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# Reminders and Management of Medication for Diabetes Patients Based on the Internet of Things

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**Abstract:** Innovative technology solutions to help patients manage their medication more effectively. Diabetes is a chronic disease that requires regular monitoring of blood sugar levels and proper regulation of medication consumption. This system is designed to make it easier for diabetics to remember when to take their medication, as well as ensure the correct dosage is in accordance with the doctor's recommendations. It uses an IoT device connected to a mobile application or web-based platform, which allows users to receive notifications at predetermined times to take medication. The system is also equipped with patient condition monitoring features, such as blood sugar level monitoring that can be synchronized with blood sugar measurement devices. The data collected will be sent in real-time to the app, so that patients and medical personnel can integrate the progress of treatment and make adjustments. With the application of IoT, this system not only improves patient awareness of medication schedules, but also provides better analysis of medication effectiveness and possible risks, and reduces the possibility of negligence in medication consumption. The implementation of this technology can improve the quality of life of people with diabetes.

**Keywords:** Diabetics, Internet of Things, Medication Reminder, Medication Output Controller, Patient Adherence

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## 1 INTRODUCTION

One of the important aspects of diabetes management is the proper and scheduled medication consumption, both in the form of oral medication and insulin. Irregularity in taking medication or non-compliance with the medication schedule can cause fluctuations in blood sugar levels which can be a risk to the health of the patient. However, many diabetics find it difficult to remember the time and dosage of their medication. With the development of technology, especially the Internet of Things (IoT), there is an opportunity to help people with diabetes remember and manage their medication. IoT technology enables the creation of connected devices to monitor patients' health in real-time and provide automatic reminders for medication consumption. By using devices such as mobile apps or wearable devices integrated with sensors, medication consumption reminders can be achieved. This IoT-based system not only provides automatic reminders, but can also integrate drug doses and even provide reports to medical personnel on the patient's condition continuously. In addition, this technology allows diabetics to more easily manage their medication in a more structured and controlled manner, which will ultimately reduce the risk of complications and increase the risk of diabetes

## 2 LITERATURE REVIEW

### 2.1 Internet of Things(IoT)

Internet of Things (IoT) is a concept where physical objects, devices, vehicles, and even buildings are equipped with technology that allows them to be integrated and exchange data through the Internet (Dave Evans). The main idea is to create a seamless network of devices that connect to each other and communicate automatically without human intervention[1]. IoT has enormous potential to change various aspects of daily life, including the way we live, work, play and communicate. However, it is also important to consider the security and privacy issues associated with the use of this technology[2].

### 2.2 Design and Build

The design of the tool that will be used for the manufacture of the Water Turbidity Monitor Tool Design and Automatic Water Pump which has three stages, namely input, process and output. Of the three stages have an equally important role. The following is a picture of the block diagram:

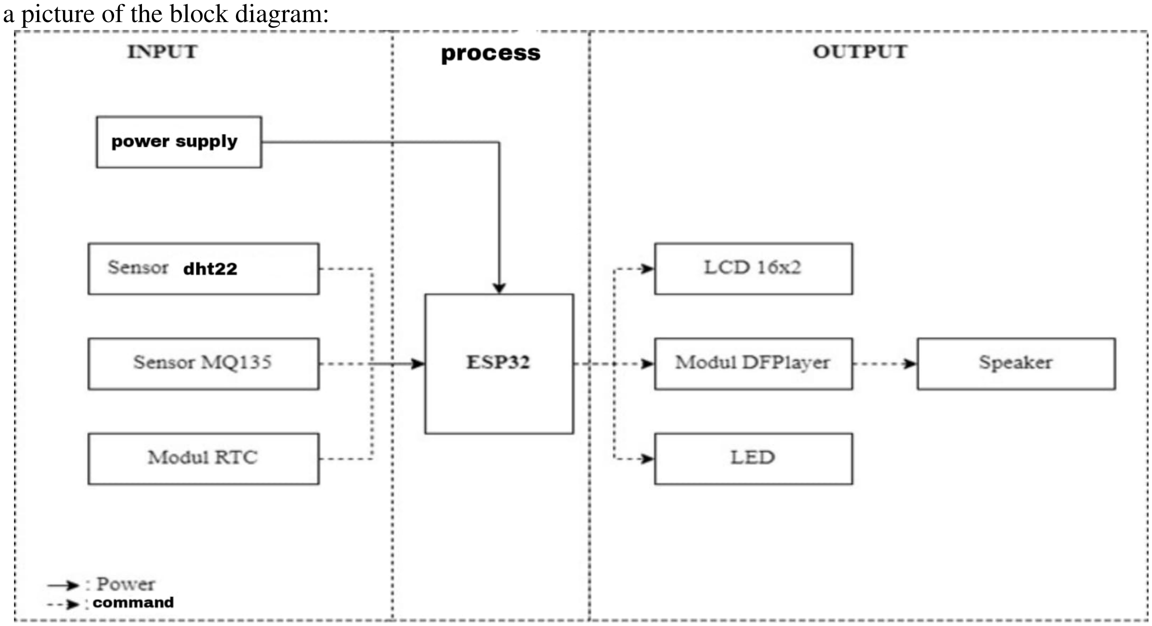


**Figure 1.** block diagram

### 2.3 Input

Input or input is the initial process in the processing of data - data that will be inputted into the next process so that it can be carried out. The input also acts as a tool to activate the subsequent data processing process as a source of energy. The inputs used are power chess, mq135 sensor, dht22 sensor and rtc mode. Here are some of the inputs required in the carburizing process of this tool

#### 2.3.1 Power Supply

A power supply is a device that can provide electrical energy for one or more electrical loads. The power supply is also a very important part in the world of electronics, because it functions as a source of electrical power, for example in batteries. Basically, this power supply has a similar structure, namely consisting of a transformer, voltage rectifier, and voltage smoother[3].

