# IoT-based Alcohol Detection Prototype for Public Transportation Drivers

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***Abstract*— Excessive consumption of alcoholic beverages can reduce a person's performance in driving, increasing the risk of accidents. By using the latest technology, such as IoT, alcohol content detection for public transportation drivers can be carried out. Here, we proposed the IoT-based prototype using an MQ3 sensor that will detect alcohol content or more from the exhalation of the driver. For real-time monitoring, the device will connect to the company management's smartphone using Blynk and send the notification via the Internet. We developed the prototype using the Research and development approach. From the evaluation, we can conclude that the prototype can give a fast detection response (3 seconds) if the distance is not more than one centimeter. It will respond in 5 seconds for 3 centimeters distance, and it did not give a response for more than 3 centimeters distance. In the product trial, we used beer (5% alcohol), Red Wine (10% alcohol), Soju (20% alcohol) and Vodka (40% alcohol). The system can also notify management if it detects 5% or more alcohol content.**

***Keywords*— IoT, alcohol detection, MQ3 sensor, public transportation***

## I. Introduction

Alcoholic beverages are one type of addictive substance whose misuse seriously impacts public health and social problems [1]. Consuming excessive amounts of alcoholic beverages is the leading cause of various criminal acts or law violations. If alcohol is consumed in excess, it can cause symptoms of euphoria that can cause fear and reluctance in those who drink it [2].

In the Regulation of the Indonesian Ministry of Health No.86/MenKes/Per/IV/1977, which regulates the production and circulation of liquor, what is meant by liquor is all types of alcoholic beverages but not drugs. includes three groups, namely: Group A, with an ethanol content of 1-5%. Group B had ethanol levels greater than 5-20%. Group C, with ethanol levels of more than 20-55%. Dizziness, nausea, vomiting, abdominal discomfort, and slurred speech are symptoms of drowning that can be brought on by alcohol levels (moderate) of 1-5%. High levels of alcohol (20-50%) can cause severe symptoms of ataxia, double or blurred vision, fainting, and occasionally convulsions, as well as a high risk of coronary heart disease and kidney failure. Moderate levels of alcohol (5-20%) can cause problems with vision, seizure loss, ataxia, and slow reaction times [3].

Accidents occurring during driving are another implication of alcohol abuse. Consuming too many alcoholic beverages can reduce human driving performance, increasing the risk of accidents. According to records from the National Police Corps [4], hundreds of thousands of traffic accidents in Indonesia occur yearly. From 2019 to 2021, human factors were as much as 97.48%, natural factors 0.08%, road factors 0.69%, and vehicle factors 1.75%. Human factors are the most critical factors. One of them is caused by drunk drivers.

By using the latest technology, such as IoT, alcohol content detection for public transportation drivers can be carried out. There are several studies related to making prototypes of alcohol detection for drivers of public transportation cars through mobile-based exhalation, such as [5], resulting in an alcohol detection device with exhalation on the steering wheel of the car using the MQ3 sensor with a distance of 5 cm. The device was also connected to an application through the GSM module to monitor the driver. If the alcohol level detected in the car driver exceeded the specified limit, the GSM module sent an SMS to the registered mobile number. Furthermore, in [6], an alcohol detection device was developed for car drivers using an Arduino Uno microcontroller and an MQ3 sensor to detect alcohol from exhalation. As an assumption for vehicle engines, the DC motors are used for the control system, and the use of GSM modules is used as a monitoring system. If the alcohol level exceeds the specified limit, the system turns off the vehicle's engine and sends the authorities a warning message via the GSM module.

The tool will connect with the Blynk application to the company manager's smartphone via an Internet network. He also can monitor the Drivers who consume alcoholic beverages. If the alcohol content detected by the driver exceeds 5%, the system sends a notification to the user's smartphone, and there is also an automatic system to turn off the engine. DC motor is assumed to be a car engine, and two yellow LED lights are hazard lights on the car.

## II. Methods

### *A. Data Collection Methods*

To obtain the information and data needed we use several data collection methods to obtain the information needed in research, in addition to supporting the theoretical basis. An interview was conducted to identify the obstacles of a Bus Company when monitoring bus drivers who are drunk while driving. The conclusion from the interview is that there is no monitoring system for bus drivers in the company, and often, the company feels disadvantaged due to drunk drivers and accidents.

