INFOKUM
Volume 13, Number 05, 2025, DOI 10.58471/infokum.v13i05
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

An Analysis and Design of an Iot Based Automated Wood Drying System With Real Time Humidity Monitoring

Arif Rahmansyah[1], Solly Aryza[2], Ahmad Dani[3]
Universitas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia

Article Info
Keywords:
Wood drying,
Internet of Things (IoT),
and humidity monitoring,

ABSTRACT
Wood drying is an important process in the wood processing industry to improve its quality and durability. However, conventional methods are often inefficient due to the lack of real-time control of moisture levels. This study aims to analyze and design an au-tomatic wood drying system with Internet of Things (IoT)-based moisture monitoring. This system uses a moisture sensor to measure the water content in wood periodically, which is then sent to an IoT platform for remote monitoring. The data obtained is used to automatically control the heating element to maintain optimal conditions in the drying room. With the implementation of this technology, the drying process becomes more ef-ficient, energy efficient, and produces wood with more consistent quality. The test results show that this system is able to adjust the temperature and drying duration adaptively based on the actual condition of the wood, thereby increasing efficiency compared to conventional methods. It is hoped that this research can be an innovative solution for the wood industry in increasing productivity and quality of the final product.

Corresponding Author:
Arif Rahmansyah
Universirtas Pembangunan Panca Budi, Medan, North Sumatera, Indonesia
arifrahmansyah431@gmail.com

INTRODUCTION

Wood is part of the trunk, branches, or twigs of plants that undergo a lignification process (wooding), so that it becomes hard. Wood has various functions in everyday life, ranging from fuel for cooking, materials for making furniture such as tables and chairs, to being used in building construction such as doors, windows, and roof frames. In addition, wood is also a raw material in the paper industry and various other products.

For information In Indonesia, the development of wood drying technology has progressed rapidly, starting from natural methods that utilize sunlight to the use of modern drying machines. Conventional wood drying aims to remove water content from the wood so that it can be released into the air. This process is generally carried out by regulating the air temperature around the wood in the range of 60-80 ° C, so that the water contained in the wood fibers can evaporate optimally.

In the traditional drying system, heat is generated from a furnace that uses wood waste as fuel. The heat energy generated is then channeled through a special channel with the help of a fan. Fans play an important role in maintaining temperature stability and ensuring even heat distribution in the drying room (chamber). Some fans function to remove water vapor from the chamber, while other fans regulate air circulation to make the drying process more efficient. However, this traditional system still relies on manual fan operation, which can cause inefficiencies in the drying process.

Wood drying is a crucial stage in the wood processing industry because it affects the strength, durability, and quality of the final product. If this process does not run optimally, various problems can occur, such as cracking, deformation, or uneven shrinkage. In addition, conventional methods that are not equipped with real-time moisture monitoring can result in energy waste and end results that are less than expected. With the advancement of technology, the concept of the Internet of Things (IoT) offers innovative solutions in the automation of various industrial systems, including the wood drying process.

The use of humidity sensors and IoT-based monitoring systems allows for more precise and efficient control of the drying process. This technology supports real-time monitoring of wood conditions and automation of heating and fan systems based on the data obtained, thereby increasing energy efficiency and the quality of drying results. Therefore, this study aims to develop a prototype of an IoT-based temperature monitoring and control system in the wood drying process, which is expected to increase effectiveness and efficiency in the furniture wood processing industry.

Literature Review

Microcontroller

Microcontroller or sometimes called embedded controller is a system that contains input/output, memory, and processor, which is used in products such as washing machines, video players, cars, and telephones. In principle, a microcontroller is a small computer that can be used to make decisions, do repetitive things, and can interact with external devices, such as ultrasonic sensors to measure the distance to an object, GPS receivers to obtain earth position data from satellites, and motors to control movement in robots. As a small computer, microcontrollers are suitable for application in small objects, for example as controllers in QuadCopters or robots.(Kurnia Hadi, 2022)

NodeMCU can be likened to the Arduino board of ESP8266. But NodeMCU has packaged the ESP8266 module type ESP-12E into a board with various features like a microcontroller and added the ability to access wifi and a USB to serial communication chip. So to program it only requires a USB data cable to connect it. In terms of function, this module is almost similar to the Arduino module platform, but what distinguishes it is that NodeMCU is specifically designed to be connected to the internet. (Vivi Yusniar Nainggolan, 2022)

NodeMCU measures 4.83 cm long, 2.54 cm wide and weighs 7 grams. The board features wifi and open source firmware.