#### 2.3.2 Transformator

A transformer or transformer is an electrical power device that has the function of transmitting electrical power from high voltage to low voltage or vice versa. The transformer works based on electromagnetic induction between the two coils inside it . In the electronics field, a transformer is a device that functions to reduce a voltage from the power supply to the load, so that it can be used in semiconductor circuits. Then the voltage can also be selected according to the required needs[4]. A transformer has three important parts, namely: the primary coil, the primary coil is the coil on the transformer which is directly connected to the voltage source on the transformer, then the second is the secondary coil, namely the coil which will be directly connected to the output of the transformer, and the third is the iron core which functions to increase the production of the magnetic field

#### 2.3.3 Diode

A diode is a semiconductor which has the function of rectifying alternating electric current (AC) into direct current (DC), namely by delivering electric current in one direction which has two electrodes (terminals), namely the anode (+) on the P type side and the cathode (-) on the N type side where the current flowing from the anode to the cathode cannot be the other way around[5]. The diode that functions as a rectifier is when the diode works directs alternating current (AC) into direct current (DC), the rectification process is assisted by the characteristics of the diode which is able to withstand the current. So this is used to reduce the rate of reverse flow to direct current.

#### 2.3.4 Electrolite Capasitor

A capacitor is an electronic component that has the function of storing temporary electrical charge. Capacitors are denoted by "C" and the unit of measurement for capacitors is Farrad (F). Capacitors are divided into non-polarized capacitors and polarized capacitors.[6] Electrolytic Capacitors (Elco) are a type of polar capacitor that is installed in an electronic circuit according to its terminals. The positive terminal (+) on the capacitor with high potential (+) in the electronic circuit. Then the negative terminal (-) in the capacitor is connected to a low potential (-) in the electronic circuit. If an error occurs when installing the capacitor, it will cause the capacitor to be damaged or explode. Large capacity electrolytic capacitor poles can be used in power supplies.[7]

#### 2.3.5 IC Regulator L7812

The Regulator IC is a component that is often found in electronic circuits, where the L7812 IC produces a 12VDC voltage. It is called an IC (Integrated Circuit) because the voltage regulator consists of tens or even hundreds of transistors, capacitors, diodes and resistors. These transistors, capacitors, diodes and resistors combine to form Regulator IC components[8] Although filtering can reduce the ripple from the power supply to low values, the most effective approach is to combine filtering of the input capacitor used with a voltage regulator. The voltage regulator is connected to the filtered output of the rectifier, even though the input, load current, and temperature changes, it can still maintain a constant output voltage[9]

#### 2.3.6 RTC Module

The RTC (Real-Timer Clock) module is a hardware device used to provide accurate time information in electronic systems. This module usually consists of an integrated circuit equipped with a stable crystal oscillator and a backup battery to maintain the time even when the main power is off. RTC is useful in many applications, especially in the areas of IoT, automatic control, time data logging, and devices that require precise time synchronization.[10] RTC modules are available in a variety of structures and sizes, and are often integrated into more complex microcontroller or microcontroller devices. Merrerka can be used in a variety of applications, ranging from simple digital watches to complex industrial control systems. One example of a popular RTC module is the DS1307 and DS3231, which are widely used in electronic and DIY projects[11].

#### 2.3.7 DHT22 Sensor

The DHT22 surge sensor, also known as the AM2302, is a digital sensor used to measure indoor air humidity and humidity. This sensor is often used in various electronic engineering projects and smart home automation systems[12]. The DHT22 sensor uses a separate dura erlermern serns to regulate air pressure and air humidity. The sensor uses a thermistor, which is a resistor component whose resistance value changes with the environmental pressure. In order to measure humidity, the sensor uses a series of capacitors that are sensitive to air humidity. Changes in humidity cause changes in the capacitance of the capacitor[13] The DHT22 signal sensor is often used in various applications such as environmental control systems in smart homes, indoor air monitoring systems, and DIY electronics engineering projects. The accuracy and reliability of this sensor has made it increasingly popular among electronics engineers and automation system engineers.