### *B. System Development Methods*

In this study, the Research and Development (R&D) system development methodology was used. The author uses this method because it can shorten the time required to produce the right product or tool. The steps of the R&D

method are potential and problems, data collection, product design, product trails and product revisions [7].

*1) Potential and Problems*

The potential and problems in this study, namely an interview was conducted with the bus company to find out the description of the system needed, and then used as a consideration in building the required system. Based on the analysis that has been done, the system that has been running so far can be seen as follows.

After knowing the current system, it can then be concluded that no system can detect alcohol in the driver when driving in real-time and can send notifications to the user's smartphone. Therefore, the author proposes a proposed system in the following figure.

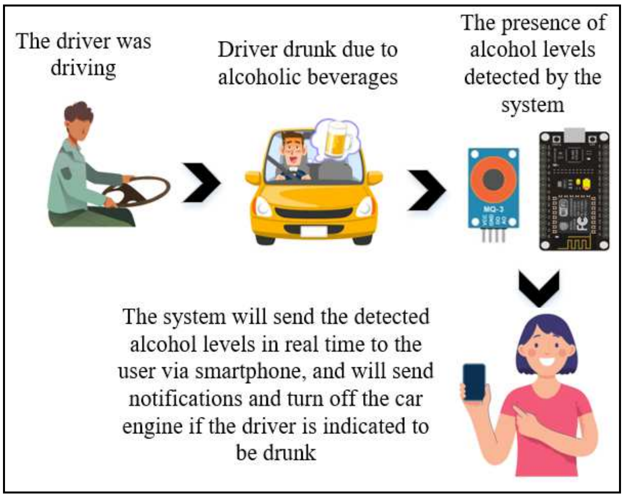


Fig. 1. Proposed system analysis

*2) Data Collection*

At this stage, the author collected data by interviewing with related parties and conducting literature studies. The results of the data collection authors obtained data about habits and constraints, components, tools, theories to be used, and data on the design and process of making tools and systems.

*3) Product Design*

In the product design stage, the focus is on developing an alcohol detection system that will focus on making blog diagrams and flowcharts. Blog diagrams and flowcharts are divided more specifically into the functions used in the system, broadly starting from the NodeMCU ESP8266 to control and process input from the MQ3 sensor that controls the relay connected to the DC motor, and the data are then sent with the ESP8266 Wi-Fi chip to the Blynk server, thus producing output. A system design architecture scenario is presented as a blog diagram.

The tool works from the power supply that provides the amount of power needed by the NodeMCU ESP8266 microcontroller and other circuits. The MQ3 sensor then sends the measurement results to a microcontroller. The microcontroller then sends the processed sensor data to the ESP8266 WiFi chip, which is then sent to the Blynk server and displayed in real-time on smartphones and LCDs.

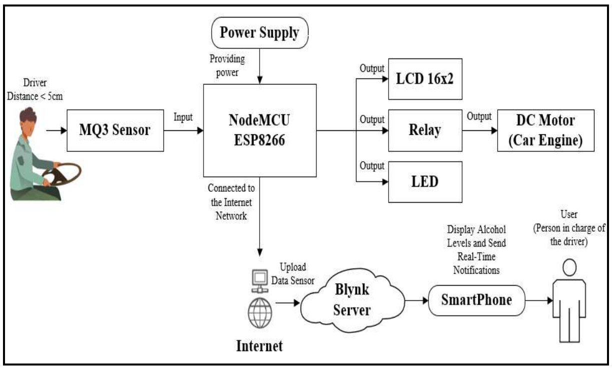


Fig. 2. Block system diagram

*4) Product Trials*

At this stage, a user acceptance test is carried out, namely, black-box testing, the way the test is performed by running or executing units or modules, and then it is observed whether the results of the unit are as desired by the user. Furthermore, functionality and performance testing will be performed to determine the success rate of the MQ3 Sensor, the response time of the ESP8266 Wi-Fi module, and the response time of the relay. The test results were observed to obtain data that discussed in the research results.

*5) Product Revisions*

The product revision stage was carried out after product trials and thorough system testing. The author revised the form to evaluate the system's performance and whether it is running according to its function. If so, the stage proceeds to the next stage. Otherwise, the previous steps are repeated.

## III. Results And Discussion

### *A. Flowchart system*

The following is an explanation from Figure 3 as follows.