The details owned by NodeMCU are as follows:

1. This board relies on the ESP8266 sequential wifi SoC (single on chip) with locally available USB to TTL. The remote used is IEE 802.11b/g/n.
2. 100 miniature farad and 10 miniature farad tantalum capacitors.

3. 3.3 volt LDO controller.
4. Blue runs as a pointer.
5. Cp2102 USB to UART range.
6. Reset button, usb port and blaze button.
7. There are 9 GPIOs which include 3 PWM pins, 1 x ADC channel, and an RX TX pin.
8. 3 ground pins.
9. S3 and S2 as GPIO pins.
10. S1 MOSI (Expert Result Slave Information) is the information path from the ace and enters the slave, sc cmd/sc.
11. S0 MISO (Expert Info Slave Info) for example information about the slave exit and go to the ace.
12. SK which is SCLK which functions from expert to slave as a clock.
13. Pin V in as voltage info.
14. Implicit 32-digit MCU.

The early history of NodeMCU development was before the arrival of ESP8266 on December 30, 2013. Starting from Espressif Frameworks as the manufacturer of ESP8266 to the creation of ESP8266 which is a wifi SoC connected to the Tensilica Xtensa LX106 processor. While NodeMCU started on October 13, 2014 when hong did the first NodeMCU-Firmware document to github. After 2 months, the effort expanded to the equipment stage when huang did the documentation of the ESP8266 board called devkit v.0.9. (Vivi Yusniar Nainggolan, 2022)

Later in the same month Mr.PM also posted the MQTT client library from contiki to the ESP8266 SoC stage and seriously to the NodeMCU project which made it support the MQTT IoT convention via Lua. The following update occurred on January 30, 2015 when devsaurus posted u8glib to the NodeMCU project which allowed NodeMCU to drive VGA, LCD and OLED events. Until finally the NodeMCU project continued to grow until now with the local open source area behind it, in the end spring 2016 NodeMCU currently consists of 40 utilitarian modules that can be utilized by designer needs. (Vivi Yusniar Nainggolan, 2022)

Table 1. Types of versions a comparison table of the three versions above:

	NodeMCU		
Specification	0.9	1.0 (Official board)	1.0 (unofficial board)
Manufacturer Vendor	Amica	Amica	Loli
ESP 8266 Type	ESP12	ESP-12E	ESP-12E
USB port		Micro USB	
GPIO pin	11	13	13
ADC		1 pin (10 bits)	
USB to Serial Converter	CH340G	CP2102	CH340G
Power Input		5 VDC	
Module Size	47 x 31 mm	47 x 24 mm	57 x 30 mm

INFOKUM
Volume 13, Number 05, 2025, DOI 10.58471/infokum.v13i05
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

ESP-12E

Because the key of NodeMCU is ESP8266 (especially in the ESP-12 series, including ESP-12E) therefore the features owned by NodeMCU are more or less the same as ESP-12 (also ESP-12E for NodeMCU V2 and V3) except NodeMCU has been wrapped by its own API built based on the eLua programming language, which is more or less similar to java scrib. Some of these features include:

1. 10 GPIO ports starting from D0-D10
2. PWM functionality
3. 12C and SPI interface
4. 1 wire interface
5. ADC

The ESP8266 can function using the JEDEC voltage standard (3.3 V voltage) unlike the AVR microcontroller and most Arduino boards that have a TTL voltage of 5 V. However, the NodeMCU can still be connected to a voltage of 5 V via the micro USB port or the Vin pin provided by the board. So to prevent damage to the board, you can use a Level Logic Converter to change the voltage to a safe value of 3.3 VDC. (Vivi Yusniar Nainggolan, 2022)

Further explanation regarding the position of each pin of the ESP-12E can be seen in the image:

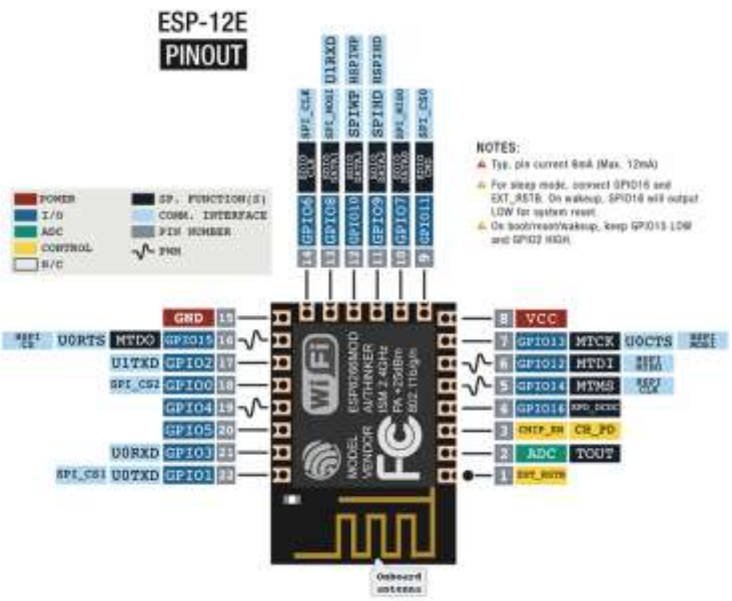

Figure 1.1ESP-12E pins

MQ-2 Detection Sensor

The MQ-2 sensor is a type of gas sensor designed to detect the presence of various types of gases, especially flammable gases such as methane, butane, LPG (Liquefied Petroleum Gas), and smoke. This sensor is widely used in safety applications, such as gas leak detection systems in homes and industries, because it is able to provide a fast response to changes in the concentration of potentially dangerous gases. The MQ-2 sensor is known for its high sensitivity and ability to detect gas concentrations in a wide range, making it a reliable tool for early detection and monitoring.(Roihan et al., 2016)

Technically, the MQ-2 sensor works on the principle of conductivity produced by a sensor element made of SnO_2 (tin dioxide) semiconductor which has different resistance when exposed to gas. When a flammable gas such as LPG, methane, or smoke is detected, the resistance of the sensor element will decrease, resulting in a measurable voltage change. This electrical signal can then be calibrated to determine the concentration of gas around the sensor. This change in resistance is proportional to the concentration of gas in the air, allowing the MQ-2 to provide fairly accurate data on the concentration of the detected gas.(Muhammad Yusuf, 2020)

The MQ-2 is designed to be easily integrated with various microcontrollers and programming platforms such as Arduino, Raspberry Pi, and ESP32. This sensor generally has two types of outputs: analog and digital outputs. The analog output provides a continuous voltage signal that is proportional to the gas concentration, while the digital output works with a certain threshold. Users can set the threshold value on the digital output using a potentiometer installed on the sensor. This feature makes it easy for users to configure the MQ-2 according to their needs, both for simple applications that require an on/off indicator or for complex applications that require detailed gas concentration measurements.(Hutagalung, 2018)

In terms of sensitivity, the MQ-2 sensor can detect gases in a concentration range of 200 to 10,000 ppm (parts per million), depending on the type of gas being detected. This sensor is most sensitive to LPG, methane, and smoke, but can also detect a variety of other gases in higher concentrations. In order for the sensor to provide consistent and accurate readings, a calibration process in a standard environment is highly recommended. Calibration is carried out to ensure that the sensor provides correct readings at known gas concentrations, thereby increasing the reliability of the sensor in high-risk surveillance applications.(Muhammad Yusuf, 2020)

The MQ-2 sensor has a simple design and relatively affordable price, making it widely used in various security applications such as fire alarms, smoke detection in buildings, and indoor air quality monitoring systems. Due to its small size and easy installation, this sensor is also often used in portable applications or low-cost gas warning systems. In addition, its rugged design and high durability allow the MQ-2 sensor to function well in a variety of environmental conditions, including humid or dusty conditions, making it suitable for home, industrial, and laboratory applications.(Muhammad Yusuf, 2020)

Figure 2. M-Q2 Sensor

INFOKUM
Volume 13, Number 05, 2025, DOI 10.58471/infokum.v13i05
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

Jumper Cables

Jumper wires are a type of small wire designed to connect points on an electronic circuit board, such as a breadboard or printed circuit board (PCB). They are popular in electronics prototyping projects because they allow users to create temporary circuits without having to solder components. Jumper wires typically have metal connector ends surrounded by a plastic coating to allow for easy connection and disconnection from the connection points. The use of jumper wires allows flexibility in designing and changing circuits quickly, making them ideal for experimentation and early product development.(Mara et al., 2023)