#### 2.3.8 MQ135 Sensor

MQ135 sensor, also known as MQ gas sensors, are a type of gas sensor that is currently used to determine regular gas concentrations in the environment. This sensor can be used to produce various gases such as alcohol gas, carbon monoxide gas (CO), merthane gas (CH4), ammonia gas (NH3), and others, depending on the type of sensor and model used.[14] The working principle of the MQ sensor is based on the change in resistance in the sensor's sensitive environment when exposed to gas. When gas is present in the vicinity of the sensor, the resistance in the sensor environment changes, and this change can be measured or interpreted in terms of gas concentration in the surrounding environment. MQ sensors usually consist of a chemical conductor layer that is sensitive to certain types of gas. Each sensor is designed to respond with high sensitivity to the target gas, although some sensors may also respond to other gases in a narrower spectrum.[15] MQ sensors are often used in a variety of applications, including monitoring indoor air quality, preventing gas leaks in households or industry, reducing breath alcohol levels for vehicle operation, and many more. Merrerka is also used in DIY (do-it-yourself) engineering and sensor technology projects. The MQ sensor works based on changes in resistance in the sensor's temperature when exposed to controlled gas. When gas is present, the sensor resistance changes, and this can be measured or interpreted according to gas concentration. The sensitive Elemen in the MQ Sensor is a chemical conductor layer that can interact with the target gas. Each sensor is designed to respond specifically to certain types of gas.[16] The MQ sensor requires appropriate settings and calibration depending on the type of gas to be detected. This can be done by adjusting the potentiometer or carrying out a repeat calibration with standard gas.[17] The flow of the MQ sensor usually takes the form of a change in voltage or flow that is due to a controlled gas concentration. This input can then be processed by a microcontroller or control system for further action, such as triggering an alarm or displaying information to the user[18]. MQ sensors are widely used in safety applications, such as gas leak detection in homes or factories, gas detection in motor vehicles to ensure low emissions, or in the development of smart devices that improve air quality control.

## 2.4 Process

The process plays a very important role in making this tool, the process will process the data collected from several inputs which will proceed to the next stage so that the data can be carried out and processed until it can produce the expected output.

### 2.4.1 Microcontroller ESP32

The ESP32 microcontroller was introduced by Espressif Systems which is the successor to the ESP8266 microcontroller. This microcontroller is the latest release from ESP and is different from the Arduino board types, for example Arduino Nano, Arduino Uno and other types of Arduino. The ESP32 microcontroller has the advantage of being a low cost, low power system with a WiFi module integrated with the microcontroller chip and having dual mode Bluetooth and power saving features making it more flexible. ESP32 is compatible with mobile devices and IoT (Internet of Things) applications. This microcontroller can be used as a complete standalone system or can be operated as a supporting device for a host microcontroller[19] .

The ESP32 is a 2.4GHz WiFi and Bluetooth chip with 40nm technology design designed for the best power and radio performance demonstrating robustness, versatility and reliability in a wide range of applications and power scenarios. (Espressif, 2019). ESP32 has a pin out that can be used as input or output to turn on the LCD, lights, and even to drive a DC motor[20]

## 2.5 Output

Output is the result of a process, either in the form of data or in the form of information that has been processed. The result of energy that is processed and classified into useful outputs and residual waste. Outputs can be inputs for other subsystems. For example, for a computer system, the heat generated is a useless output and is a waste result, while information is a required output. The output components used in this research are LED, LCD (Liquid Crystal Display) 16x2, dfplayer module and speaker

### 2.5.1 DFPlayer Module

The DFPlayerr module is an audio printer module that is often used in electronic engineering projects to play audio filers from external storage media such as microSD cards or UrSB drivers. This module is very popular because of its simple but effective ability in adding audio playback capabilities to various projects, such as the Ardurino project, ErSP32, Raspberry Pi, and other microcontrollers[21]. The DFPlayer module has various features and characteristics that make it easy to use in various projects. One of its main features is external media connectivity, where this module can play audio files stored on a microSD card or USB drive, so users can play various types of audio files such as MP3 and WAV easily. Additionally,[22] DFPlayer communicates with the microcontroller via a serial interface (UART), allowing users to control functions such as play, pause, stop, and skip songs with commands sent via serial communication. This module also has a simple interface, consisting of a few pins that can be connected directly to a microcontroller or development board such as an Arduino, making it easy to integrate into various projects[6]. Additionally, DFPlayer supports adjustable volume settings via serial commands, providing flexibility in audio control. Users can also easily select and play specific songs from the list available on the external storage media. With its wide range of features, DFPlayer is very flexible and can be used in a variety of projects, including in-car entertainment systems, automatic call receivers, smart music devices, and more[23].

### 2.5.2 Speaker

A speaker is an electronic device that converts electrical signals into sound waves. This is an important part of the audio system and is used to curate and produce sound from various audio sources such as music printers, televisions, mobile phones, computers, and many more. The working principle of speakers is based on the conversion of electrical energy into sound waves. An audio signal in the form of an electric current is given to the speaker from an audio device such as a music player, cell phone, or computer. This electric current flows through the voice coil which is connected to the transducer in the speaker. The voice coil is usually mounted on a frame around a magnet. The magnetic field produced by a permanent magnet or electromagnet around the voice coil interacts with the electric current flowing through it. This working principle is in accordance with electromagnetic laws which cause electromagnetic forces on the voice coil.[5] When an electric current flows through the voice coil, the resulting electromagnetic force causes the voice coil to move up and down in the magnetic field. This voice coil is connected to a transducer, such as a cone or membrane, which vibrates with the movement of the voice coil. The transducer's vibrations move the air around it, creating sound waves that listeners can hear as sound produced by the speaker.[24]