- The first process is the initializing of each component connected to the ESP8266 NodeMCU, such as MQ3 sensors, Relays, LCDs, and LEDs.
- Furthermore, the MQ3 sensor detects alcohol levels.
- The first condition is that if the detected alcohol content is <=5%, then the LCD will print "Normal" and the relay is open, which means the engine is on. In this study, the author used an alcohol content of <= 5% because this level is included in Group A following the regulations of the Ministry of Health No. 86. At this level, usually a person is still conscious and has not experienced drunkenness.
- The second conditioning is if the detected alcohol content is >5% and <=20%, then the LCD will print "Drunk," and the LED will blink. The Relay is closed, which means the engine is off and sending notification messages on the Blynk application. In this study, the author used alcohol levels of >5% and < 20% because these levels were included in Group B following the Ministry of Health Regulation No. 86. At this level, the person is slightly drunk.

In the third conditioning, if the detected alcohol content is >20%, then the LCD will print "Danger," the LED will blink, and the Relay is closed, which means the engine is off, sending notification messages on the Blynk application. In this study, the author used an alcohol content of >20%.

This level was included in Group C following the regulations of the Ministry of Health No. 86. At this level is the highest level of alcohol that humans can consume because it can make a person drink heavily, namely, loss of consciousness. The system developed are described as follow.

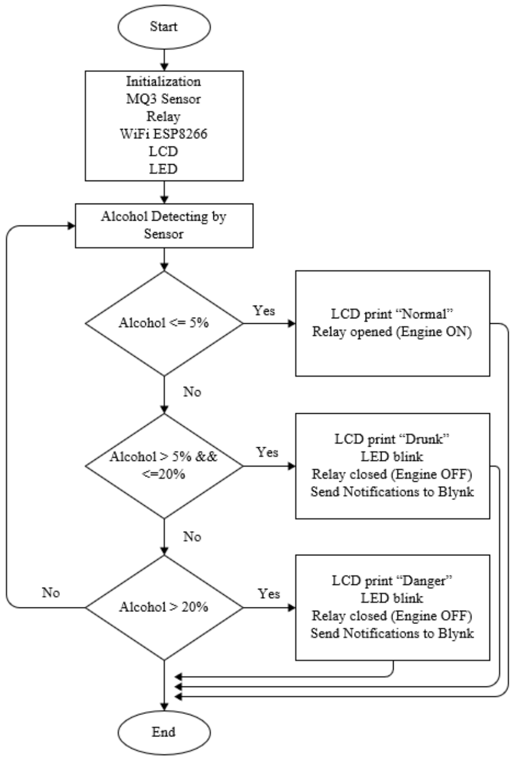


Fig. 3. Flowchart system

## B. *Schematic Design of Tools*

In this schematic design, the NodeMCU ESP8266 can connect with other devices such that it becomes a unified tool.

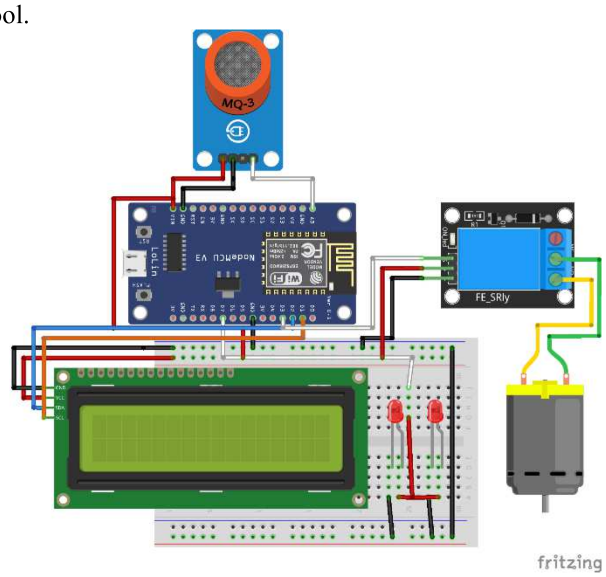


Fig. 4. Schematic of the tool suite

The electronic circuit design in Figure 4 is designed using the Fritzing software because it is very easy to use [8]. It can be seen in the schematic combination of each hardware component. NodeMCU ESP8266 is the main component (microcontroller) for controlling all components. NodeMCU ESP8266 will receive input from all connected components, process the received data, and then send it to the Blynk server over the internet network. Then, send it to the Blynk server over the internet network.

## C. *Product Prototype Display*

In the building phase of this system, the focus is on developing a prototype alcohol detector using a mobile-based MQ3 sensor. Then, the components and modules are prepared by referring to the pin configuration determined at the schematic stage.

