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# CLEAN WATER RECOMMENDATION SYSTEM BASED ON WATER QUALITY WITH TURBIDITY AND TDS (TOTAL DISSOLVE SOLID) SENSORS BASED ON INTERNET OF THINGS (IOT)

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**ABSTRACT**

Residents of Khayangan Residence Cepu typically use water from natural sources such as rivers, lakes, and wells, often unaware of the potential dangers posed by contaminated water. To address this, a detection system is proposed to monitor and provide real-time information on water quality using Turbidity and Total Dissolved Solids (TDS) sensors. The system is developed using the Waterfall methodology, which ensures a structured and systematic approach, with each stage of development completed before proceeding to the next. This minimizes errors and enhances the accuracy of the final system. The IoT-based system utilizes Turbidity and TDS sensors connected to an ESP32 microcontroller, which processes data every 3 seconds and displays it on a website. The system measures water quality, with recorded values of PPM at 276, TDS at 0.34, and Turbidity at 16.08. This real-time monitoring system provides a straightforward process for assessing water quality in the housing complex, ensuring that residents have access to safe and clean water. The aim is to empower residents to make informed decisions about water use, thereby enhancing efficiency and safety in daily water consumption.

***Keywords—*** *ESP32; Turbidity Sensor; and TDS Sensor*

## I. INTRODUCTION

Khayangan residence Cepu is in Petak, Tambakromo, Cepu District, Blora Regency, Central Java. This contemporary Islamic residential area is located in a strategic location with easy access to the main road and has many facilities, such as a mosque, Islamic boarding school, orphanage foundation, Tahfidz Quran House, pharmacy, general practitioner practice and public clinic. It has an 8 meter road row and a single door system, which allows traffic in the household to remain safe. Water is very important for daily human needs, such as drinking, cooking, bathing and washing (Dewi &Putra, 2021). The water used by the community comes from various sources, including groundwater from household pumps, rivers, and PDAM (Regional Drinking Water Company). In some places, groundwater is often of low quality and cannot be used for any purpose (Hariyanto &Maslihah, 2017). Clean water will become more important as demand will increase. Clean water that is not contaminated by bacteria or viruses is what is really needed. Clean water that is used daily is generally used to meet this need. Most people don't know whether the water they drink is safe to drink (Ardiansyah &Bianto, 2022). So that water does not damage human life, it must remain free from impurities and odors. Water quality standards are a general method for determining water quality.

A microcontroller is a digital system consisting of a collection of integrated circuits (ICs) (Sundari et al., 2019). Unlike computers, microcontrollers have supporting components such as memory, incoming and outgoing ports, analog to digital converters and vice versa, and serial communication. Additionally, the microcontroller can be connected directly to the system via a USB port. As a measurement tool, energy consumption such as microcurrent and power is very important (Dewi &Putra, 2021). New technologies accessed via the Internet that enable detection and communication with intelligent objects related to decision-making processes. Internet of Things (IoT) refers to the general concept of network devices that collect data via the Internet, which is then sent via the Internet to be processed and used for certain purposes (Balusa &Gorai, 2019).

In the Khayangan Residence Cepu housing complex, most people are used to using ordinary water, which consists of river, lake and well water. People in housing complexes worry about whether the water is clear, free of harmful substances, and not cloudy because they don't know how dangerous it is to use the water. Therefore, it is necessary to have a detection system that can indicate clean and unclean water quality.

## II. METHOD

### A. *Microcontroller*

Microcontrollers are computers embedded in chips that help regulate the efficiency and cost of various electronic devices. Technically, there are two types of microcontrollers: RISC (Reduced Instruction Set Computer) and CISC (Computer Complex Instruction Collection). RISC has more functions but has limitations. CISC is a broader class but has fewer options. In other words, microcontrollers are tools made by people who code. In these programs, microcontrollers are instructed to perform some basic actions so that they can perform more complex tasks as the programmer desires. Pay attention a significant figure and avoid an unnecessary long digit number (Sundari et al., 2019).

### B. *Rule-base*

Rule Base is software that presents expert expertise in the form of rules to solve a specific problem. A simple rule-based model that can be applied to a variety of problems. However, too many rules will make the system more complicated and create errors. This rule-based theory uses a simple method. It starts with a foundation of rules, which includes all the knowledge about the problem at hand. This knowledge is then encoded into if-then rules, which contain data, statements, and initial information. The system will start and perform the conditions after that. Until one or two conditions are met, this loop will continue. If the rule is not found, the system must exit the loop (Dharmawan &Gata, 2019).

