DESIGN OF AIR QUALITY MONITORING SYSTEM IN OFFICE WORKSPACE WITH MQ135 SENSOR

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Abstract. The indoor air quality is a critical issue that must be addressed as it can have an impact on human health. The numerous activities taking place indoors can lead to air pollution,making it a serious concern. Indoor air pollution sources include cigarette smoke and emissionsfrom electronic devices. Therefore, there is a need for a device to monitor the indoor air pollution levels, as well as to determine the temperature and humidity in the surroundings, aiding in measuring air quality. Data collection was conducted in the offices of the BPBD Ciamis City, with a focus on measuring the concentration of carbon dioxide (CO_2). This systemis designed using an MQ135 sensor to detect CO_2. The system can monitor and measure the air quality indoors, displaying two conditions: good and hazardous air quality. Additionally, the system incorporates notification features to alert occupants about the air quality in the surrounding area. With this information, workers can determine whether the environment is safe or hazardous to their health. The assessment index for good or hazardous air quality, basedon PMK RI Number 1077 of 2011, establishes a minimum limit for CO_2 concentration at 1000 ppm (parts per million). It is expected that the implementation of the indoor air quality monitoring system can create a healthier and more comfortable environment for occupants.

Keywords: Air Quality, MQ135, Monitoring, CO_2, Notification, System.

1 INTRODUCTION

Today's developments have changed manyaspects of life, not only in the industrial sphere, but also affecting many areas of everyday life, one of which is air. Air is a mixture of gases thatencircles the planet Earth that is a vital component for the survival of all beings, including humans, animals, and plants. Human activity has changed air quality, there are severalmajor factors that affect indoor conditions such as smoking habits and the use of chemicals. Smoking smoke is one of the factors that can cause health-threatening air pollution wheninhaled [1].

Poor air quality can seriously affect human health and comfort. Indoor air pollution caused by smoking habits and the use of chemicals can lead to a variety of health problems, such as headaches, eye irritation and respiratory problems. At the moment most people just judgethe air quality by merely exploring the sky or guessing.

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Nowadays, Internet of Things technology is increasingly used, especially for environmental monitoring. The use of IoT in air quality monitoring systems allows faster data processing. Improving the responsiveness and efficiency of air quality surveillance is essential. With the advancement of technology, robotics has become increasingly important in science and other fields such as agriculture, medicine and even the military. Nowadays, robotics hasentered human everyday life in a variety of ways[2].

The MQ135 sensor detects the air quality andcollects data from which the data can be monitored using smart phone, the system is also equipped with notifications that can provide information about indoor air quality. To ensure that a working environment remains healthy and comfortable, the indoor air quality standardization assessment index measures the levels of carbon dioxide (CO_2) in ppm (parts permillion), at a rate of 1000 ppm withmeasurements carried out for 8 hours. This indicates that indoor Air quality must beined so that CO_2 levels do not exceed the standard limit.

2 LITERATURE REVIEW

2.1 Air

Air is a mixture of various gases that arecolorless, have no smell, and are everywhere. The air also contains bacteria, dust and others, which can be harmful to health [4]. All the gaseson the surface of the earth are made up of air. We breathe air that consists of 78% nitrogen, 21% oxygen and the rest of gas, liquid and solid. When the air conditions change from normal conditions and interfere with the lives of humansand other living creatures, it indicates that the airis polluted [5].

1. Carbon dioxide (CO_2), is a kind of chemical compound consisting of two oxygen atoms covalently bound to a carbon atom. Based on volume, the average concentration of carbon dioxide in the Earth's atmosphere is about 387 ppm, but this amount can vary depending on location and time [6].
2. *Part per Million* or ppm is a unit ofconcentration commonly used in chemistry, which indicates the amount of a compound in a solution. Including the salt content of seawater, pollutants or iodine content in salt is also expressed in ppm. Ppm shows a comparison between the quantity of such compounds and onemillion parts of the measured system [7].

2.2 WhatsApp Bot

The WhatsApp Bot is a computer program that is programmed to automatically respond to questions, product or service related, share content and send notifications. The bot can provide responses such as text messages, pictures, or videos that can help get help in real time [8]. There are also bots used for IoT purposes, where users can control and monitor IoT devices. With this integration, they can quickly monitor device status, control devices such as room temperature and lighting.

2.3 Blynk

Blynk is an app for iOS or Android that can beused to operate Arduino, Raspberry Pi, Wemos, and other similar modules remotely. Blynk applications have three main components: Applications, Servers, and Libraries. The Blynk server is responsible for managing communication between hardware and smartphones. Button, Value Display, History Graph, Twitter, and Email are some blynk widgets. While not limited to the type of microcontroller, Blynk requires support from theselected hardware [9].

