

AIR QUALITY MONITORING SYSTEM IN LINE PRODUCTION USING RASPBERRY AND IOT

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Abstract

Based on Decree of the Minister of health of the Republic of Indonesia Number 1405 / MENKES / SK / XI / 2002, in the industrial work environment there is a requires limit on temperature, humidity, and carbon monoxide. The threshold value for the temperature is 18 °C - 30 °C, humidity is 65 % - 95 %, and carbon monoxide is 100 ppm. When it is exceeding the specified threshold value, then there will be some symptoms in humans such as respiratory disorders. Based on the problems above, it needs a system in the form of hardware and software which is able to detect temperature, humidity, and carbon monoxide, and also needs a system which is relatively cheap and easy to operate. Unfortunately, this system is not available on the market. Thus, this research aims to make an air quality monitoring system. Air quality monitoring system is a system which is able to detect temperature, humidity, and carbon monoxide. This system is assembled using several components such as Raspberry Pi 3B, MQ-7 sensor, DHT11 sensor, mockup, jumper wire, and breadboard. The component is run by using some software such as Python IDLE and Blynk. To make the system, there are several steps that are carried out. First choose the best framework, where the framework is selected based on price and ability to detect air parameters. After selecting the framework, the next step is assembling. In this step, components that have been purchased are assembled using wiring system. And the last step is testing. Raspberry as the processing module will be connected to the internet for sending the data to Blynk as the server that will be accessed by smartphone which have been integrated with the system. Testing is done by monitoring the air quality on the mockup as a prototype of the production line. It is known that the system can work well. The system detected the temperatures in mockup at 27 °C - 30 °C. The system also detected the humidity at 58 % - 80 %. And the system detected the carbon monoxide at 9 ppm – 11 ppm. Then the test results are analyzed and states that the condition of the mockup room is in the healthy category.

Keyword : Temperature, Humidity, Carbon Monoxide, Air Quality Monitoring System.

1. INTRODUCTION

Based on the Law of The Republic of Indonesia Number 36 Year 2009 Concerning Health [1], Health is a healthy condition, both physically, mentally, spiritually and socially, which enables everyone to live productively socially and economically. It will usually have an impact on the quality of one's work, and its problems have been growing at faster rate especially in urban areas of developing countries where industrialization leads to release of lot of gaseous pollutants. For example, in car factory is shown in Figure 1.1, there is a process which needs make the car's machine must be start. When it is starting, it emits pollution gas in the form of carbon monoxide [2]. The starting machine also makes the surrounding environment become hot and the humidity become decrease. Inhaling too much carbon monoxide can cause nausea, dizziness, and lack of oxygen in the brain. Improper temperatures can cause the body become tired faster. Meanwhile, if the air humidity is too low it causes coughing or flu and if the humidity is too high it causes breathing problems [3]. Based on Decree of the Minister of health of the Republic of Indonesia Number 1405 / MENKES / SK / XI / 2002 [4], the threshold value for temperature, humidity, and carbon monoxide in the industrial work environment shown in Table 1.1.

Table 1.1 Threshold Value in Industry [4]

Parameters	Threshold Value
Temperature	18 °C - 30 °C
Humidity	65 % - 95 %
Carbon Monoxide	100 ppm

Seeing these problems, the authors are interested in making research to produce air quality monitoring systems on the production line. Previous research with the title "Air Quality Monitoring System based on Arduino Microcontroller" conducted by Kaur [5], the microcontroller using Arduino Uno, and Zigbee module as the Wi-Fi module. And on the previous research with title "Implementation of Monitoring System for Air Quality using Raspberry PI: Experimental Study" conducted by Alkandari [6], the microcontroller using Raspberry Pi, and using DHT22 as the sensor for detecting temperature and humidity and using MiCS-5525 as the sensor for detecting carbon monoxide.

In this research, the authors designed an air quality monitoring system using wireless communication by sending information data using the Blynk application which acts as a server. the temperature and humidity sensor used is DHT11, the sensor used for carbon monoxide is MQ-7. Using microcontroller Raspberry Pi 3B as the processing unit. To access the data that has been sent by Raspberry to Blynk, it needs a smartphone that is connected to the internet network.

2. LITERATURE REVIEW

2.1 Raspberry Pi 3B

Despite of the Raspberry Pi size, it has the capabilities to become a fully functioning computer that can run several programs at once [7].