C. *ESP32*

The ESP32 microcontroller comes as a replacement for the ESP8266 microcontroller in the Espressife framework. This microcontroller has an open in-chip wifi module, which makes it very powerful for creating Web of Things application frameworks. The advantages of the ESP32 microcontroller compared to other microcontrollers are more pin outs, lighter pins, more memory, and low power Bluetooth 4.0, which makes it possible to use Snare of Things (Tantowi &Wijayanti, 2023). The module ESP32 can be seen in Figure 1.

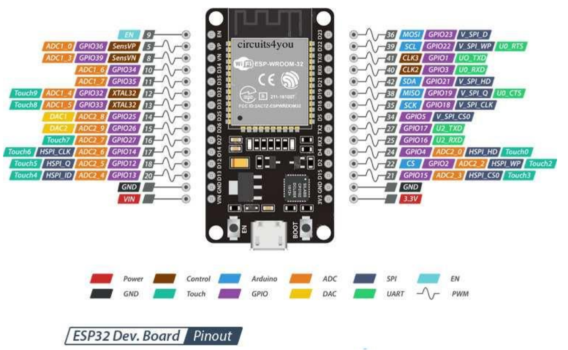


**Figure 1.** Module ESP32

D. *Turbidity Sensor*

A turbidity sensor is a tool that can be used to measure the level of turbidity in water, which basically cannot be seen with the naked eye. Simply put, the more dissolved particles in the water, the more turbid the water, and the more changes produced by the sensor the higher the turbidity of the water. The sensors used are equipped with functional systems that can detect physical events and chemical changes. These changes are processed into electrical signals, such as voltage or current, and these signals can be used to measure the level of water turbidity (Tantowi &Wijayanti, 2023). This item can be seen in Figure 2.

**Figure 2.** Turbidity Sensor

E. *TDS Sensor*

TDS (Total Dissolve Solid) Meter sensor is a type of sensor that is suitable for measuring TDS levels in water. TDS is a measure of the concentration of solid substances dissolved in water, and a higher TDS value indicates that the water is more turbid, and a lower TDS value indicates that the water is clearer (Tantowi &Wijayanti, 2023). This item can be seen in Figure 3.

**Figure 3**. TDS Sensor

F. *Arduino IDE*

Writing diagrams using Arduino IDE 1.8.0, which is pre-installed. Arduino IDE Design Sketch software is a tool used to create microcontroller applications, such as writing sources, compiling, uploading compilation results, and conducting tests via a serial terminal. The Arduino IDE is Java-based and comes with a C/C++ library known as wiring, which makes input and output operations easy. Sketch is the name for the Arduino IDE code.

G. *Waterfall Method*

Research procedures using the waterfall method can be seen in Figure 4. The waterfall method is a development method that has 5 phases, namely problem identification, system design, implementation, testing and maintenance. Additionally, the Waterfall method was chosen because it allows a structured and systematic system development process.