2.4 NodeMCU ESP8266

NodeMCU is an Internet of Things (IoT) product development board based on Firmware eLua and System on a Chip (SoC) ESP8266-12E. ESP8276 itself is a WiFi chip with a complete TCP/IP protocol stack. To operate the ESP8266 requires a working voltage that follows the JEDEC voltage standard, which is 3.3V, unlike the AVR microcontroller and most Arduino boards that use a TTL voltage of 5 volts. Although the standard voltage is 3 volt. The 3 volt (3V), NodeMCU still allows connecting to a 5 volt (5V) axle using the micro USB or V_{in} pin ports available on the board, with the operating voltage configuration according to user requirements [10].

2.5 Sensor MQ135

The MQ-135 is an air sensor to detect ammonia gas (NH_3), sodium (di) oxide (NO_x), alcohol/ethanol (C_2H_5OH), benzene (C_6H_6), carbon dioxides (CO_2), sulphur gas/sulphur- hydroxide (H2S) and other gases present in the atmosphere. The MQ-135 sensor output for air quality detection shows a change in the analogueresistance value on the output pin [11].

2.6 OLED 0,96

OLED 0.96 is a 0.96-inch graphics display with a resolution of 128 x 64 pixels using OLEDtechnology. The 0.96 OLED uses 2 pins namely SDA and SCL pins so it can save pins, which communicate I2C series. The OLED display differs from the LCD screen, the 2.9 OLED screens, capable of generating its own light from each of its own pixels without requiring additional backlights, so the display on the OLED monitor is brighter and clearer. OLED provides a clearer image quality/appearance compared to the LCD [12].

According to Sugiyono, the researchmethod is a scientific way to obtain data for a specific purpose and use [13]. Research methodsare closely related to the methods, techniques, tools and design of the research used. The research design must match the chosen research approach.

Research Phase

This research phase covers comprehensive stepsranging from the initial stage of problem identification to the planning phase and the final phase of analysis and conclusion.

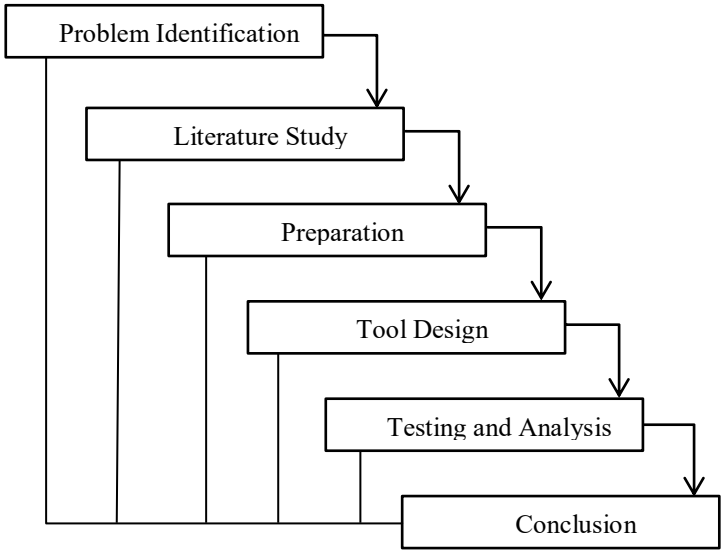

Figure 1. A Research Phase

1. Problem identification, The purpose of the problem identification setting is to keep research focused on indoor air quality monitoring systems, especially to detect carbon dioxide air pollution. Once the problem is discovered, the systems and devices developed areexpected to be able to effectively identify the levelof CO_2 pollution in the office workroom environment. After conducting observations in theoffice of BPBD Ciamis on June 7, 2024, it was found that various activities, such as the use of chemicals, the presence of cigarette smoke, dust, and poor ventilation, could deteriorate air quality.
2. Collect references, Collect references on similar systems from journals, dissertations and other sources throughliterary studies. The purpose of this process is togain an understanding of the tools to be used, as well as to study the applications used in similar research from previous research. Previous research on “Air Quality MonitoringSystem Using ESP32 Microcontroller with Internet of Things-Based MQ2 Sensor” by Andiko Pridiantoko Putro, etc. in 2023, specifically explored the MQ2-sensor in the detection of hazardous gas (CO) concentrations [3].
3. Preparations, in this study, the preparations were carried outcarefully to assemble the necessary equipment, including the MQ-135, the DHT11, the ESP8266, and the 0.96 Oled screens, all of whichwill be used to support the planning and analysisthat will be undertaken.