2.2 DHT11

DHT11 is type of sensor used to detect temperature and humidity. It is use for measuring the temperature and humidity by using temperature & humidity sensing technology and digital-signal-acquisition technique with output in the form of calibrated digital signal [5].

2.3 MQ-7

MQ-7 sensor is a semi conduct sensor-tor made of tin dioxide (SnO₂) material sensitive to CO gas [8].

2.4 PCF8591

The PCF8591 is a single-chip, single-supply low-power 8-bit CMOS data acquisition device with four analog inputs. The functions of PCF8591 is 8-bit analog-to-digital conversion and an 8-bit digital-to-analog conversion [9].

2.5 Breadboard

A breadboard is a circuit which if of a temporary nature used for the purpose of testing and prototyping circuits. Breadboards are generally used to test circuits. As this device have holes in it. In order to form a circuit, wires are inserted simply inside the holes. An advantage of using a breadboard is that the positions of the wires can be changed if they are placed in a wrong order [10].

2.6 Jumper Wire

Jumper wire is a cable that physically has a very small size and not too long. Jumper cables are used to connect sensors or breadboard devices to the microcontroller and as a transmission medium for electrical conductors and signals from sensors [11].

2.7 Python

Python is a programming language. Python is used for software development [12].

2.8 Blynk

Blynk is an application for iOS and Android OS to control Arduino, NodeMCU, Raspberry Pi and the likes over the Internet. This application can be used to control hardware devices, display sensor data, store data, visualization, and others [13].

2.9 IoT

Internet of Things (IoT) is a concept / scenario where an object can transfer data over a network without requiring human-to-human or human interaction to a computer [14].

2.10 Waterfall Model

The waterfall model as a design method is the most commonly used for software development. This development model is linear from the initial stage of system development [15].

3. RESEARCH METHODOLOGY

To produce output in accordance with the objectives of the study, it is needed a flow chart that serves to describe the concept of problem solving in a structured way. Flow Process for testing can be seen Figure 3.1.

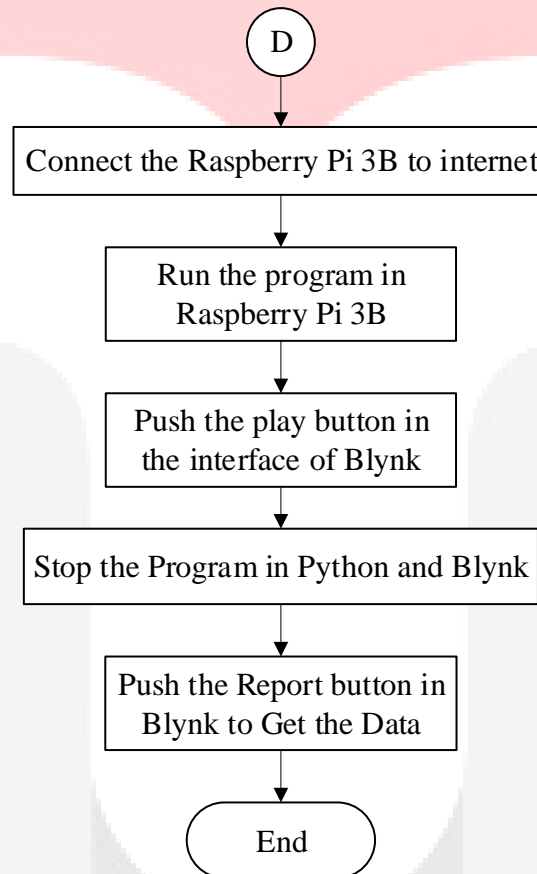


Figure 3. 1 Research Methodology

On the Figure 3.1, it is a flow process for implementing the system. First step to do in this flow process is input the program of sensor into raspberry. Then, make the interface of blynk in smartphone. After that, input the program of blynk into raspberry. Then, connect the raspberry to the internet. If already connected, run the program in raspberry. Next, push the play button on the interface of Blynk.

4. RESULT AND DISCUSSION

a. Temperature's Data

Table 4.1 is the testing data for knowing the system is running or not. The testing data obtained from the detection of DHT11 sensors for temperature in the mockup. Data collection conducted on September 4th, 2019 for one hour from 10:15 to 11:15. According to Decree of the Minister of health of the Republic of Indonesia Number 1405 / MENKES / SK / XI / 2002 [4], to get the actual data, the data collecting should be done in 8 hours. But, in this research, the data collecting is done in one hour because just to know the sensitivity of the sensor.