#### 2.5.3 LCD

LCD (Liquid Crystal Display) is a type of display screen that uses liquid crystals to produce images or text. An LCD screen consists of a number of small pixels consisting of two layers of electrodes connected by a liquid crystal material. When a voltage is applied to the electrode layer, the liquid crystal will regulate the light that passes through the pixels, thus forming an image or text.[25] To control and display information on an LCD screen, an LCD module is often used that is integrated with a suitable controller. This LCD module usually consists of an LCD screen, a controller (usually a driver chip), and an interface that allows connection with a microcontroller or other system[7]

## 3 RESEARCH METHOD

### 3.1 Hardware Planning

Hardware planning is a tool that will be made which begins with a block diagram of the overall design. This planning includes the selection of components to be used, making a schematic circuit or component layout, installing components and the last stage is finishing. The hardware used is the components used in this design, namely the sensors used, ESP32, LCD, led, dfplayer module, rtc module and speaker The aim of the tool design stage is to ensure that the tool manufacturing process runs smoothly and according to expectations, so that the tool can be used perfectly. What is currently being done is to create an efficient tool design to organize the layout of the components, so that the components can be installed correctly and in an orderly manner. Furthermore, in order to complete the design documents for this tool, a flowchart was created. This flowchart is intended to design the process steps of this tool so that it can produce the desired results The design of the tool that will be used in the smart pill box (medication reminder box) based on the interface of things will be depicted using a schematic series of the tool as shown in the image below:

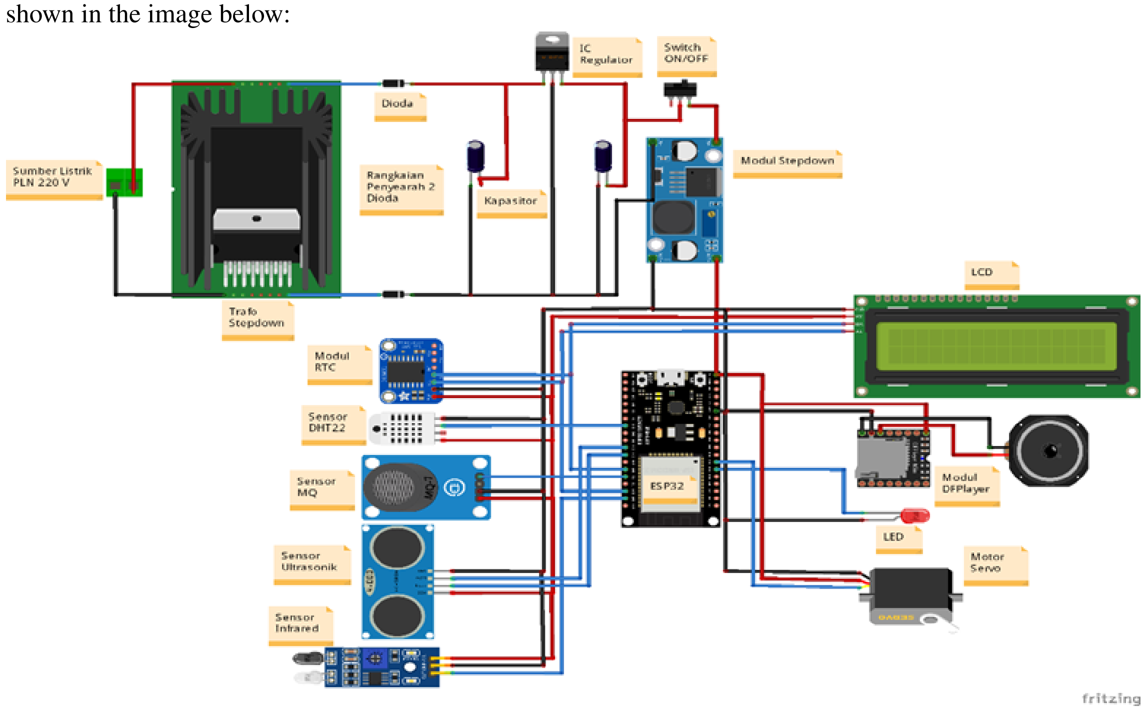


**Figure 2.** Circuit Schematic

The picture shows a schematic of the circuit of the components used in this research. Here are the specifications and working methods of the components used:

a. PLN is the main power source used in this research, providing a voltage of 220 V.
b. Power Chess is the power supply used in this research. It includes several components such as a transformer, diodes, capacitors, and a voltage regulator IC.
c. LM2596 Step-Down Module is a voltage converter module that converts the 5 VDC power supply with a current range of 3 A to 5 A. This 5 VDC source is used to power the DHT22 sensor, MQ sensor, RTC module, and the 16x2 LCD display.
d. DHT22 Sensor functions to detect environmental signals such as temperature and humidity.
e. MQ135 Sensor is used to detect indoor air quality, including the presence of substances such as alcohol, acetone, and carbon monoxide ($CO_2$).
f. ESP32 serves as the main controller (the “brain”) for the connected components.
g. 16x2 LCD Display is used to display solar-related data and the readings from the MQ135 sensor.

h. The RTC module is used to control the medication administration time for the customer.
i. DFPlayer Module functions as an audio output device that plays various alarm sounds to remind the user when it is time to take their medication.

