p–ISSN: 2723 – 6609 e-ISSN: 2745-5254
Vol. 6, No. 2, February 2025 http://jist.publikasiindonesia.id/

Design of an Automatic Clothes-Drying System System Based on Arduino

Profitri Atmawarni
Universitas Kristen Indonesia
Email: profitriatmawarni@gmail.com

*Correspondence

Keywords: arduino uno; blynk; DHT22; drying clothes

ABSTRACT

Drying is essential when it is needed. One example of a drying system can be seen on clothing. It aims to enable this system to work without seeing the weather conditions. The system design uses the DHT22 sensor to get the temperature and humidity values, heater and fan, and the Blynk application on Android to know the temperature, humidity, and active or not heater and fan values. The study aimed to create a system that functions independently of weather conditions, offering an efficient drying process. The methodology involves using an Arduino Uno, a DHT22 sensor, a WiFi ESP8266 module, and a 1500-watt heater to control the drying environment. The tests were conducted in various weather conditions, comparing manual, heating-based, and light-based drying systems. The results showed that the automated system significantly reduced the drying time, with an average drying time of 1:30:32 compared to 8:16:23 for manual drying. In addition, the system maintains consistent performance regardless of external conditions. The findings show that the automatic drying system substantially increases efficiency and energy consumption. In conclusion, the automated system effectively overcomes the limitations of manual drying, offering a reliable solution for both domestic and industrial applications. The implications of this research extend to the development of more brilliant household appliances, contributing to energy conservation and the adoption of automated systems in everyday tasks.

Introduction

In modern times, the drying system has a vital role. Its application can be carried out in different ways and depends on the needs of the area. One example of the application of a drying system is on clothes. (Listyanto, 2018). Clothing is one of the most basic human needs, as it protects the body from heat and cold. (Andaryanti & Indrawati, 2018; Hutabarat et al., 2020; Yuniar, 2021).

Drying is the evaporation of water into the air due to the difference in moisture content between the air and the material being dried. In this case, the moisture content of the air is less, or the air has a low relative humidity so that evaporation occurs (Saklani et al., 2024). Drying can be done in two ways: manual drying, with the help of sunlight, and automatic drying. Drying with the help of the sun should also consider the weather; if the weather is not good, the clothes cannot dry thoroughly. As for automatic drying, it does not depend on the weather. Therefore, a system that can work automatically is needed (Ortiz-Rodríguez et al., 2022).

Arduino is a hardware and software that allows anyone to prototype a microcontroller-based electronic circuit easily and quickly. (Barrett, 2022; Bhuyan & Hasan, 2020; Multazam & Hasanuddin, 2017; Suheri & Setiawan, 2020; Ulfada et al., 2022). More specifically, the Arduino board is based on a microcontroller issued by the Atmel company. (Atiyah, 2023). Regarding software, the Arduino IDE is a valuable tool for writing programs (specifically called sketches on Arduino), compiling them, and simultaneously uploading them to the Arduino board (Kadir, Abdul) (Mehdipour, 2023). By using Arduino, various applications can be created more practically. (Blum, 2019). The drying system in this design is divided into 2 (two), namely automatic drying using heaters and incandescent lamps. (Dana et al., 2023). In an automatic clothes-drying system, the Arduino Uno can control or give commands to the heater and fan according to the room temperature and humidity sensor readings. (Arjitya, 2017). If the room temperature is low and the room humidity is high, then the heater and fan work to dry clothes, and vice versa; if the room temperature is high and the room humidity is low, the heater and fan stop working to dry clothes. Another function of Arduino in the clothes drying system is to display the results of temperature and humidity measurements in the room through the Blynk application on Android, which is connected through the WiFi ESP8266 module. Meanwhile, Arduino's function in drying using a lamp functions in the process of reading temperature and humidity values with the help of the DDHT22 sensor connected to the Arduino. The purpose of the 2 (two) tests is so that later comparisons can be made. Then, there will also be a calculation of the energy changes that occur using lamps and heaters.

According to Madhuri et al., (2025) It shows that this tool can accurately detect weather conditions and clothing humidity and move the clothesline automatically based on the installed sensors. Additionally, the DC fan works well as a dryer when clothes are wet, making this system more effective and efficient. According to Priyandha & Wati, (2023) Stated that a control system was designed for an air heater-based clothes dryer. The controller can operate the clothes dryer automatically. The controller can determine the operating temperature value on the clothes dryer according to the type of clothes being dried.

This research focuses on the development and testing of Arduino-based automatic clothes-drying systems. The system integrates a temperature and humidity sensor (DHT22), an Arduino Uno microcontroller, and a Blynk app to monitor and control the drying process. The novelty of this research lies in combining these technologies to create a highly automated and adaptable drying system suitable for a wide range of climates and materials.

The urgency of this research is driven by the growing demand for efficient drying systems in domestic and industrial environments. With climate variability and energy costs increasing, it is critical to find solutions that can operate independently regardless of weather conditions while still being efficient in energy use. In addition, the research aims to contribute to the knowledge of automation and smart home technology, offering practical applications in household appliances.