The data is retrieved from emails sent by the blynk application after pressing the report button on the blynk interface. The data contained in the table is data that has been averaged from the both of DHT11 every minute, so there are as many as 60 pieces of data.

Table 4. 1Temperature Data

Time	Temperature Detected (°C)	Time	Temperature Detected (°C)
9/4/2019 10:15	27	9/4/2019 10:46	28
9/4/2019 10:16	27	9/4/2019 10:47	28
9/4/2019 10:17	27	9/4/2019 10:48	28
9/4/2019 10:18	27	9/4/2019 10:49	28
9/4/2019 10:19	27	9/4/2019 10:50	28
9/4/2019 10:21	27	9/4/2019 10:51	28
9/4/2019 10:22	27	9/4/2019 10:52	28
9/4/2019 10:23	27	9/4/2019 10:53	28
9/4/2019 10:24	27	9/4/2019 10:54	28
9/4/2019 10:25	28	9/4/2019 10:55	28
9/4/2019 10:26	28	9/4/2019 10:56	28
9/4/2019 10:27	28	9/4/2019 10:57	28
9/4/2019 10:28	28	9/4/2019 10:58	28
9/4/2019 10:29	27	9/4/2019 10:59	27
9/4/2019 10:30	27	9/4/2019 11:00	28
9/4/2019 10:31	28	9/4/2019 11:01	27
9/4/2019 10:32	28	9/4/2019 11:02	28
9/4/2019 10:33	28	9/4/2019 11:03	27
9/4/2019 10:34	28	9/4/2019 11:04	28
9/4/2019 10:35	28	9/4/2019 11:05	28
9/4/2019 10:36	28	9/4/2019 11:06	27
9/4/2019 10:37	28	9/4/2019 11:07	29
9/4/2019 10:38	28	9/4/2019 11:08	29
9/4/2019 10:39	28	9/4/2019 11:09	30
9/4/2019 10:40	28	9/4/2019 11:10	30
9/4/2019 10:41	28	9/4/2019 11:11	30
9/4/2019 10:42	28	9/4/2019 11:12	30
9/4/2019 10:43	28	9/4/2019 11:13	30
9/4/2019 10:44	28	9/4/2019 11:14	30
9/4/2019 10:45	28	9/4/2019 11:15	30

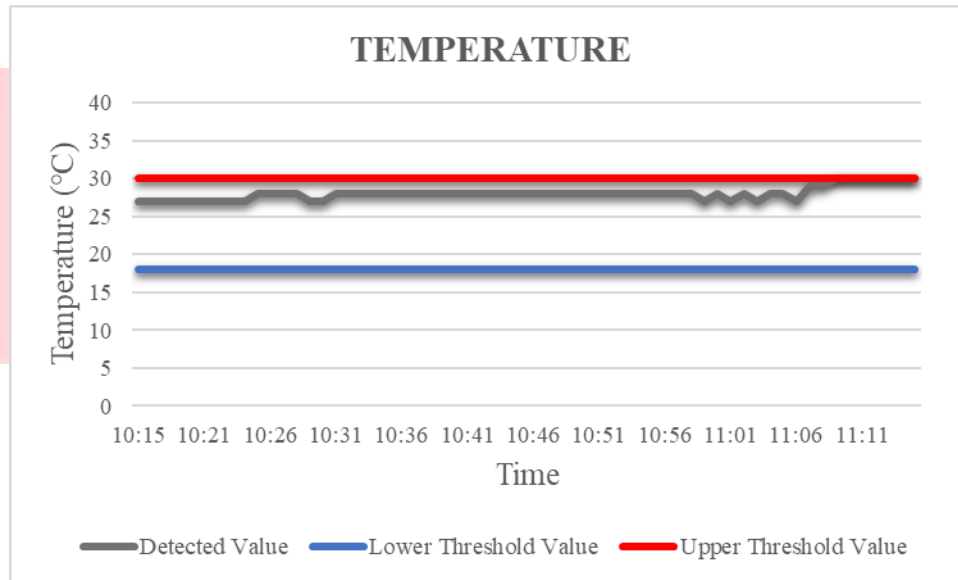


Figure 4. 1 Graphic of Temperature

Figure 4.1 is a graphic of the results of the DHT11 that detects the temperature of the mockup for one hour. This graph is got form Table 4.1. From 10:15 to 10:31 the temperature is at 27 °C - 28 °C. Then at 11:08 to 11:15 the temperature is at 30 °C which is at the upper limit of the threshold value which indicates that the mockup room is already hot for worker. Based on experiments conducted, the overall situation in the mockup is healthy.