### 3.2 Software Planning

At this stage, making a flowchart is done by designing a simple algorithm in the form of a flowchart to facilitate the manufacture of tools. In order for the manufacture of the tool to be carried out smoothly.

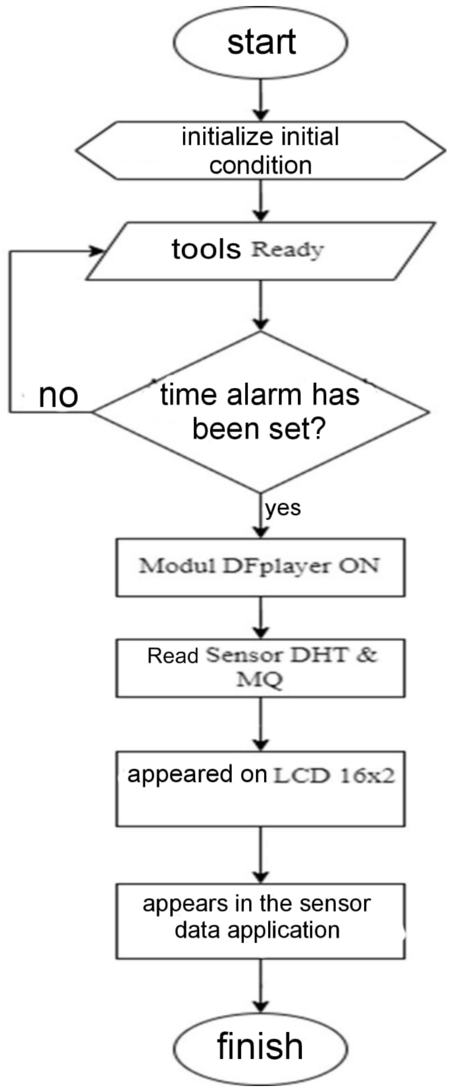


**Figure 3.** flowchart

This flowchart describes the working process of an RTC (Real-Time Clock) based system for sensor monitoring and audio playback. The process begins with an initial state initialization stage, where the system prepares the device and ensures all components are ready. Once the tool is ready, the system will check whether the time set in the RTC is in accordance with the specified schedule. If it is not appropriate, the system will continue to monitor until the set time is reached.

When the time is right, the DFPlayer module will be activated to play audio as a notification. After that, the system reads data from the DHT sensor, which measures temperature and humidity, and the MQ sensor, which detects gas or air quality. The obtained sensor data is then displayed on a 16x2 LCD screen to provide direct information. Apart from that, sensor data is also sent and displayed on the monitoring application for further monitoring. Once all these stages are completed, the system reaches the final stage and the process ends

## 3.3 Hardware Planning

### 3.3.1 Instalation of power supply

In this section, there is the installation of the components used in the installation of the power supply. The components in the power supply are in the form of a power supply, transformer, diode, capacitor and L7805 regulator IC. The results can be seen in the image below

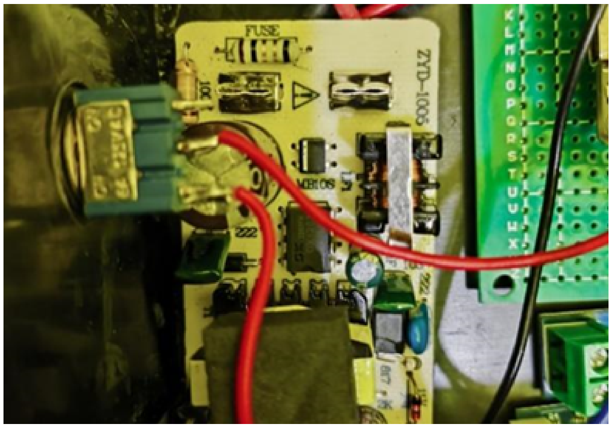

**Figure 4.** power supply

### 3.3.2 Instalation of microkontroller

In this section, namely the installation of the microcontroller used in this research. The microcontroller used in this tool is an ESP32 microcontroller. The advantage of the ESP32 is that it is a low cost, low power system with a WiFi module that is integrated with a microcontroller chip and has Bluetooth with dual mode and power saving features making it more flexible. The results can be seen in the image below

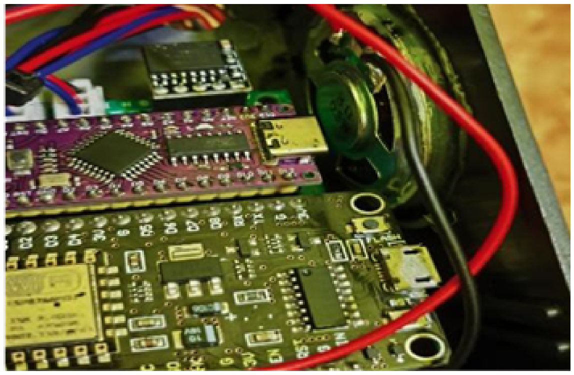

**Figure 5.** microcontroller

### 3.3.3 Instalation of MQ sensor

In this section, namely the installation of the components used, namely the installation of the MQ sensor. The function of the mq sensor for this tool is to detect the air quality in the hospital room so that the air quality in the room is normal and there is no pollution. The results can be seen in the image below