Based on this incident, an auxiliary device, titled "Design and Build an Arduino-Based Automatic Clothes Drying System," will be designed to dry clothes that are being dried in the sun. Research Objectives to create a clothes drying system that can work automatically and know the drying time of clothes Research Benefits

Increase knowledge about the work of the clothes drying system and obtain appropriate technology for drying clothes with electrical energy.

Method

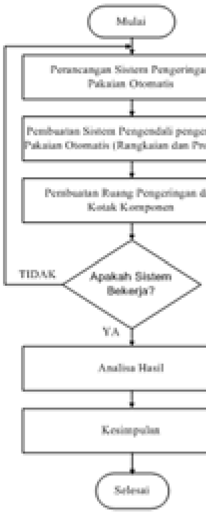

Figure 1. Typical Flow of Research Stage

The components used are the WiFi ESP8266 Module, Arduino Uno, DHT22 Sensor, 1500 Watt Heater, Fan, Relay, and Digital Thermometer.

The test in this field was conducted with a closed system because clothes were dried in a drying room. In this study, three tests will also be carried out, namely using a heater, manual testing with sunlight, and the third using 15 lamps with a power of 1500.

Result Analysis

If the design test is successful, data will be taken. The data that will be collected from these variables are:

1. Indoor air temperature data
2. Indoor air humidity data
3. Clothes drying time data

The relationship between temperature and air humidity is essential in the design of this system, so the movement of the heater and fan is controlled based on the temperature and humidity that the clothes need when drying.

After the data was successfully taken, the temperature and air temperature readings were analyzed in tables and graphs. If the tables and charts are obtained, they are analyzed based on the data received. After the data has been analyzed, a conclusion is made on the results. The heater and fan will work when the air temperature is >=31°C and the humidity is >70%.

Results and Discussion

This system test determines whether the parts communicate well to produce the desired system**.**

Figure 2. Clothes Drying Room

The clothes drying room has a 1500-watt heater, a fan, a clothesline, and a component box containing assembled components. How the clothes drying system works:

When the heater and fan are on, the heater produces heat, and the fan spreads the heat generated by the heater, which then spreads throughout the room and provides hot air that helps dry clothes in the room.

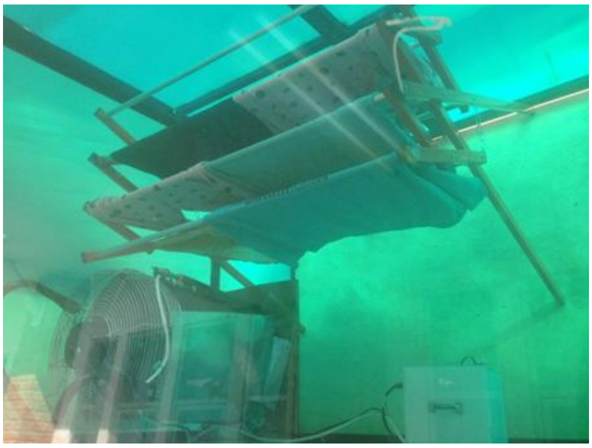

Figure 3. Top View Automatic Clothes Drying Chamber

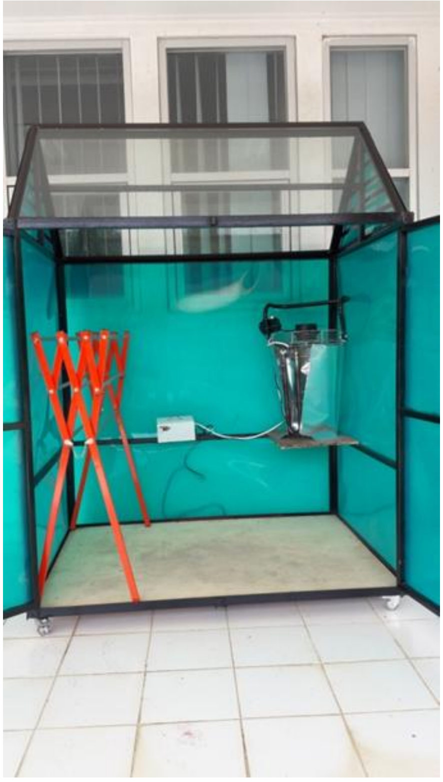

Figure 4. Deep Visible Automatic Clothes Drying Chamber

Figure 5. Heater and Fan

Figure 4.1 shows the automatic clothes drying room from the front view. The creation of the drying room is based on a design that has been made previously, which can be seen in Figure 3.3. The drying room has a capacity of 150 cm, a width of 153 cm, and a height of 200 cm. The system used in this drying room is a closed system. The material used is glass at the top of the drying room, so sunlight can also enter and help with drying. Polycarbonate is used in door manufacturing and on each side of the drying room. Meanwhile, four wheels are used at the bottom of the drying room to make it easy to move or shift the room.