There are three main types of jumper cables: male-to-male jumpers, female-to-female jumpers, and male-to-female jumpers. Male-to-male cables have metal pins on both ends, which are suitable for connecting two points on a breadboard or connecting a breadboard to a header on a microcontroller such as an Arduino or Raspberry Pi. Female-to-female cables have through-hole connectors on both ends and are typically used to connect header pins on a device or module. Meanwhile, male-to-female cables, which have pins on one end and through-hole connectors on the other, are often used to connect header pins to a breadboard or external module. These types of connectors allow users to easily connect multiple devices and components in a circuit.(Fauziyah et al., 2020)

Figure 3. Jumper Cable

Servo Motor

Servo motor is a development of DC motor and already has gear, but the difference is that the servo motor can be adjusted for speed. Inside there is a potentiometer and motor driver, so it can be adjusted by degrees. Servo motors can be used to make legged robots, arm robots, and others. The maximum limit of right rotation movement is up to 180 degrees and left rotation is up to 180 degrees.

A servo motor is a rotary device or actuator (motor) designed with a closed-loop feedback control system (servo), so that it can be set up or adjusted to determine and ensure the angular position of the motor output shaft. A servo motor is a device consisting of a DC motor, a series of gears, a control circuit, and a potentiometer. A series of gears attached to the DC motor shaft will slow down the rotation of the shaft and increase the torque of the servo motor, while the potentiometer with its resistance changes when the motor rotates functions as a determinant of the servo motor shaft rotation limit (Muh. Fajar Gunawan., 2019).

INFOKUM
Volume 13, Number 05, 2025, DOI 10.58471/infokum.v13i05
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

Figure 4. Servo Motor

RESEARCH METHODS

In this study, the method used is designed to design, implement, and evaluate an IoT-based automatic wood drying system. This research method includes several main stages as follows: This research is an experimental research that aims to design and test the effectiveness of an Internet of Things (IoT)-based wood drying system. In addition, this study also uses a quantitative descriptive method to analyze temperature, humidity, and energy efficiency data from the developed system.

The stages of research are as follows:

a. Reviewing previous research on conventional and automatic wood drying methods.
b. Study the concepts of IoT, temperature and humidity sensors, and automatic control systems in industry.
c. Designing hardware consisting of:
   1. Temperature and humidity sensors (e.g. DHT22, SHT31).
   2. Microcontroller (e.g. ESP32 or Arduino).
   3. Fans, heaters, and relays as actuators.
d. Designing software that includes:
   1. Web/mobile based monitoring system.
   2. Automatic control algorithm based on sensor data.
e. Assemble the hardware components and connect the sensors to the microcontroller.
f. Developing IoT systems for automated monitoring and control.
g. Connect the system to the cloud or local server for data storage.
h. Conduct system trials under various temperature and humidity conditions.
i. Records changes in temperature, humidity, drying time and power consumption.
j. Comparing the results of automated systems with conventional methods.
k. Quantitative analysis to evaluate system effectiveness based on temperature, humidity and energy efficiency data.
l. Comparative analysis with traditional wood drying methods.
m. Drawing conclusions based on test results and data analysis.
n. Provide recommendations for further development.

INFOKUM
Volume 13, Number 05, 2025, DOI 10.58471/infokum.v13i05
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

Tools and materials

a. Hardware:
   1. Temperature and humidity sensor (DHT22/SHT31)
   2. Microcontroller (ESP32/Arduino)
   3. Fans, heaters and relays
   4. Power supply and wireless communication module
b. Software:
   1. Programming with Arduino IDE/Python
   2. IoT based monitoring system (Firebase, Blynk, or ThingSpeak)

Data collection technique

a. Direct observation: Observing system performance under real conditions.
b. Sensor data recording: Using IoT devices to record temperature and humidity.
c. Experiments and trials: Measuring drying time efficiency and power consumption.

Data Analysis Techniques

a. Descriptive Statistical Analysis: Presenting temperature, humidity, and energy efficiency data in the form of graphs and tables.
b. Efficiency Comparison: Comparing the performance of automated systems with conventional methods.

This research method is designed to produce a more efficient IoT-based wood drying system compared to traditional methods. With an experimental approach and quantitative data analysis, this research is expected to contribute to the wood processing industry.