b. Humidity’s Data

Table 4.2 is the testing data for knowing the system is running or not. The testing data obtained from the detection of DHT11 sensors for temperature in the mockup. Data collection conducted on September 4th, 2019 for one hour from 10:15 to 11:15. According to Decree of the Minister of health of the Republic of Indonesia Number 1405 / MENKES / SK / XI / 2002 [4], to get the actual data, the data collecting should be done in 8 hours. But, in this research, the data collecting is done in one hour because just to know the sensitivity of the sensor.

The data is retrieved from emails sent by the blynk application after pressing the report button on the blynk interface. The data contained in the table is data that has been averaged from the both of DHT11 every minute, so there are as many as 60 pieces of data.

Table 4. 2 Humidity Data

Time	Humidity Detected (%)	Time	Humidity Detected (%)
9/4/2019 10:15	74	9/4/2019 10:46	68
9/4/2019 10:16	72	9/4/2019 10:47	68
9/4/2019 10:17	72	9/4/2019 10:48	68
9/4/2019 10:18	71	9/4/2019 10:49	68
9/4/2019 10:19	71	9/4/2019 10:50	68
9/4/2019 10:21	71	9/4/2019 10:51	68
9/4/2019 10:22	70	9/4/2019 10:52	68
9/4/2019 10:23	70	9/4/2019 10:53	67
9/4/2019 10:24	70	9/4/2019 10:54	68
9/4/2019 10:25	70	9/4/2019 10:55	65
9/4/2019 10:26	70	9/4/2019 10:56	60
9/4/2019 10:27	70	9/4/2019 10:57	58
9/4/2019 10:28	70	9/4/2019 10:58	58

Table 4. 2 Humidity Data (Cont.)

Time	Humidity Detected (%)	Time	Humidity Detected (%)
9/4/2019 10:29	74	9/4/2019 10:59	63
9/4/2019 10:30	74	9/4/2019 11:00	57
9/4/2019 10:31	70	9/4/2019 11:01	64
9/4/2019 10:32	70	9/4/2019 11:02	63
9/4/2019 10:33	70	9/4/2019 11:03	65
9/4/2019 10:34	70	9/4/2019 11:04	58
9/4/2019 10:35	70	9/4/2019 11:05	59
9/4/2019 10:36	70	9/4/2019 11:06	72
9/4/2019 10:37	70	9/4/2019 11:07	64
9/4/2019 10:38	70	9/4/2019 11:08	63
9/4/2019 10:39	69	9/4/2019 11:09	62
9/4/2019 10:40	69	9/4/2019 11:10	58
9/4/2019 10:41	69	9/4/2019 11:11	60
9/4/2019 10:42	69	9/4/2019 11:12	60
9/4/2019 10:43	69	9/4/2019 11:13	78
9/4/2019 10:44	68	9/4/2019 11:14	74
9/4/2019 10:45	68	9/4/2019 11:15	73