Figure 5 shows the automatic clothes drying room in the top view. It can also be seen that in Figure 5, some clothes that have been washed and squeezed are being dried. The washing and wringing of the clothes are done manually. Based on Figure 4.2, the material of clothes that are being dried is cotton, with many clothes in 6 pieces. Drying clothes in the space can be done in two ways: placing clothes directly on the clothesline and using a hanger. The clothesline used is made of aluminum. The clotheslines are placed in front of the heater and fan.

Figure 6 shows the automatic clothes drying room. It also shows the placement of component boxes, clotheslines, heaters, and fans. The component box is in the middle and close to the heater and fan due to the cable connection between the heater, fan, and component box. The heater and fan are placed in the right corner. The placement of the heater and fan can later affect how quickly the dryer can dry clothes in the sun.

Then, in Figure 7, it can be seen that the heater and fan are placed close together, which aims to dry clothes by working. When the heater and fan are turned on, the heater will produce heat, and the fan will spread the heat generated by the heater, which will then spread throughout the room and provide hot air that will help dry clothes in the room.

DHT22 Sensor Testing

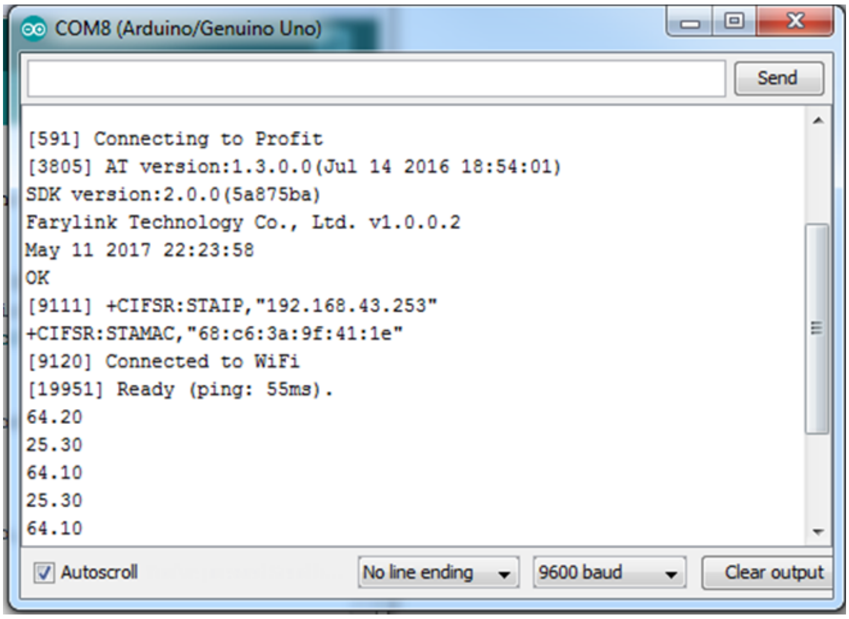

Figure 6. DHT22 Sensor Testing

Figure 4.5 shows the readings of the DHT22 sensor, which is a temperature and humidity sensor. The temperature read was 25.3°C, while the humidity was 64.2%. Testing of this DHT22 sensor is carried out outside.

(a) (b)

Figure 7. Temperature and Air Humidity Sensor Readings in the Drying Chamber

a. When heater and fan are on
b. When the heater and fan do not turn on

Figure 4.6 shows the temperature and humidity sensor readings in the drying chamber. When the heater and fan are on, the temperature value read is 30.1°C, while for the humidity value, 76.9% is obtained, as shown in Figure 4.6 (a). Then Figure 4.6 (b) shows the results of the temperature and humidity sensor readings when the heater and fan are not on. The room's temperature and humidity values affect the non-turning on of the heater and fan.

Manual Manual Testing of Clothes Drying System

Table 1. Data on Manual Drying of Clothes

Experiment	Day/ date	Condition		Drying Time
		Weather	Digital Thermometer	
Experiment 1	Saturday, 12/5/18	Dark Rain	27°C	22:06:04
Experiment 2	Monday 14/5/18	Overcast Rain	26°C	47:11:31
Experiment 3	Tuesday 15/5/18	Dark Rain	29°C	34:19:12
Experiment 4	Wednesday 16/5/18	Bright Hot	31°C	10:13:30
Experiment 5	Thursday	Hot	30°C	10:26:32

Experiment	Day/ date	Condition		Drying Time
		Weather	Digital Thermometer	
	17/5/18	Rain		
Experiment 6	Friday 18/5/18	Bright Hot	33°C	8:50:25
Experiment 7	Saturday 19/5/18	Dark No Rain	28°C	23:45:19
Experiment 8	Sunday 20/5/18	Dark No Rain	28°C	9:11:16
Experiment 9	Monday 21/5/18	Dark No Rain	23°C	12:23:23
Experiment 10	Tuesday 22/5/18	Overcast No Rain	24°C	12:40:30