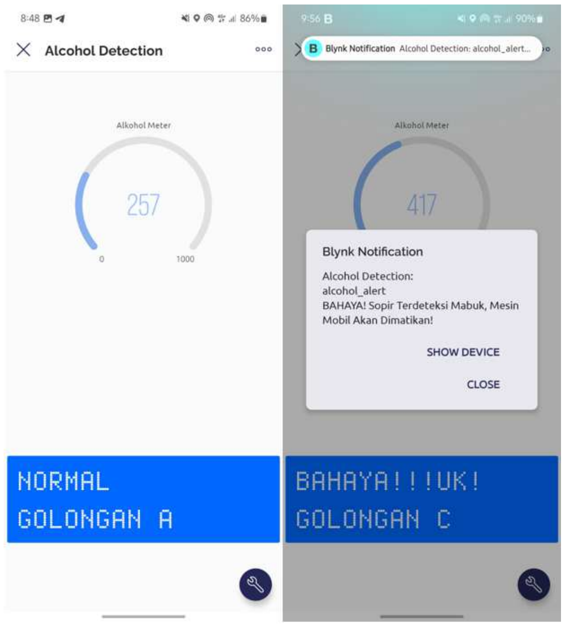


Fig. 5. Display of Blynk Application on Smartphone

## D. *Testing*

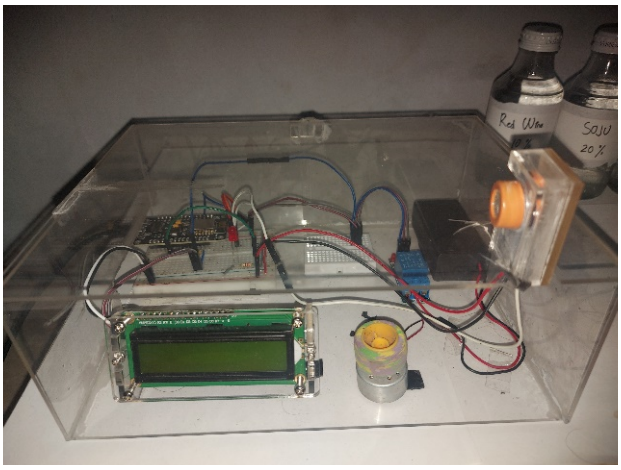

Fig. 6. Prototype view

In the testing stage, we used the Black-box Testing method, which is the way testing is done by running or executing units or modules; then, it is observed whether the results of the unit are as desired [9]. We test microcontrollers and other tools that are assembled and connected to each other to determine whether the function has run according to the design and program code that has been made.

To test the alcohol detection device using the MQ3 sensor, the author made several samples of alcoholic beverages using a dilution formula. Dilution converts a thinner solution from a more concentrated solution by adding a certain amount of solvent to a solution of a specific volume and concentration [10]-[13]. Alcohol dilution is the process of decreasing alcohol concentration by adding a solvent in the form of water to a concentrated alcohol solution to reduce the concentration of the concentrated solution to become more diluted.

The alcohol used was 70% ethanol alcohol, which was diluted to 5%, 10%, 20%, and 40% with mineral water as a solvent. For more details, the dilution formula is as follows:

$$V_1 \times K_1 = V_2 \times K_2 \quad (1)$$

With caption:
$V_1$ = Required volume of solution.
$K_1$ = Solution Concentration.
$V_2$ = The volume of solution to be created.
$K_2$ = Required solution concentration.

Diluting 70% alcohol was perSformed manually using a measuring cup and standardized using an alcohol meter. After the alcohol content read on the alcoholmeter matches the required level, it is poured and stored in a 140 ml glass bottle.

*1) MQ3 Sensor Testing*

This test was carried out to determine the Analog to Digital Converter (ADC) value received by the MQ3 sensor against alcoholic beverage samples. The test material used was a sample of an alcoholic beverage that had been made. Based on previous research [5] and [14], ADC value testing was carried out to determine the parameters of alcoholic beverage samples that will be used as conditioning in the program. In this study, it was used as a reference for the author to test the ADC value.

