internet Of Thing By Telegram Notification

No	Date	System Operation Completed Notification	System Operation Not Completed Notification	Description
1	15 March 2026	✓		Successful sent
2	16 March 2026	✓		Successful sent
3	18 March 2026		✓	Delay
4	19 March 2026	✓		Successful sent
5	20 March 2026		✓	Successful sent

6	21 March 2026	✓	Delay
7	22 March 2026	✓	Successfulsent
8	23 March 2026		✓ Successfulsent
9	24 March 2026	✓	Successfulsent
10	25 March 2026	✓	Delay
11	26 March 2026	✓	Successfulsent

The results below represent the electrical energy (Watt) generated by a 20 WP (Watt Peak) solar panel. A 20 WP solar panel produces a maximum power of 20 watts under ideal conditions. In one hour, it generates about 20 Wh of energy. However, in real conditions, the output is usually only 70–80% or around 14–16 Wh per hour due to weather and light intensity. In a day with 4–5 effective sunlight hours, the panel can produce about 80–100 Wh. This panel is suitable for small applications such as sensors, LED lights, and microcontroller systems. This can be seen in Table 7

Tabel 7. Test Result of Solar Cell

No	Date	Low Energy	High Energy	Watt Hours (Wh) Value	Time	Total Number of Hours	Total Of Electrical Energy (Watt)	Description
1	15 March 2026	✓		5 Wh	04.00-06.00 wib	2 Hours	10 Watt	Abnormal
2	16 March 2026	✓		2 Wh	03.00-05.00 wib	2 Hours	4 Watt	Abnormal
3	18 March 2026		✓	14 Wh	05.00-09.00 wib	4 Hours	56 Watt	Normal
4	19 March 2026	✓		6 Wh	16.00-18.00 wib	2 Hours	12 Watt	Normal
5	20 March 2026		✓	16 Wh	09.00-14.00 wib	5 Hours	80 Watt	Normal
6	21 March 2026	✓		4 Wh	06.00-08.00 wib	2 Hours	8 Watt	Abnormal
7	22 March 2026	✓		3 Wh	05.00-06.00 wib	2 Hours	6 Watt	Abnormal
8	23 March 2026		✓	16 Wh	10.00-13.00 wib	3 Hours	48 Watt	Normal
9	24 March 2026		✓	18 Wh	10.00-15.00 wib	5 Hours	90 Watt	Normal
10	25 March 2026		✓	19 Wh	06.00-06.30 wib	2 Hours	38 Watt	Normal
11	26 March 2026		✓	18 Wh	07.00-09.00 wib	2 Hours	36 Watt	Normal

The system architecture illustrates a solar powered shrimp drying control system. Solar energy is converted and stored through a charge controller and battery, then supplied to the control system. Sensors such as temperature, humidity, and light collect environmental data and send it to a microcontroller. The microcontroller processes the data and controls actuators like heaters, fans, and ventilation. The drying chamber maintains optimal conditions for shrimp drying. Additionally, the system can be monitored remotely using a WiFi module and smartphone application. It can be seen in Figure 3 below

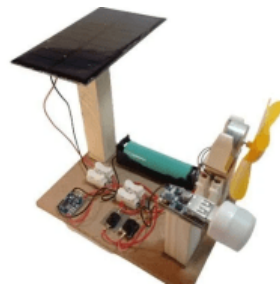


Figure 3. Architecture Shrimp Drying Control System

The specification of the equipment used in this study is the microcontroller uses an Arduino Uno / ESP32. The temperature and humidity sensor is DHT22. The heating element has a power of 100–300 Watts, with an operating temperature range of 50°C–70°C. The fan uses a 12V DC supply. An LCD is used as the display. The drying chamber is a closed box made of wood. The solar panel capacity is 20 WP.

## 5. Conclusion

In conclusion, the solar panel-based shrimp drying control system provides an efficient and sustainable solution for the drying process. By integrating sensors, a microcontroller, and automatic actuators, the system can maintain optimal temperature, humidity, and airflow. The electrical energy generated from the solar panel reaches a maximum of 90 within 5 hours. Based on the SAW method calculation, the highest value is obtained by rebon shrimp (Acetes) as Alternative 5, with a score of 18.16. Meanwhile, the lowest humidity value measured by the sensor is 10.5% RH, indicating that the drying chamber has reached optimal conditions, allowing the shrimp to dry properly without spoilage.

This research can be further developed to study various types of shrimp, provide more detailed validation of final moisture content, analyze energy efficiency, and test performance under different weather conditions.

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