Source: Data processed

Table 1 is the data on the results of drying clothes manually, only with the help of sunlight. This experiment was carried out 10 times to find out when clothes can dry. As can be seen in Table 1, the experiment was carried out from Saturday, May 12, 2018, to Tuesday, May 22, 2018. The experiment's weather conditions were based on the weather during data collection. The weather can be said to be good if the conditions are bright and hot, but if it is rainy, cloudy, or drizzling, it will be noted that the weather is not good. This is because manual drying depends on weather changes. If the weather is bright or hot at that time, then the clothes can be dried right in the sun. However, if there is a change in the weather, the clothes will be immediately moved to a place that is not exposed to rain. Temperature values taken when clothes start to dry are taken using a digital thermometer. Weather and temperature factors are among the causes of the long drying time. The most extended drying occurred on Monday, May 14, 2018, with a temperature of 26°C with a drying time of 47:11:31. As for the fastest drying occurred on Friday, May 18, 2018. The temperature value obtained at that time was 33°C with a drying time of 8:50:25.

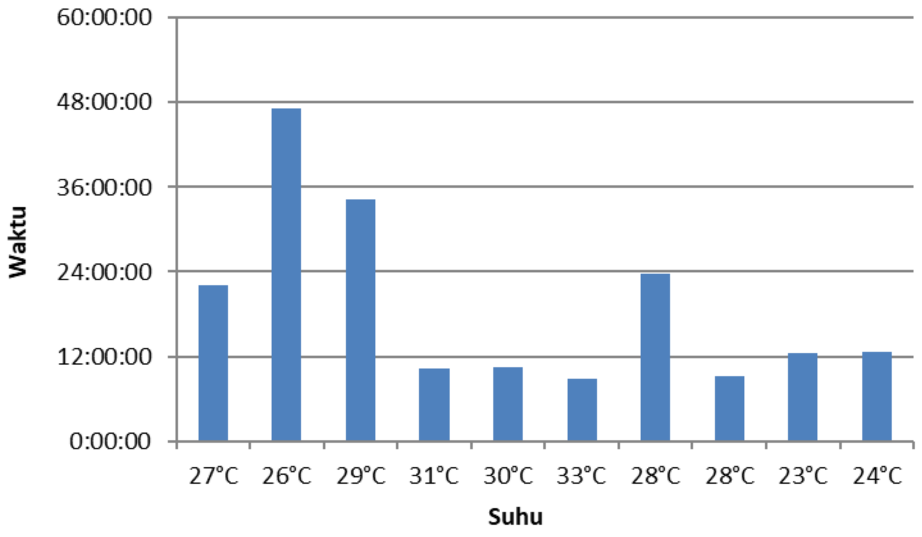

Figure 8. Graph of Manual Clothes Drying Results Data

Figure 4.7 shows the data on manual clothes drying in a Graph. The graph makes it easier to read the temperature and time values for drying clothes.

Automatic Clothes Drying System Testing

Table 2. Data on Automatic Clothes Drying Results

Experiment	Day/ Date	Condition			Drying Time
		Weather	Sensor DHT 22		
			Temper ature	Moisture	
Experiment 1	Friday, 6/22/18	Overcast No Rain	31.3°C	68.7%	1:50:47
Experiment 2	Saturday, 23/6/18	Hot Rain	36°C	76.9%	1:47:33
Experiment 3	Sunday 24/6/18	Rain	31.7°C	70.3%	1:41:33
Experiment 4	Monday 25/6/18	Hot	39.5°C	67.5%	1:33:40
Experiment 5	Tuesday 26/6/18	Rain	31.2°C	66.7%	1:57:47
Experiment 6	Wednesda y, 27/6/18	Hot	38.1°C	64.1%	1:45:37
Experiment 7		Rain	34.1°C	69.1%	1:47:47

Experiment	Day/ Date	Condition			Drying Time
		Weather	Sensor DHT 22		
			Temperature	Moisture	
	Thursday 28/6/18				
Experiment 8	Friday, 29/6/18	Rain	36.4°C	61.3%	1:52:13
Experiment 9	Saturday, 30/6/18	Dark Drizzle	31.4°C	64.7%	1:49:41
Experiment 10	Sunday 1/7/18	Dark No Rain	37.1°C	70.5%	1:53:15

Source: Data processed

Table 2 is the data on the automatic drying of clothes. Drying is done automatically by utilizing heat from the heater and fan. This experiment was also performed 10 times to determine how long clothes took to dry. In Table 4.2, the experiment was carried out from Friday, June 22, 2018 to Sunday, July 1, 2018. In the automatic drying experiment, the length of the clothes did not depend on weather changes. Therefore, the one that can determine the length or speed of the drying works depends on the temperature and humidity values in the drying chamber. Based on the results, the time required to dry clothes is less than 2 hours. Based on Table 4.2, it can be seen that drying works very quickly at 1:33:40.