4. Tool Design, the design of this instrument indicates the physical form of the instrument which should beprovided to facilitate the research process. There are two parts in the tool design: The hardware design is used as the planning material for the design, namely by designing the tools that will be used as follows: ESP8266, MQ-135, Oled 0.96, jumper cable, and others. The architectural design of the tool can be seen in Figure 2. Architectural Design of the Tool.

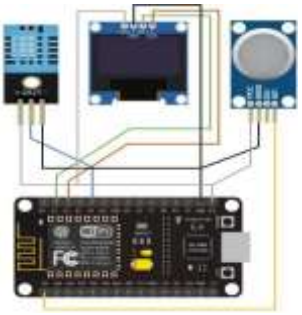

Figure 2. Architectural Design of the Tool

5. Testing and Analysis, instruments are tested to ensure that the instruments made work as planned. The objectiveis to ensure the performance of the device in monitoring indoor air quality. Analysis of data toidentify whether or not the air quality is bad.
6. Conclusions, in the final phase this involves drawing conclusions from the entire system development process. The results of the analysis will then be used to draw conclusions.

3 RESEARCH AND DISCUSSION

3.1 System Testing

System testing is done to ensure that the device can work properly. The device will measure the concentration of CO_2, as well as temperature and humidity. Tests will be carried out on cigarette smoke and various roomconditions. The test will be placed in the office workspace, aimed at measuring the air quality inthe working environment.

1. Testing on cigarette smoke, system testing is done on figure 3, to find outthat the tool can work properly. This test uses cigarette smoke because cigarette fumes contain carbon dioxide (CO_2). This test showed that ppm reached 1982.97, which is where the air quality is dangerous. In the Blynk app, all the information from each sensor is displayed fully.

Figure 3. Testing on Cigarette Smoke

2. Testing in the Office Workspace, The testing of the air condition in the Drainageand Logistics field room can be seen in Figure 4, with the condition that there are 6 people in it, performed monitoring of air quality tomeasure the air conditions. This monitoring is carried out in order to determine whether the condition of the room belongs to the clean or hazardous category. The device testing and data collection process took about eight hours with changes in weather conditions. The test will takeplace on June 10, 2024, from 8 a.m. to 3 p.m..

Figure 4. Testing in The Office Workspace

The testing in the Rehabilitation and Reconstruction field room can be seen in Figure 5, with the condition that there are 5 people in it, performed monitoring of air quality tomeasure the air condition. This monitoring iscarried out in order to determine whether the condition of the room belongs to the clean or hazardous category. The device testing and data collection process took about eight hours with changes in weather conditions. The test will takeplace on June 11, 2024, from 8 a.m. to 3 p.m..

Figure 5. Testing in The Office Workspace

3.2 Test Results

After testing and measuring the concentration of carbon dioxide (CO_2) for eight hours in the two rooms. The test results of this device can beseen in Figure 6. It is the result of a test of the device on the premises of the Drainage and Logistics field on June 10, 2024, which was conducted for 8 hours from 08:00 to 15:00. It is seen on Figure 14, that the air temperature ranged between 28.00°C to 29.80°C during the test period from 10:00 to 14:00. The air humidity also changed from 70.00% to 80.00%. For air quality(CO_2) showed values ranging from 239.78 ppm to 299.82 ppm during the test period. Despite some changes in the value, the indoor air quality is recorded as "clean". The average during the clearance period is 262.39 ppm, which indicates that this indoor environment is considered safe.

Tempat Pengujian	Waktu Pengujian	Suhu	Kelembapan	Kadar CO_2 (ppm)	Kualitas Udara
Ruang Bidang KL	08:00	28.00 °	70.00 %	239.78	Bersih
	09:00	28.70 °	70.00 %	248.24	Bersih
	10:00	29.80 °	74.00 %	253.90	Bersih
	11:00	29.80 °	76.00 %	273.30	Bersih
	12:00	29.80 °	80.00 %	246.78	Bersih
	13:00	29.80 °	80.00 %	299.82	Bersih
	14:00	29.80 °	78.00 %	276.16	Bersih
	15:00	28.60 °	78.00 %	261.17	Bersih
Rata - rata				262.39	Bersih