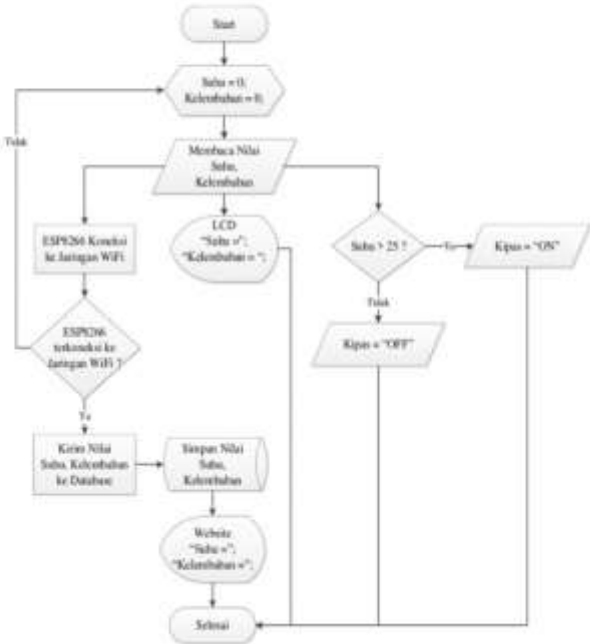

Figure 5. System Flowchart

1. Start

   The research begins by determining the main focus and objectives of the research related to the IoT-based automatic wood drying system.

2. Identification of problems
   Analyzing the weaknesses of conventional wood drying methods, such as low energy efficiency, manual temperature and humidity control, and the risk of wood defects due to a suboptimal drying process.
3. Literature Study
   Reviewing previous research on wood drying systems and IoT technology. Understand how temperature and humidity sensors work that can be used in this system.
4. System Design
   Designing hardware, such as temperature and humidity sensors, microcontrollers, and fans and heaters for the drying system. Developing IoT based software for automatic temperature monitoring and control.
5. System Implementation
   Building a prototype of an automatic wood drying system. Integrating IoT-based sensors and monitoring systems.
6. System Testing
   Conducting tests on the accuracy of temperature and humidity sensors. Observe how the system maintains optimal temperature and humidity during the wood drying process.
7. Analysis & Evaluation
   Comparing the effectiveness of IoT-based systems with conventional drying methods. Assess energy efficiency, temperature stability, and quality of wood drying results.
8. Conclusion & Suggestions
   Drawing conclusions based on test results and data analysis. Provide recommendations for further system development, such as improving control algorithms or implementing them on an industrial scale.
9. Finished
   The research ends after all stages are completed and documentation of the research results is carried out.

RESULT

Program Coding Testing

Figure 6. Temperature Sensor Pin Program Coding Testing

INFOKUM
Volume 13, Number 05, 2025, DOI 10.58471/infokum.v13i05
ESSN 2722-4635 (Online)
https://infor.seaninstitute.org/index.php/infokum

The coding program above shows the determination of the temperature sensor PIN to the microcontroller PIN, after which the minimum and maximum temperatures detected by the sensor are determined against the fan rotation.

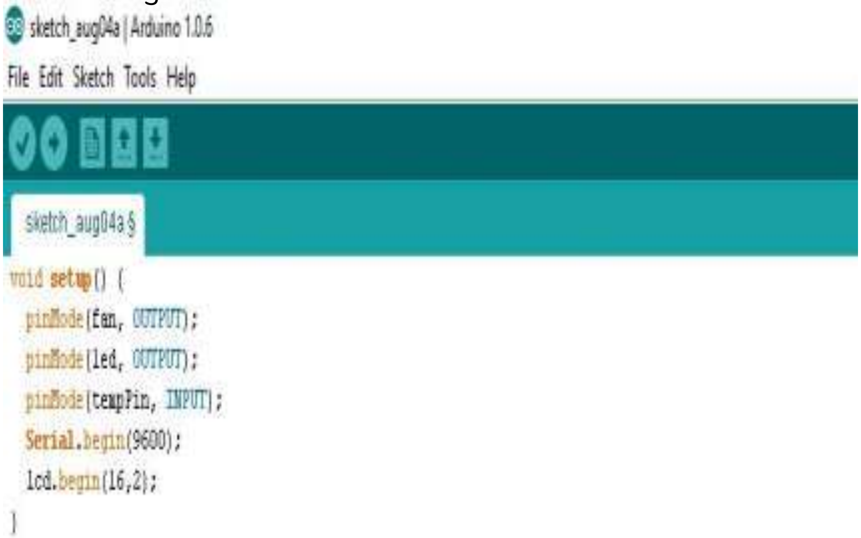

Figure 7. Void setup

The coding program above is in the form of Arduino command code to determine the function of a pin. All the program codes invoid setup.