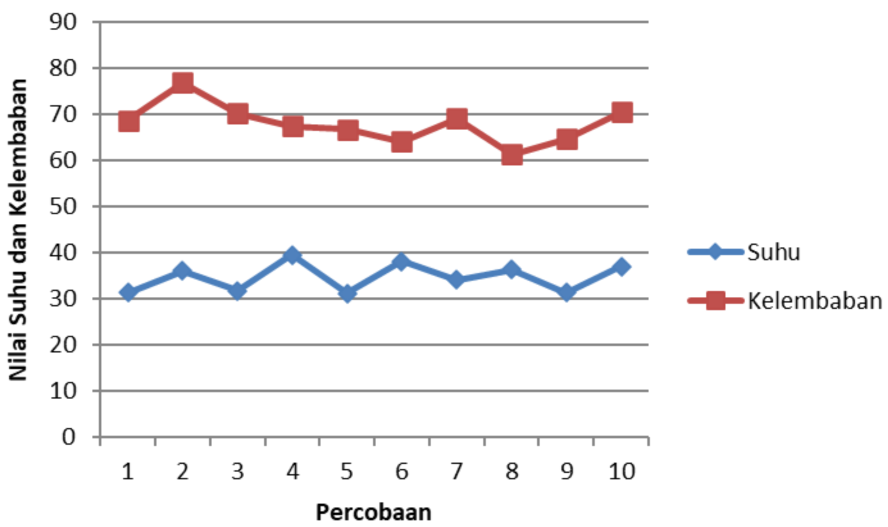

Figure 9. Graph of Automatic Clothes Drying Results Data

Figure 9 shows the data on automatic clothes drying in a Graph. The graph was created to make it easier to read the temperature, humidity, and time needed to dry clothes.

In Graphs, blue indicates the temperature value, while blue indicates the humidity value. Values from 1 to 10 represent the number of experiments performed, and numbers from 1 to 50 indicate values for temperature and humidity.

Time Comparison Testing Between Manual Drying System and Automatic Drying System

Table 3. Results of Comparison of Manual and Heater Clothes Drying Time

	Hari/ Tanggal	**Cuaca**	**Sistem Pengeringan**	**Sensor DHT22**				**Waktu Pengeringan**
				Keadaan Awal		**Keadaan Akhir**		
				Suhu	**Kelembaban**	**Suhu**	**Kelembaban**	
1	Selasa, 3/7/18	Panas	Manual	30.1°C	75%	31.3°C	56.4%	4:19:14
			Otomatis	35°C	64.5%	45.4°C	32.3%	1:26:10
2	Rabu, 4/7/18	Hujan	Manual	25°C	90%	30°C	51%	10:30:04
			Otomatis	35.1°C	62%	46°C	37.6%	1:39:57
3	Kamis, 5/7/18	Panas	Manual	30.4°C	75%	28°C	61%	12:37:41
			Otomatis	39.3°C	63.9%	43.2°C	43.7%	1:18:35
4	Jumat, 6/7/18	Panas	Manual	33.7°C	67.5%	27.5°C	60.5%	7:15:17
			Otomatis	34.6°C	59.5%	41.1°C	42.5%	1:50:29
5	Sabtu, 7/7/18	Panas	Manual	34°C	69%	30°C	57%	6:39:40
			Otomatis	30.8°C	67.3%	47.7°C	34.3%	1:17:30
Rata-rata			Manual					8:16:23
			Otomatis					1:30:32

Source: Data processed

Table 3 shows that the reading of the DHT22 sensor, which functions to read temperature and humidity, is divided into two types. The initial temperature and humidity are the values taken when the clothes are about to dry. In contrast, the final temperature and humidity value is when the clothes are dry. The drying time will be obtained based on these temperature and humidity values. You can use a stopwatch to make it easier to determine the drying time. There is a difference in values between temperature and humidity due to room differences. In manual drying, temperature and humidity values are taken outdoors, whereas in automatic drying, temperature values are taken indoors. The average manual drying time was 8:16:23, while the average automatic drying time was 1:30:32.

Testing of Automatic Clothes Drying System with Different Materials

This test takes data from the garment's material; then, there are hours, the garment's weight in grams, and the moisture content. For more details, please see Table 4.

Table 4. Test Results of Automatic Clothes Drying with Different Materials Using Heaters