TABLE I. ADC VALUE ON MQ3 SENSOR

| ADC Value Reading on MQ3 sensor | | | | |
|---|---|---|---|---|
| Time(s) | Samples of Alcoholic Beverages | | | |
| | Beer 5% | Red Wine 10% | Soju 20% | Vodka 40% |
| 1 | 451 | 570 | 627 | 713 |
| 2 | 453 | 547 | 639 | 726 |
| 3 | 452 | 546 | 639 | 740 |
| 4 | 448 | 545 | 639 | 736 |
| 5 | 447 | 537 | 644 | 745 |
| 6 | 450 | 530 | 642 | 748 |
| 7 | 463 | 526 | 655 | 744 |
| 8 | 464 | 521 | 654 | 727 |
| 9 | 452 | 516 | 654 | 727 |
| 10 | 457 | 523 | 652 | 736 |
| 11 | 456 | 525 | 648 | 736 |
| 12 | 453 | 523 | 662 | 736 |
| 13 | 442 | 523 | 663 | 735 |
| 14 | 442 | 523 | 665 | 735 |
| 15 | 446 | 523 | 667 | 735 |
| 16 | 447 | 524 | 660 | 736 |
| 17 | 445 | 524 | 644 | 736 |
| 18 | 439 | 522 | 632 | 735 |
| 19 | 437 | 522 | 633 | 739 |
| 20 | 445 | 519 | 624 | 739 |
| 21 | 450 | 547 | 622 | 739 |
| 22 | 448 | 570 | 623 | 712 |
| 23 | 447 | 570 | 623 | 694 |
| 24 | 444 | 565 | 627 | 694 |
| 25 | 446 | 560 | 622 | 673 |
| 26 | 446 | 560 | 612 | 666 |
| 27 | 442 | 555 | 612 | 654 |
| 28 | 442 | 555 | 612 | 629 |
| 29 | 442 | 550 | 612 | 629 |
| 30 | 442 | 550 | 612 | 629 |
| Average | 450 | 550 | 620 | 720 |

In the testing process of reading the ADC value in Table I, the sensor was placed on the alcoholic beverage sample container for 30 s, and the distance between the sensor and the sample was 1 cm. The measurement results were then averaged and the average results are used as a reference parameter for the alcoholic beverage sample. These parameters are used in the conditioning program code, namely, the value of ADC 450 is 5%, and the value of ADC 620 is 20%.

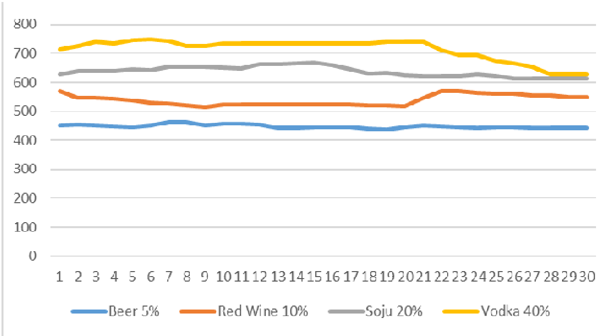


Fig. 7. ADC Value Graph

Based on the test results of the MQ3 sensor in Table 3.3, it can be observed that the ADC value read by the MQ3 sensor is directly proportional to the alcohol content during the test time. However, sometimes there is instability in reading the jump value (ADC).

*2) MQ3 Sensor Testing Against Distance*

This test is carried out to determine the maximum distance that can be detected, and the amount of value that the MQ3 sensor can detect from that distance.

TABLE II. SENSOR TESTING AT DISTANCE OF 1CM

| Samples of Alcoholic Beverages | ADC Value | Sensor Distance (cm) | Sensor Reaction (s) |
|---|---|---|---|
| 5% | 450 | 1 | 3 |
| 10% | 550 | 1 | 3 |
| 20% | 620 | 1 | 3 |
| 40% | 720 | 1 | 3 |

From the test results of the MQ3 sensor with a distance of 1 cm in Table II, it is known that the detected ADC value is stable, and the sensor reacts quickly to a distance of 1 cm.

TABLE III. SENSOR TESTING AT DISTANCE OF 3CM

| Samples of Alcoholic Beverages | ADC Value | Sensor Distance (cm) | Sensor Reaction (s) |
|---|---|---|---|
| 5% | 330 | 3 | 8 |
| 10% | 350 | 3 | 8 |
| 20% | 380 | 3 | 8 |
| 40% | 400 | 3 | 8 |

From the test results of the MQ3 sensor with a distance of 3 cm in Table III, it is known that the detected ADC value decreases, and the sensor reacts slowly to a distance of 3 cm.