Figure 8. Void loop

The above program coding is in the form of command codes to the INPUT and OUTPUT pins on the Arduino. All program codes in the void loop will be read after the void setup and will be read continuously by the Arduino. After being done testing in programming language then the program can be uploaded to the hardware for the process of running the tool.

Figure 9. Overall Series

The next stage is testing components such as the LM35 sensor, Load Cell, Button and Heater Blower to see the results of the research that has been carried out.

Table 2. LM35 temperature sensor test results

No	Testing	SensorLM35	Thermometer	Error
1	Max	60oC	55oC	9%
2	Stable	48oC	45oC	6%
3	Standby	34oC	30oC	4%

Table 3. Load Cell Weight Sensor Test Results

NO	Tester	Load Cell	Scales Digital	Error
1	Matlab Book	43 ounces	45 ounces	4%
2	Samsung cellphone	28 ounces	29 ounces	3%
3	Charger Netnook	52 ounces	55 ounces	5%

Table 4. Button Test Results

No	Tester	Push button
1	Red Button	4.8 volts
2	Green Button	0 volt
3	Red Button	4.8 volts
4	Green Button	0 volt

Table 5. Heater Blower Test Results

NO	Tester	Heater Blower
1	Maximum Speed	27000RPM
2	Stable speed	14000RPM
3	Standby speed	3000RPM

Power Supply Testing

The purpose of testing the power supply is to determine the output voltage of the power supply that will be used as the input voltage of the microcontroller circuit. This test is carried out to avoid unexpected voltages. The power supply circuit testing system can be done by measuring the output voltage of the circuit using a Voltmeter.

The voltage source used as the working voltage in the Arduino-Based Temperature-Based Fan Speed Monitoring Tool circuit has a source originating from DC12 V. In this study, testing will be carried out on the power supply circuit, namely by measuring the output voltage produced by each voltage source that is supplied to the microcontroller circuit. The following is a table of the results of measuring the power supply circuit to the microcontroller.

Table 6. Power supply stability test

Test	It is expected based on data sheet	Measurement results
	Vcc	Vcc
1st	12V	11.98 V
2nd	12V	11.98 V
The 3rd	12V	11.98 V
4th	12V	11.98 V
The 5th	12V	11.98 V
Average value	12V	11.98 V

The use of regulators on the Arduino-Based Temperature-Based Fan Speed Monitoring Device is used to provide constant voltage to the minimum system circuit of the device. Based on the datasheet, there are several types of regulator ICs that indicate the output voltage produced. In the Arduino-Based Temperature-Based Fan Speed Monitoring Device Circuit made using the 7805 regulator IC, according to the data sheet on the 7805 regulator IC, it produces a voltage of 5 volts DC which is stated in the two digits from the back on the regulator body. The testing system on the 7805 regulator IC is carried out to determine the output voltage produced by the 7805 regulator IC.

Table 7. IC Regulator Test Results

Test	It is expected	Measurement results	Presentation
1st	5 V	4.96V	0.8%
2nd	5 V	4.96 V	0.8%
The 3rd	5 V	4.96V	0.8%
4th	5 V	4.96V	0.8%

Test	It is expected	Measurement results	Presentation
The 5th	5 V	4.96V	0.8%
Average value	5 V	4.96 V	0.8%

CONCLUSION

This study presents the analysis and design of an IoTbased automated wood drying system capable of realtime humidity monitoring. The integration of IoT technology enables continuous data acquisition and remote supervision, significantly improving control over the drying process. By utilizing sensors and microcontrollers, the system can monitor wood moisture content and environmental humidity, and automatically regulate the drying parameters to optimize energy usage and drying efficiency. The results demonstrate that the proposed system enhances the consistency and quality of wood drying while reducing manual intervention and operational errors. Realtime monitoring ensures timely adjustments, preventing overdrying or underdrying conditions. Furthermore, the system's modular design allows for scalability and future integration with data analytics platforms for predictive maintenance and performance optimization. In conclusion, the developed IoTbased wood drying system provides a reliable, efficient, and intelligent solution for modern wood processing industries seeking to improve product quality and operational efficiency.