Material	Time	Weight (grams)	Initial Weight	Final Weight	Up Air(%)
Material Katn	Jam 8.27	2800	2800	2600	92.857143
	Jam 8.42	2600	2800	2300	82.142857
	Jam 8.57	2300	2800	2100	75
	Jam 9.12	2100	2800	2000	71.428571
	Jam 9.27	2000	2800	1700	60.714286
	Jam 9.42	1700	2800	1500	53.571429
	Jam 9.57	1500	2800	1400	50
	Jam 10.12	1400			
Material Flanel	Jam 8.27	2400	2400	2000	83.333333
	Jam 8.42	2000	2400	1900	79.166667
	Jam 8.57	1900	2400	1800	75
	Jam 9.12	1800	2400	1750	72.916667
	Jam 9.27	1750	2400	1700	70.833333
	Jam 9.42	1700	2400	1650	68.75
	Jam 9.57	1650	2400	1500	62.5
	Jam 10.12	1500	2400	1450	60.416667
	Jam 10.27	1450	2400	1300	54.166667
	Jam 10.42	1300	2400	1200	50
	Jam 10.57	1200	2400	1100	45.833333
	Jam 11.12	1100	2400	1000	41.666667
	Jam 11.27	1000	2400	800	33.333333
	Jam 11.42	800			
Material *Flax*	Jam 8.27	1400	1400	1300	92.857143
	Jam 8.42	1300	1400	1250	89.285714
	Jam 8.57	1250	1400	1200	85.714286
	Jam 9.12	1200	1400	1150	82.142857
	Jam 9.27	1150	1400	1100	78.571429
	Jam 9.42	1100	1400	1000	71.428571
	Jam 9.57	1000	1400	900	64.285714
	Jam 10.12	900	1400	800	57.142857
	Jam 10.27	800	1400	750	53.571429
	Jam 10.42	750	1400	650	46.428571
	Jam 10.57	650	1400	500	35.714286
	Jam 11.12	500	1400	450	32.142857
	Jam 11.27	450	1400	400	28.571429
	Jam 11.42	400			
Material Denim	Jam 8.27	1200	1200	1100	91.666667
	Jam 8.42	1100	120	1000	83.333333
	Jam 8.57	1000	1200	900	75
	Jam 9.12	900	1200	850	70.833333
	Jam 9.27	850	1200	820	68.333333

Material	Time	Weight (grams)	Initial Weight	Final Weight	Up Air(%)
	Jam 9.42	820	1200	810	67.5
	Jam 9.57	810	1200	800	66.666667
	Jam 10.12	800	1200	780	65
	Jam 10.27	780	1200	750	62.5
	Jam 10.42	750	1200	700	58.333333
	Jam 10.57	700	1200	680	56.666667
	Jam 11.12	680	1200	650	54.166667
	Jam 11.27	650	1200	600	50
	Jam 11.42	600			

Source: Data processed

Based on Table 4, a table of automatic drying test results with different clothing materials can be seen. One of the reasons for drying different clothes is to know the drying time on each garment. Drying clothes starts at 08.27 until the clothes are dry. In this test, the moisture content of each material was also calculated. The clock description in Table 4. is when drying begins, where each ingredient is carried out simultaneously. Each garment is placed on the clothesline according to its material. In the first row are clothed with five pieces of cotton, namely shirts, pants, and T-shirts. The second row is filled with flannel clothes; on the last row, towels with flax and jeans with denim are dried. Moisture content data was taken at intervals of 15 minutes. So, every 15 minutes, a weight measurement will be carried out on each material. The moisture content rate will also be displayed with a graph for more details. Graphs are made to show the decrease in moisture content that occurs during the drying process.

Testing of Clothes Drying Systems Using Lights

Placing clothes on the clothesline using a hanger. This drying is carried out using 15 incandescent lamps that have a power of 100 Watts each on each lamp.

Table 5. Results of Clothes Drying Test Using 15 Pieces Lights with 1500 Watts of Power

Time	Temperature (°C)	Moisture (%)	Cotton		Flannel		*Flax*		Denim	
			Weight (grams)	Up to Air (%)	Heavy	Up to Air (%)	Heavy	Up to Air (%)	Heavy	Up to Air (%)
Jam 12.25	28.6	89.1	2800	92.857	2400	91.667	1400	92.857	1200	91.667
Jam 12.40	28.6	88.9	2600	92.857	2200	75	1300	89.285	1100	83.333
Jam 12.55	28.6	88.7	2600	85.714	1800	66.667	1250	85.714	1000	75
Jam 13.10	28.8	88.6	2400	85.714	1600	66.667	1200	85.714	900	75
Jam 13.25	29.9	88.4	2400	80.357	1600	66.667	1200	85.714	900	75
Jam 13.40	30.7	79.4	2250	80.357	1600	66.667	1200	85.714	900	73.333
Jam 13.55	30.9	76.6	2250	77.857	1600	66.667	1200	82.142	880	73.333

Time	Temperature (°C)	Moisture (%)	Cotton		Flannel		*Flax*		Denim	
			Weight (grams)	Up to Air (%)	Heavy	Up to Air (%)	Heavy	Up to Air (%)	Heavy	Up to Air (%)
Jam 14.10	31	76	2180	77.857	1600	65.833	1150	82.142	880	73.333
Jam 14.25	31	75.8	2180	77.857	1580	65.833	1150	82.142	880	73.333
Jam 14.55	32.2	76.7	2180	77.857	1580	65.833	1150	82.142	880	70.833
Jam 15.10	32.5	75.2	2180	77.857	1580	65.833	1150	82.142	850	70.833
Jam 15.25	32.2	74.8	2180	77.857	1580	65.833	1150	78.571	850	70.833
Jam 15.40	32.4	72.3	2180	76.785	1580	64.5833	1100	78.571	850	70.833