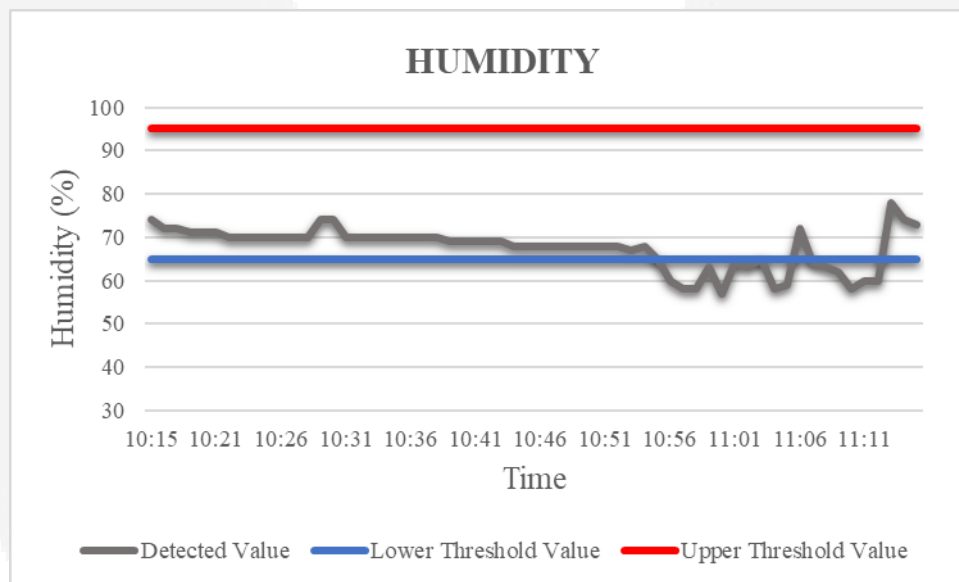


Figure 4. 2 Graphic of Humidity

Figure 4.2 is a graphic of the results of the DHT11 that detects the humidity in the mockup for one hour. This graph is got from Table 4.2. From 10:54 to 10:24 the humidity is at the level of 70%. Then at 10:55 to 10:57 the temperature is at the level of 58% which is in the outside range of values that should be. Then at 11:13 until 11:15 the humidity is at the level of 80%. Based on experiments conducted, the overall situation in the mockup is on the range of threshold value. It shows that air condition around the mockup is healthy for worker.

c. Carbon Monoxide's Data

Table 4.3 is the testing data for knowing the system is running or not. The testing data obtained from the detection of DHT11 sensors for temperature in the mockup. Data collection conducted on September 26th, 2019 for one hour from 10:11 to 11:10. According to Decree of the Minister of health of the Republic of Indonesia Number 1405 / MENKES / SK / XI / 2002 [4], to get the actual data, the

data collecting should be done in 8 hours. But, in this research, the data collecting is done in one hour because just to know the sensitivity of the sensor.

The data is retrieved from emails sent by the blynk application after pressing the report button on the blynk interface. The data contained in the table is data that has been averaged from the both of MQ-7 every minute, so there are as many as 60 pieces of data.

Table 4. 3 Carbon Monoxide Data

Time	CO Detected (ppm)	Time	CO Detected (ppm)
9/26/2019 10:11	97	9/26/2019 10:41	98
9/26/2019 10:12	97	9/26/2019 10:42	99
9/26/2019 10:13	96	9/26/2019 10:43	99
9/26/2019 10:14	96	9/26/2019 10:44	99
9/26/2019 10:15	97	9/26/2019 10:45	99
9/26/2019 10:16	96	9/26/2019 10:46	99
9/26/2019 10:17	96	9/26/2019 10:47	99
9/26/2019 10:18	96	9/26/2019 10:48	99
9/26/2019 10:19	97	9/26/2019 10:49	99
9/26/2019 10:20	97	9/26/2019 10:50	99
9/26/2019 10:21	97	9/26/2019 10:51	99
9/26/2019 10:22	98	9/26/2019 10:52	99
9/26/2019 10:23	98	9/26/2019 10:53	99
9/26/2019 10:24	98	9/26/2019 10:54	99
9/26/2019 10:25	98	9/26/2019 10:55	99
9/26/2019 10:26	98	9/26/2019 10:56	99
9/26/2019 10:27	99	9/26/2019 10:57	100
9/26/2019 10:28	99	9/26/2019 10:58	100
9/26/2019 10:29	99	9/26/2019 10:59	101
9/26/2019 10:30	99	9/26/2019 11:00	101
9/26/2019 10:31	99	9/26/2019 11:01	101
9/26/2019 10:32	99	9/26/2019 11:02	101
9/26/2019 10:33	99	9/26/2019 11:03	100
9/26/2019 10:34	99	9/26/2019 11:04	100
9/26/2019 10:35	99	9/26/2019 11:05	100
9/26/2019 10:36	99	9/26/2019 11:06	99
9/26/2019 10:37	99	9/26/2019 11:07	99
9/26/2019 10:38	99	9/26/2019 11:08	99
9/26/2019 10:39	99	9/26/2019 11:09	99
9/26/2019 10:40	99	9/26/2019 11:10	99