Figure 6. Air Quality Test Result in KL Office

Tempat Pengujian	Waktu Pengujian	Suhu	Kelembapan	Kadar CO_2 (ppm)	Kualitas Udara
Ruang Bidang RR	08:00	28.20 °	78.00 %	246.63	Bersih
	09:00	28.20 °	78.00 %	248.24	Bersih
	10:00	29.80 °	80.00 %	255.55	Bersih
	11:00	29.80 °	80.00 %	264.46	Bersih
	12:00	29.80 °	84.00 %	283.89	Bersih
	13:00	29.80 °	80.00 %	261.43	Bersih
	14:00	29.80 °	78.00 %	266.57	Bersih
	15:00	29.80 °	78.00 %	265.33	Bersih
Rata- rata				261.51	Bersih

Figure 7. Air Quality Test Result in RR Office

The results of the testing of the device in the Rehabilitation and Reconstruction room on 11 June 2024 were conducted for 8 hours from 08:00 to 15:00. It can be seen in Figure 7, that the air temperature ranges from 28.20°C to 29.80°C between 10:00 and 15:00. The air humidity also showed a change from 78.00% at 08:00 to 84.00% by 12:00, and returned to 78,00%. For air quality (CO_2), the values rangedfrom 283.89 ppm at 08:00 until an increase at 12:00 at 299.82 ppm, and went back down to 261.43 at 13:00 and continued to change over theremainder of the test period. Despite some changes, the indoor air quality of the Rehabilitation and Reconstruction field is recorded as "clean". The average during the refurbishment period is 261.51 ppm, which indicates that this indoor environment is considered safe.

3.3 Analysis of Test Results

This measurement indicator uses PMK No. 1077 by measuring indoor air quality levels, a provision that includes CO_2 (Carbon Dioxide) parameters in units of ppm, with a maximum limit set at 1000 for measuring standards. Measurement indicators can be seen in table 1.

Table 1. Standards Measurement Indicators

No	Jenis Parameter	Satuan	Kadar Maksimal dipersyaratkan	keterangan
1	Sulfur dioksida (SO_2)	Ppm	0,1	24 Jam
2	Nitrogendioksida (NO_2)	Ppm	0,04	24 Jam
3	Carbon monoksida(CO)	Ppm	9,00	8 Jam
4	Carbondioksida (CO_2)	ppm	1000	8 Jam

On table 1, the MQ135 sensor candetect the concentration of CO_2 in the air. In the KL Fields, the air quality varies between 239.78ppm to 299.82 ppm, while in the RR Field, the value ranges between 246.63 ppm and 283.89 ppm. In addition, the DHT11 sensor measures temperature and humidity well. Figure 8 is an assessment of the indoor air quality index, whererooms in the fields of Insolvency and Logistics and Rehabilitation and Reconstruction have high quality with a category of less than 400 ppm.

Kualitas	Kategori	Keterangan
Kualitas Tinggi	Kurang dari 400	Udara dalam kategori ini sangat baik. Kondisi ini ideal untuk ruangan yang sering digunakan.
Kualitas Menengah	400 – 600	Udara dalam kategori ini masih tergolong baik. Peningkatan ventilasi diperlukan untuk menjaga kenyamanan
Kualitas Sedang	600 - 1000	Udara dalam kategori ini cukup buruk. Bisa mempengaruhi kenyamanan dan konsentrasi
Kualitas Rendah	Lebih dari 1000	Udara dalam kategori ini buruk. Berdampak pada kesehatan seperti sakit kepala, kelelahan dan masalah pernapasan.

Figure 8. Indoor Air Quality Index (Resource: www.airgradient.com)

4 CONCLUSION AND SUGGESTION

1. Based on the results of this final task, some conclusions can be drawn, as follows :
   a. The system has been designed to workaccording to its function, it is also effective in monitoring air quality, especially in measuring carbon dioxide (CO_2) parameters. The system automatically sends notification messages via WhatsApp when ppm exceeds the limit (1000 ppm). The system successfully sends real-time air quality data to the blynk platform, where users can monitor indoor weather conditions through the Blynk app that can be accessed using mobile phones.
   b. After testing the device in several rooms for CO_2 concentrations. The results of thistest show that the CO_2 levels in each roomare below 1000 ppm, this indicates that theair quality meets the standard.
2. Through this research, the design and development process can be further improved,here are some suggestions to optimize this system:
   a. By adding the number of sensors at severalpoints in the room, the system can detect air pollution more efficiently.
   b. By adding a data storage feature, so that theair quality data can be stored for further routine analysis.
   c. To keep the sensor active when the power is out is expected to be equipped with a battery or other power source.

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