Source: Data processed

Based on Table 5, the test results of drying clothes using lamps with different clothing materials can be seen. One of the reasons for drying different clothes is to know the drying time on each garment. In this test, the moisture content of each material will also be calculated. Moisture content data was taken at intervals of 15 minutes. So, every 15 minutes, a weight measurement will be carried out on each material. Testing using lights is carried out to see how long clothes can dry. The advantage of testing with lights is that they are inexpensive and easy to obtain in stores. However, drying with lamps also has disadvantages. Based on tests carried out with lights, the drying time required is quite long, which is about 6 to 7 hours. In addition, clothes are also not completely dry on some materials, such as flannel and flax. The clothes do not dry out in some of these materials due to the thickness of the material and the absence of wind in the clothes drying room.

Comparison of Clothes Drying System Testing Using Heaters and Lights

After a test using a heater and lamp, a test comparison will be carried out by calculating the decrease in water content on the energy consumed and energy consumption. The calculation of the reduction of water content on the energy consumed can be done using the following equation:

(Clothing Weight)/(Time⁄Watt)... (2)

In equation 2, the value entered into the equation is the value of the subtraction of the weight of the initial garment to the final weight value of the garment. After obtaining the weight of the clothes, enter the drying time in units of hours, which will then be divided into the power used so that the results will be obtained later in units of gr/Wh. After calculating the moisture content rate, calculate the energy changes in each material. The calculation of the energy consumption that occurs can use the following equation:

(Power) x (Time/60) .... (3)

In equation 3, the power in question is the power used when drying clothes. Then there is the time; the time here is the time when the drying of clothes occurs. It can be noted that in equations 2 and 3, there is a difference in calculations. In equation 2, the calculation is done by entering the weight of the clothes, which is then divided by the drying time and divided by the power used. At the same time, in equation 3, the calculation is done only by entering the power value, multiplying by the time, and dividing by 60. In Equation 3, the estimate is based on the energy during the drying process but does not include the garment's weight. For more details, the calculation of moisture and energy content in the drying system with heaters and lamps can be considered as follows:

$$1400/(1.25/1500)= 0.746 \text{ gr/Wh}$$

The calculation above results from energy changes in the clothes drying system using a heater on cotton. Based on the calculation using equation 2, the result is 0.746 gr/Wh. This means that in cotton materials utilizing a heater, the water content decreases to the energy consumed as much as 0.746 gr/Wh.

$$(1500) \times (1.25)=1875 \text{ Wh}$$

Based on the calculations obtained using equation 3, the result is 1875 Wh. This means that the energy consumption of cotton materials using heaters is 1875 Wh. Then, for the calculation of energy changes in the clothes drying system using lamps on cotton materials, the following can be considered:

$$1400/(3.083/1500)=0.302 \text{ gr/Wh}$$

The calculation using equation 1 yields 0.302 gr/Wh. This means that in cotton materials heated with a heater, the water content decreases to the energy consumed as much as 0.302 gr/Wh.

$$(1500) \times (3.083)=4624.5 \text{ Wh}$$

The calculations obtained using equation 2 result in 4626.5 Wh. This means that the energy consumption of cotton materials using heaters is 4624.5 Wh. Table 4 provides more details on calculating energy changes in the clothes drying system using heaters and lamps on all materials.

Table 3. Comparison of Clothes Drying System Testing Using Heaters and Lights

Drying System	Janis Bahan	Decrease in Moisture Content (gr/Wh)	Energy Consumed (Wh)
Heater	Cotton	0.746	1875
	Flannel	0.328	4875
	Flax	0.205	4875
	Denim	0.123	4875
Lamp	Cotton	0.127	4875
	Flannel	0.164	4875
	Flax	0.061	4875
	Denim	0.071	4875

Source: Data processed

Based on the tests carried out using heaters and lamps, the following analysis can be carried out:

The test used a heater and lamp with the same clothing material. The clothing materials used are cotton, flannel, flax, and denim. Each ingredient has a different drying time and degree of dryness. The time needed to dry cotton clothes using a heater only takes 1 hour and 15 minutes. The degree of dryness in cotton materials can be noted in Table 4.4 in the weight column. In the weight column, the initial weight of the clothes when they are about to be dried is equal to that of the clothes when they are dry. When drying with a heater, clothes that have been dried can be used immediately. However, when drying clothes with a lamp, the time needed is 3 hours and 15 minutes. One of the reasons for the long-time dry clothes is the absence of wind in the drying room. So that the clothes only receive the heat generated from the incandescent lamp. For the dryness of cotton materials, clothes are slightly dampened using lamps. Drying on the flannel with a heater and a lamp takes 3 hours and 15 minutes, with the note that the clothes with the lamp have not yet entirely dried as it does with cotton. Clothes with flannel material are thicker, so it is one of the things that causes old clothes to dry out. Furthermore, clothes with flax material are used to make towels. It takes for the heater to dry towels 3 hours and 5 minutes, just like the drying time with lights. The lack of drying with a lamp causes not all parts of the towel to dry. The last is the drying of clothes on denim material. The time needed to dry denim using a heater and a lamp is the same, which is 3 hours and 15 minutes, with the note that drying using a lamp does not make the denim material completely dry, which is different from using a heater.