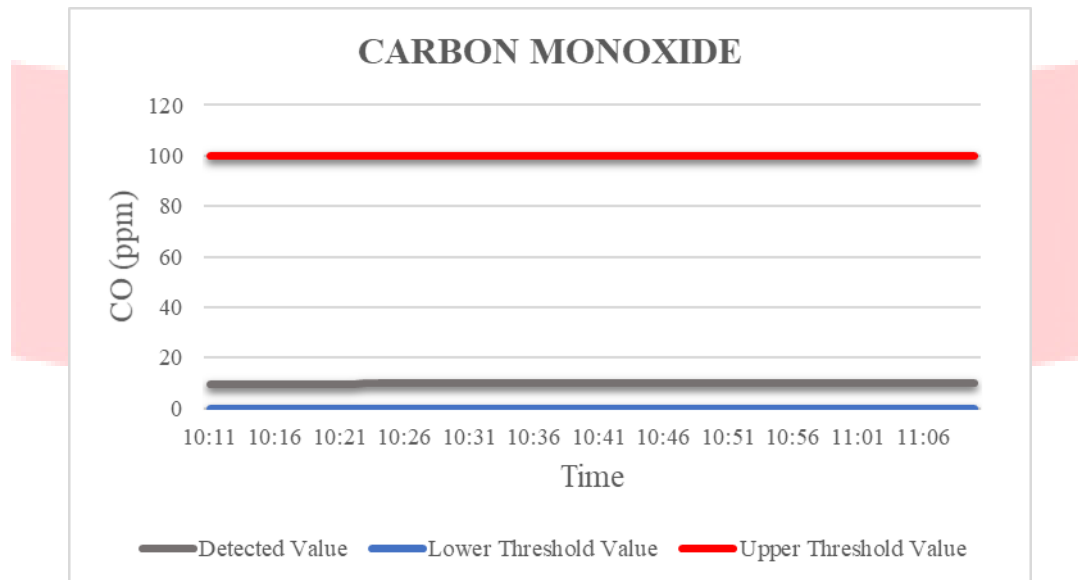


Figure 4. 3 Graph of Carbon Monoxide

Figure 4.3 is a graphic of the results of the MQ-7 which detects carbon monoxide gas in the mockup for one hour. This graph is got from Table 4.3. From 10:11 to 11:10 carbon monoxide is between 9 ppm and 11 ppm. This shows the carbon monoxide in the mockup is below the upper limit of threshold value which means that the air condition in the mockup is still healthy.

The values produced in table 4.3 state that all values are more than 100 ppm which is on the threshold value which means that there is a lot of carbon monoxide in the air around the mockup. Even though at the time of data collection, there was actually no carbon monoxide source.

Because there is no carbon monoxide source and when the data is taken nothing happens to humans, so the value is divided into 10 to state that the value is below 100 ppm where at a value below 100 ppm states that air quality is healthy.

5. CONCLUSION

Based on research that has been done on the manufacture of air quality monitoring systems, the following conclusions are obtained:

1. From several frameworks has been chosen based on the budget and the function. The budget of selected framework is IDR 852.000 consists of Raspberry Pi 3B, MQ-7 sensor, DHT11 sensor, PCF8591, and jumper wire. The DHT11 to detect temperature and humidity, MQ-7 to detect carbon monoxide. The Raspberry as the processing unit and the PCF8591 as the converter for calibration of MQ-7 sensor. This framework is created schematic diagram using fritzing as the software for designing the wiring system.
2. Based on the schematic diagram, device system is constructed on the breadboard to connected each component. The line production prototype is described by mockup. The Mockup's engineering drawings was made using solidwork software which consists of 3 parts namely DHT11 sensor, MQ-7 sensor, and factory. Its dimensions are 32 x 8 x 12 cm which made of acrylic material. Python program is created to run the device that are program import source code of components, setup the components, and looping process of components. The program will be process in raspberry to send data from the sensor to Blynk server in internet, and it accessed by smartphone which have been integrated with the device.
3. The device testing is done on a mockup for one hour, and the data displayed on Blynk in smartphone which is the graph of temperature, humidity, and carbon monoxide. The graph of the X-axis mean real time and the Y-axis mean value of temperature, humidity, and carbon monoxide. The data range of temperatures at 27 °C - 30 °C, the humidity at 58 % - 80 %, and the carbon monoxide at 9 ppm – 11 ppm. Then the test results are analyzed by comparing to the Decree of the Minister of Health of the Republic of Indonesia and states that the condition of the mockup room is in the healthy category.

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