TABLE IV. SENSOR TESTING AT DISTANCE OF 3CM

| Samples of Alcoholic Beverages | ADC Value | Sensor Distance (cm) | Sensor Reaction (s) |
|---|---|---|---|
| 5% | 315 | 5 | - |
| 10% | 315 | 5 | - |
| 20% | 316 | 5 | - |
| 40% | 320 | 5 | - |

From the test results of the MQ3 sensor with a distance of 5 cm in Table IV, it is known that the detected ADC value is constant at the idle value, and the sensor does not provide a sample detection reaction to a distance of 5 cm.

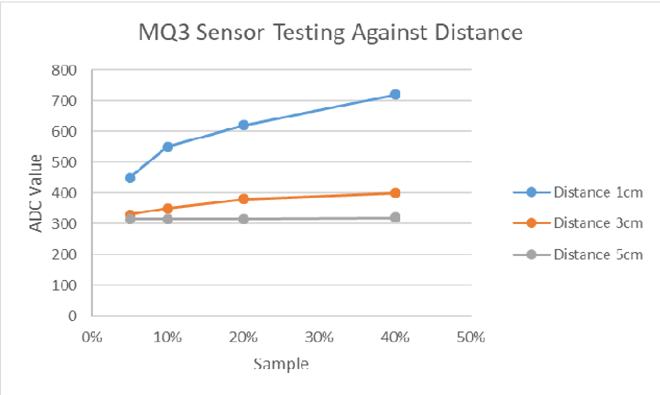


Fig. 8. Graph of MQ3 sensor test results against distance

Based on Figure 7, the ADC value is higher and more stable for the sample when the distance is closer. The sensor reaction also detected alcohol faster when the sensor was closer to the sample.

### *3) System Function Testing*

This test is performed to determine all system functions run according to the code that has been created. The test was carried out three times for each alcohol content sample.

TABLE V. SYSTEM FUNCTION TESTING

| Sample | Expected Output | Test Results | Conclusion |
|---|---|---|---|
| 5% | Engine ON | Engine ON | Success |
| | LED OFF | LED OFF | Success |
| | Notification OFF | Notification OFF | Success |
| | LCD Print "Normal" | "Normal" | Success |
| | | | |
| 10% | Engine OFF | Engine OFF | Success |
| | LED Blink | LED Blink | Success |
| | Notification ON | Notification ON | Success |
| | LCD Print "Drunk" | "Drunk" | Success |
| | | | |
| 20% | Engine OFF | Engine OFF | Success |
| | LED Blink | LED Blink | Success |
| | Notification ON | Notification ON | Success |
| | LCD Print "Drunk" | "Drunk" | Success |
| | | | |
| 40% | Engine OFF | Engine OFF | Success |
| | LED Blink | LED Blink | Success |
| | Notification ON | Notification ON | Success |
| | LCD Print "Danger" | "Danger" | Success |

In the overall test of the System, the MQ3 sensor successfully detected samples of alcoholic beverages, and only the detection was very unstable. All tools and features were run according to the code created.

## IV. CONCLUSION AND SUGGESTION

Based on the results of the research and discussion in the previous section, the following conclusions can be drawn:

1. A prototype of alcohol content detection in mobile-based public-transport car drivers was successfully developed. The MQ3 sensor, which detects alcohol content through exhalation, was connected to the NodeMCU ESP8266 as the control center. The detection data are then sent over the Internet network to the Blynk server so that the data can be displayed on the user's smartphone in real-time and notification messages can be sent. There are several outputs such as driver state information via LCD, LED flame output as a hazard in the car, and the automatic system turning off the engine when the alcohol content is detected following with the conditioning parameters that have been made.
2. Based on the test results of the MQ3 sensor, it is known that the ADC value read is directly proportional to the detected alcohol sample, because the sensor has warmed up for several minutes for stable detection.\
3. Based on the results of testing the MQ3 sensor against distance, it can be concluded that distance affects the sensor's ADC value and the sensor's reaction time when performing detection.
4. Based on the results of user-level testing, this tool's percentage level of suitability with users was 100%.

For further development, many aspects still need to be considered. The authors suggest using the MQ3 sensor to be more conditioned by warming up for a few minutes to obtain stable and accurate readings. then it is expected to convert the analog value data of the detected alcohol content into a percentage of alcohol content. It can be applied to design public transportation vehicles under actual conditions. Also we expect to add a database to store sensor detection data so that it can be used as evaluation material for the person in charge of the driver.

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