**Figure 6.** mq sensor

#### 3.3.4 Instalation of DHT22 sensor

In this section, namely the installation of the components used, namely the installation of the DHT sensor. The function of the DHT sensor for this tool is to determine the temperature in the hospital room so that it can control the temperature in the room so that it does not exceed it. The results can be seen in the image below:

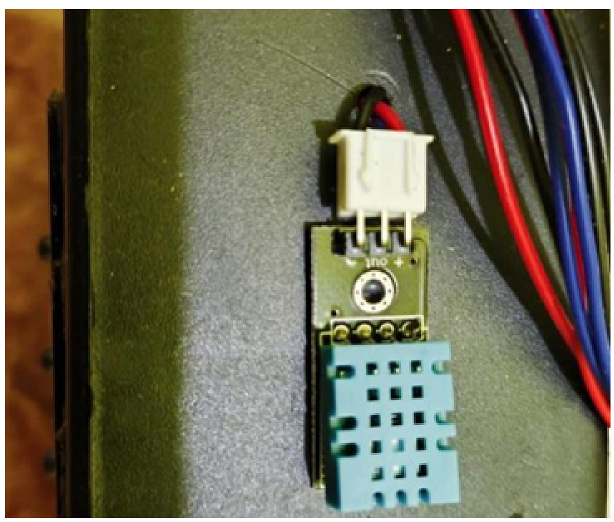

**Figure 7.** dht22

#### 3.3.5 Instalation of ultrasonic sensor

In this section, namely the installation of the components used, namely the installation of the ultrasonic sensor. The function of the ultrasonic sensor in this device is to detect the amount of medicine in the container to make it easier to find out how much medicine is left in it. The results can be seen in the image below:

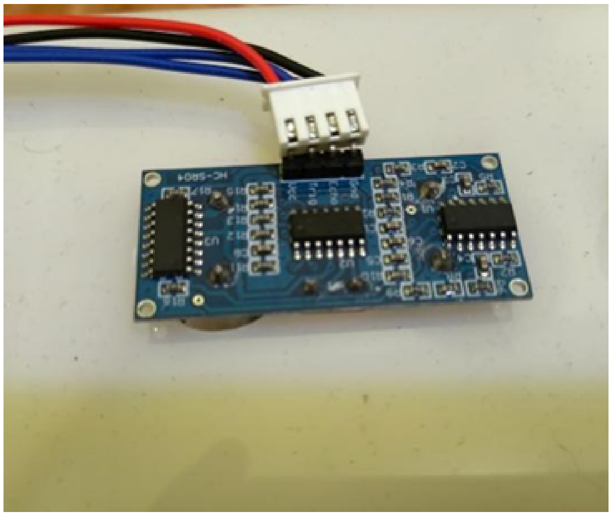

**Figure 8.** ultrasonic

#### 3.3.6 Instalation of infrared sensor

In this section, namely the installation of the components used, namely the installation of the infrared sensor. The function of the infrared sensor in this device is as a detector to determine whether the medicine in the container has been released or not. The results can be seen in the image below:

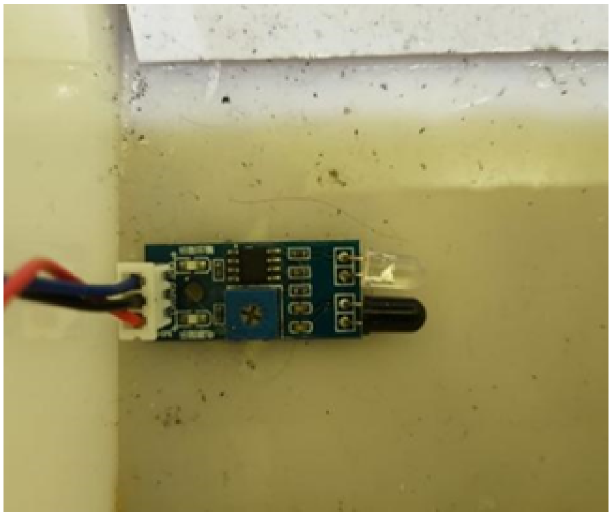

**Figure 9.** infrared

#### 3.3.7 Instalation of LCD

In this section, namely the installation of the components used, namely the 16x2 LCD installation. The function of the LCD on this device is to determine whether the device is connected or not and to determine the temperature and air quality in the room. The results can be seen in the image below:

**Figure 10.** lcd

#### 3.3.8 Tool Making Process

In this section, there is the installation progress of the tool. This is a ready-made tool that can be tested. The results can be seen in the image below:

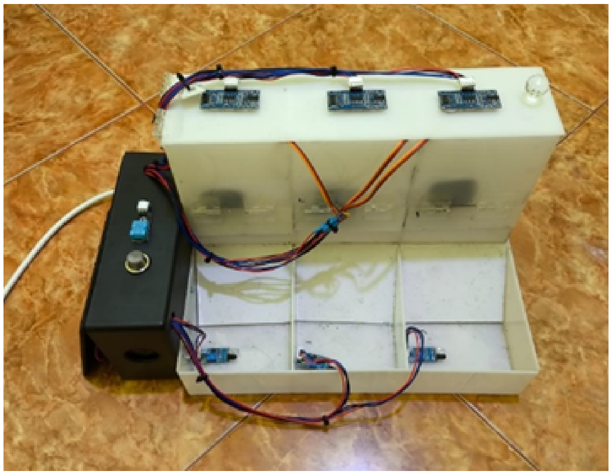

**Figure 11.** tool result

## 4 RESULT

### 4.1 Measurement Point

The measurement points can be seen in the tabel below:

**Table 1.** Measurement Table

| No | Measurement Position | MP | Unit | MR1 | MR2 | MR3 | MR4 | MR5 | x | Information |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | power supply | TP1 | Vac | 220 | 220 | 218 | 219 | 220 | 219 | input trafo to pln 220V |
| 2 | trafo | TP2 | Vac | 12.9 | 12.16 | 12.6 | 12.8 | 12.8 | 12.7 | output trafo to diode |
| 3 | diode | TP3 | Vdc | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | output to capacitor |
| 4 | diode | TP4 | IdcmA | 300 | 301 | 300 | 299 | 300 | 300 | output to capacitor |
| 5 | capacitor | TP5 | Vdc | 12.5 | 12.5 | 12.5 | 12.4 | 12.4 | 12.4 | input to IC 7824 |
| 6 | IC 7824 | TP6 | Vdc | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | input stepdown |
| 7 | step down | TP7 | Vdc | 12.6 | 12.5 | 12.5 | 12.7 | 12.6 | 12.5 | input voltage |
| 8 | step down | TP8 | Vdc | 5.4 | 5.4 | 5.3 | 5.4 | 5.3 | 5.4 | output to ESP32 |
| 9 | ESP32 | TP9 | Vdc | 5.8 | 5.9 | 5.7 | 5.7 | 5.7 | 5.6 | input voltage ESP32 |
| 10 | DHT22 sensor | TP10 | Vdc | 5.4 | 5.4 | 5.5 | 5.5 | 5.4 | 5.56 | output ESP32 |
| 11 | MQ sensor | TP11 | Vdc | 4.8 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | output to ESP32 |
| | | TP11 | Vdc | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | output to ESP32 |
| 12 | infrared sensor | TP12 | Vdc | 4.8 | 4.9 | 5.0 | 5.0 | 5.1 | 4.9 | output to ESP32 |
| | | TP12 | Vdc | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | output to ESP32 |
| 14 | ultrasonic sensor | TP13 | Vdc | 5.8 | 5.9 | 5.8 | 5.9 | 5.8 | 5.8 | output to ESP32 |
| 15 | LED | TP14 | Vdc | 4.9 | 4.9 | 4.9 | 4.8 | 4.9 | 4.9 | output to ESP32 |
| 16 | RTC module | TP15 | Vdc | 5.1 | 5.1 | 5.1 | 5.2 | 5.1 | 5.1 | output to ESP32 |
| 17 | LCD 20x4 | TP16 | Vdc | 5.08 | 5.09 | 5.07 | 5.03 | 5.01 | 5.056 | output ESP32 |
| 18 | DFPlayer module | TP17 | Vdc | 5.18 | 5.19 | 5.17 | 5.13 | 5.11 | 5.156 | output ESP32 |

Description:

TP 1: Measurement point at the PLN source which is the input voltage to the transformer.

TP 2: Transformer measurement point, calculating the voltage issued by the center tap type transformer.

TP 3: Voltage measurement point after the diode in the power supply.

TP 4: Voltage measurement point after the diode in the power supply.

TP 5: Voltage measurement point after the capacitor in the power supply.

TP 6: Measurement point at the output voltage of IC 7824.

TP 7: Measurement point at the input voltage of the stepdown module.

TP 8: Measurement point on the output voltage of the stepdown module.

TP 9: Measurement point as ESP32 voltage source

TP 10: Measurement point of the output voltage on the dht22 sensor.

TP 11: Measurement point of the output voltage on the mq Sensor.

TP 12: Output voltage measurement point on infrared sensor.

TP 13 : Output voltage measurement point on ultrasonic sensor.

TP 14 : Output voltage measurement point on led.

TP 15 : Output voltage measurement point on rtc module

TP 16 : Output voltage measurement point on 20x4 LCD.

TP 17 : Output voltage measurement point on the dftplayer module

### 4.2 Transformer Voltage Calculation

Transformer voltage is calculated based on existing specifications with measured data, the values can be obtained as below:

$$a = \frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{220}{24} = 9.16V$$