REFERENCES

Aulia Rachman, L., & Hasbullah, H. (2022). Fearless Design (Fire Suppression and Smart Alert System) for Gas Leaks. Technomedia Journal, 7(2), 262–279. https://doi.org/10.33050/tmj.v7i2.1904

Aryza, S., Efendi, S., & Sihombing, P. (2024). A ROBUST OPTIMIZATION TO DYNAMIC SUPPLIER DECISIONS AND SUPPLY ALLOCATION PROBLEMS IN THE MULTI-RETAIL INDUSTRY. *Eastern-European Journal of Enterprise Technologies*, (3).

Aryza, S., Lubis, Z., Indrawan, M. I., Efendi, S., & Sihombing, P. (2021). Analyzed New Design Data Driven Modelling of Piezoelectric Power Generating System. *Budapest International Research and Critics Institute-Journal (BIRCI-Journal)*, *4*(3), 5537-5547.

Eko Soemarsono, B., Listiasri, E., & Candra Kusuma, G. (2015). Early Detection Device for LPG Gas Leaks. Tele Journal, 13(1), 1–6. https://jurnal.polines.ac.id/index.php/tele/article/view/150

Fauziyah, IN, Harliana, H., & Gigih, MB (2020). Design and Construction of LPG Gas Leak Detector Using Arduino-Based MQ-6 Sensor. Intech Scientific Journal: Information Technology Journal of UMUS, 2(01). https://doi.org/10.46772/intech.v2i01.185

Hakim, L., & Yonatan, V. (2017). LPG Gas Leak Detection using Arduino Detector with Fuzzy Logic Mandani Algorithm. RESTI Journal (System Engineering and Information Technology), 1(2), 114–121. https://doi.org/10.29207/resti.v1i2.35

Hutagalung, DD (2018). Design and Construction of Gas and Fire Leak Detection Device Using MQ2 Sensor and Flame Detector. Information Engineering Journal, 7(2), 1–11.

Iksal, I., Sumiati, S., & Harizal, H. (2020). Design and Construction of a Prototype for Early Handling and Detection of LPG Leaks Based on Microcontrollers via SMS. PROSISKO

Journal, 3(2), 26–32.
Inggi, R., & Pangala, J. (2021). Design of LPG Gas Leak Detector Using Arduino-Based MQ-2 Sensor. Simkom, 6(1), 12–22. https://doi.org/10.51717/simkom.v6i1.51
Kurnia Hadi, T. (2022). Analysis of LPG Gas Leak Detection Device Design Based on MQ-2 Sensor and Arduino Uno. Jurnal Minfo Polgan, 11(2), 105–108. https://doi.org/10.33395/jmp.v11i2.11804
Mara, IM, Bawa Susana, IG, Alit, IB, Adhi WA, IGAKC, & Wirawan, M. (2023). Counseling on Fire Hazard Prevention Using Household LPG Gas Stoves. Journal of Community Service, 5(1), 9–15. https://doi.org/10.29303/jkp.v5i1.146
Puspaningrum, AS, Firdaus, F., Ahmad, I., & Anggono, H. (2020). Design of Gas Leak Detection Device on Android Mobile Device with Mq-2 Sensor. Journal of Embedded Technology and Systems, 1(1), 1Puspaningrum, AS, Firdaus, F., Ahmad, I., An. https://doi.org/10.33365/jtst.v1i1.714
Ridwan, M. (2021). Design and Construction of an IoT-Based LPG Gas Leak Detection System. Journal of Science and Applied Sciences, 4(1), 35–39. https://doi.org/10.59061/jsit.v4i1.94
Roihan, A., Permana, A., & Mila, D. (2016). GAS LEAK MONITORING USING ARDUINO UNO and ESP8266 MICROCONTROLLERS BASED ON INTERNET OF THINGS. ICIT Journal, 2(2), 170–183. https://doi.org/10.33050/icit.v2i2.30
Suprianto, G., Alya Rizky Natasya, & Arfi Indra Riskiawan. (2023). IoT-Based Gas Leak Detection System as an Assistance Tool for MSMEs. Journal Zetroem, 5(1), 62–67. https://doi.org/10.36526/ztr.v5i1.2631
Lubis, Z., & Aryza, S. (2023). AN IMPROVEMENT CONTROL PERFORMANCE OF AC MOTOR 3 PHASE WATER TOWER CENTRIFUGAL PUMP. *Jurnal Scientia*, *12*(04), 2086-2093.