Based on the comparison between drying clothes using heaters and lamps, it can be concluded that drying with a heater is better in terms of dryness. In terms of time, heaters are better on cotton clothing materials, while time on the other three materials, namely flannel, flax, and denim, has the same drying as lights.

Conclusion

Based on the tests that have been carried out, the design of the clothes drying system using a heater can work automatically. When the temperature in the drying room is above 31°C and the humidity is below 70%, the heater and fan will not turn on, and vice versa. That way, it can be said that drying using a heater is better than manually and using lights.

REFERENCE

Andaryanti, B. C., & Indrawati, E. S. (2018). *Hubungan Antara Konsep Diri Dengan Perilaku Konsumtif Terhadap Pakaian Pada Siswi Kelas Xi Sman 1 Pati*. Undip.

Arjitya, F. M. (2017). Perancangan Prototipe Jemuran Pakaian Otomatis Berbasis Arduino Mega 2560. *Eprints. Um. Ac. Id*.

Atiyah, N. S. (2023). *Development Of An Industrial Atmega328p Microcontroller Based On An Open-Source Platform*. University Of Kerbala.

Barrett, S. F. (2022). *Arduino Microcontroller Processing For Everyone!* Springer Nature.

Bhuyan, M. H., & Hasan, M. (2020). Design And Simulation Of A Heartbeat Measurement System Using Arduino Microcontroller In Proteus. *International Journal Of Biomedical And Biological Engineering*, *14*(10), 350–357.

Blum, J. (2019). *Exploring Arduino: Tools And Techniques For Engineering Wizardry*. John Wiley & Sons.

Dana, S., Peli, Y. S., Indranata Panggalo, A. M. G., & Laleb, I. O. (2023). *Evaluation Of Power Consumption In Moringa Leaves Dryer*.

Hutabarat, R., Hadita, N. W., Deby, E., Abadi, A., & Prayogo, B. (2020). *Prototype Jemuran Otomatis Berbasis Arduino Mega 2560*. Hal.

Listyanto, T. (2018). *Teknologi Pengeringan Kayu Dan Aplikasinya Di Indonesia*. Ugm Press.

Madhuri, A. V., Abduh, H., & Suppa, R. (2025). Prototype Sistem Penjemuran Pakaian Otomatis Berbasis Arduino Uno. *Jurnal Informatika Dan Teknik Elektro Terapan*, *13*(1). http://dx.doi.org/10.23960/jitet.v13i1.5680

Mehdipour, F. (2023). *Arduino-Based Wireless Sensor Networks Programming Using Matlab*. Politecnico Di Torino.

Multazam, A. E., & Hasanuddin, Z. B. (2017). Sistem Monitoring Kualitas Air Tambak Udang Vaname. *Jurnal It*, *8*(2), 118–125.

Ortiz-Rodríguez, N. M., Condorí, M., Durán, G., & García-Valladares, O. (2022). Solar Drying Technologies: A Review And Future Research Directions Focusing On Agroindustrial Applications In Medium And Large Scale. *Applied Thermal Engineering*, *215*, 118993. https://doi.org/10.1016/j.applthermaleng.2022.118993

Priyandha, H., & Wati, D. A. R. (2023). Perancangan Prototipe Sistem Kendali Otomatis Pada Pengering Pakaian Berbasis Air Heater. *Jambura Journal Of Electrical And Electronics Engineering*, *5*(1), 71–78. https://doi.org/10.37905/jjeee.v5i1.17212

Saklani, P., Prabhakar, P., Kumar, S., & Siddhnath. (2024). Drying-Induced Changes In Fish And Fishery Products. In *Dry Fish: A Global Perspective On Nutritional Security And Economic Sustainability* (Pp. 95–114). Springer.

Suheri, A., & Setiawan, W. J. (2020). Prototipe Cscm (Coin Sorting And Counting Machine) Berbasis Arduino Uno R3 Studi Kasus: Koperasi Melati. *Media Jurnal Informatika*, *11*(1), 1.

Ulfada, E., Nurfiana, N., & Handayani, R. D. (2022). Perancangan Desain Ui/Ux Pada Implementasi Sistem Kontrol Smart Farming Berbasis Internet Of Things (Iot). *Prosiding Seminar Nasional Darmajaya*, *1*, 145–155.
Junior, E. (2021). *Kebutuhan Bertingkat Tokoh Lara Cameron Dalam Novel The Stars Shine Down Karya Sidney Sheldon*. Universitas Muhammadiyah Sukabumi.