Transformer voltage based on measurements as in table, the results are as below:

$$a = \frac{Vmeasurement}{V_2}$$

$$V_2 = \frac{Vmeasurement}{a} \frac{217.6}{9.16}$$

$$V_2 = 23.75V$$

### 4.3 Power Supply Equation

a. Calculation TP3

TP3 can be calculated using the following equation:

$$[V_{dc} = 0,636(V_m - V_t]$$

where:

$$V_m = V_{rms} \cdot 2$$

$$V_m = 23.75 \cdot 2$$

$$V_m = 33.58V$$

so we get VDC :

$$V_{DC} = 0.636 \cdot (V_m - V_t)$$

$$V_{DC} = 0.636 \cdot (33.58 - 0.7)$$

$$V_{DC} = 21.102V$$

The magnitude of the voltage ripple before the capacitor in a full wave rectifier uses the equation below:

$$V_r(RMS) = 0.707 \cdot V_m$$

$$V_r(RMS) = 0.707 \cdot 33.58$$

$$V_r(RMS) = 23.74V$$

b. Calculation TP4

TP4 is calculated using the following equation:

$$V_{DC2} = V_m - \frac{23.74 \cdot I_{DC}}{C}$$

$$V_{DC2} = 33.58 - (23.74) \cdot (0.0003)0.0001$$

$$V_{DC2} = 33.58 - 7.122$$

$$V_{DC2} = 26.458V$$

The magnitude of the voltage ripple is:

$$V_{DC(rms)} = \frac{23.74 \cdot I_{DC}}{C} \times \frac{V_{DC2}}{V_m}$$

$$V_{DC(rms)} = \frac{(3.1722) \cdot (0.0003)}{0.001} \times \frac{26.258}{33.58}$$

$$\overline{0.001 \times \frac{26.258}{33.58}}$$

$$V_{DC(rms)} = (7.122) \cdot (0,78)$$

$$V_{DC(rms)} = 5.55V$$

So, the voltage VDC2 after ripple is as follows:

$$V_D C2 = 26.458 - 5.55 = 20.908V$$

### 4.4 percentage of error

The percentage error can be found by looking for the percentage error value for each component as below:

$$\%error = \frac{measurement - calculation}{measurement} \cdot 100\%$$

$$\%error = \frac{24.48 - 20.908}{24.48} \cdot 100\%$$

$$\%error = 0.14$$

By using the same formula as the calculation of the percentage of error in TP4, the percentage of error can be found at each measurement point. The following is a table of the results of the calculation of the percentage of error from each measurement point.

**Table 2.** percentage of error

| No | Measurement Position | Measurement Point (Volt) | Datasheet (Volt) | Measurement (Volt) | Calculation (Volt) | Error (%) | Information |
|---|---|---|---|---|---|---|---|
| 1 | power supply | TP1 | 220 | 217 | - | 0.0004 | - |
| 2 | trafo | TP2 | - | 12 | 11 | 0.43 | - |
| 3 | diode | TP3 | - | 11 | 11 | 0.15 | - |
| 4 | capasitor | TP5 | - | 12 | 11 | 0.2 | - |
| 5 | ic 7824 | TP6 | - | 12 | - | - | - |
| 6 | step down | TP7 | 0-40 | 12 | - | - | in-range |
| 7 | step down | TP8 | 3-40 | 5 | - | - | in-range |
| 8 | esp32 | TP9 | 4.5-5.5 | 5.05 | - | - | in-range |
| 9 | dht22 sensor | TP10 | 3.3-5.5 | 5.05 | - | - | in-range |
| 10 | mq sensor | TP11 | 3.3-5.5 | 4.9 | - | - | in-range |
| 11 | infrared sensor | TP12 | 3.3-5,5 | 4.9 | - | - | in-range |
| 12 | ultrasonic sensor | TP13 | 3.3-5.5 | 5.056 | - | - | in-range |
| 13 | led | TP14 | 3.3-5.5 | 4.9 | - | - | in-range |
| 14 | rtc module | TP15 | 3.3-5.5 | 5.1 | - | - | in range |
| 15 | lcd20x4 | TP16 | 3.3-5.5 | 5 | - | - | in range |
| 16 | dfplayer | TP17 | 3.3-5.5 | 5 | - | - | in range |

## 5 DISCUSSION

Based on the results of the measurements and calculations that have been carried out, several things can be analyzed as follows. First, from the measurements that have been made, the error percentage is at 0.31%. The error percentage for all components is below 1%, which means the tool is working well and as expected. Second, testing shows that the DHT22 sensor functions optimally in detecting temperatures according to the set limit, namely 35°C. From 11 trials, the system will give a warning in the form of an “Abnormal Temperature” sound when the temperature exceeds 35°C and stops when the temperature is below or equal to 35°C, indicating that the system is responding correctly and consistently. No problems were found in reading the temperature, and the success rate for controlling sound alerts reached 100%, confirming that this system works well according to the expected specifications. Third, testing the PZEM sensor shows that this sensor is able to detect the temperature inside the medicine box so that the temperature inside remains controlled. Controlling the medicine box via the Blynk application also functions well without any problems. With a high success rate, PZEM sensors have proven effective in monitoring temperatures as needed.

## 6 CONCLUSSION

Based on the results and discussion of the research "Reminding and Managing Medication Output for Diabetes Sufferers Based on the Internet of Things," several things can be concluded. Measurements show that the error percentage is 0.31%, with all components below 1%. This indicates that the tool is working well and according to expectations. The DHT22 sensor functions optimally in detecting temperature according to the set limit, namely 35°C. Of the 11 experiments carried out, the system gave an "Abnormal Temperature" sound warning when the temperature exceeded 35°C and stopped when the temperature was below or equal to 35°C. This indicates that the system is responding correctly and consistently. No problems were found in reading the temperature, and the success rate for controlling sound alerts reached 100%, which confirms that this system works well according to the expected specifications.

## 7 DECLARATIONS

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