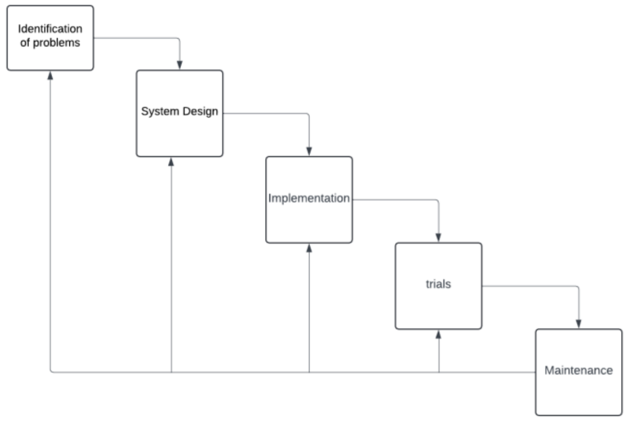


**Figure 4.** Research Procedures

1. Identification of problems
   Problem identification is the process of identifying problems that arise, and seeking research thinking, including problem analysis and the objectives of the problem and the solutions that will be proposed. The problem identification process also involves observation and literature study to gain an in-depth understanding of the context of the problem to be solved.
2. System Design
   In this step, the tool is made according to the tool design diagram which is created by increasing components, designing sensors, and developing tool programming. After the tool creation is complete, it will be displayed on the website using the Arduino IDE to create a fully functional system and the purpose of water detection at the Khayangan Residence Cepu housing complex. Apart from that, the results of this tool will be displayed via a simple website page so that clean water detection in the Khayangan Residence Cepu housing complex can be accessed and monitored easily by users.
3. Implementation
   At this implementation stage, the Turbidity sensor and TDS (Total Dissolve Solid) sensor were implemented using C and HTML on the Arduino IDE platform, and entered into the MySQL database. This aims to obtain and process data from the Turbidity sensor and TDS (Total Dissolved Solid) sensor. Once the data is successful, it is displayed on the web system connected to the ESP32. This process allows users to detect clean water through an easily accessible and responsive web interface.
4. Trials
   System testing is carried out by researchers to ensure that the water detection device suitable for consumption with a turbidity sensor and TDS (Total Dissolved Solid) sensor works well and is relevant. In addition, this testing aims to identify and find the possibility that the tools and systems have weaknesses or errors being developed.
5. Maintenance
   System maintenance is what researchers do when the water detection device is suitable for consumption when it experiences problems. Turbidity sensors and TDS (Total Dissolved Solid) sensors need to be calibrated periodically to ensure that the measurements taken are accurate and consistent. In addition to performing routine calibration and cleaning, it is also important to monitor sensor performance regularly.

## III. RESULT AND DISCUSSION

Schematic of the Turbidity sensor circuit and TDS (Total Dissolve Solid) sensor sent from the website connected to the ESP32 which will use a Wireless Fidelity (WiFi) connection which is forwarded and processed in a simple website display that can be accessed on multiplatform as shown in Figure 5.

The explanation in Figure 5 is the design process of the research tool. The first step taken was to place the Turbidity sensor and TDS (Total Dissolve Solid) sensor strategically and accurately detect the water concentration. This sensor is connected to the ESP32, a microcontroller which has the ability to collect data from the sensor and manage communication via a Wi-Fi network. Furthermore, after the water sample data has been successfully collected, the information will be sent via a Wi-Fi connection to the local server.

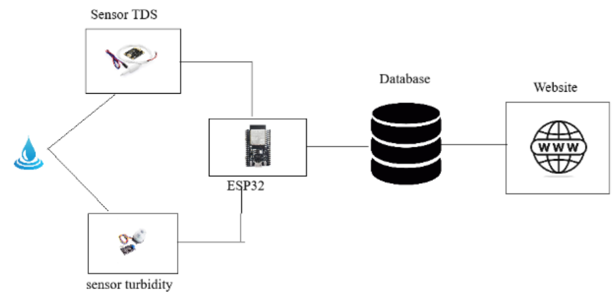


**Figure 5.** Schematic

On the server side, the data is processed through a further process which will be displayed on the website. The website display is in the form of a value table, status, and effect table as well as suggestions, and a visual graphic table relevant to water concentration. The results of designing this tool can provide useful information in detecting water in housing complexes. In the website display, the collected data can be easily accessed and understood by users regarding the value intensity of clean water, and provides broader benefits in making appropriate decisions or actions related to water quality conditions in the community.

The Turbidity Sensor will initialize the water conditions. Then, the task of the TDS (Total Dissolve Solid) sensor will be to determine the level of the water. Processing data from the database, namely, if the clean water content obtained by the turbidity sensor and for Total Dissolve Solid (TDS) is 0-300 ppm and NTU >18, then the value displayed on the website will show the information "fit for use" and the status "Clean Water" . If the medium water obtained by the sensor is around the turbidity sensor and for Total Dissolve Solid (TDS) 300-1000 ppm and NTU <17, then the value display on the website will show the information "requires filtering" and the status "Medium Water". If the dirty water obtained by the sensor is in the vicinity of the turbidity sensor and for Total Dissolve Solid (TDS) >1000 ppm and NTU <15, then the value displayed on the website will show the information "not suitable for use" and the status "Dirty water". Then, the data to be managed will be sent back to the website where it has been displayed as a result of processing the data in the database. As for the rule-based sensor flow diagram can be seen in Figure 6.

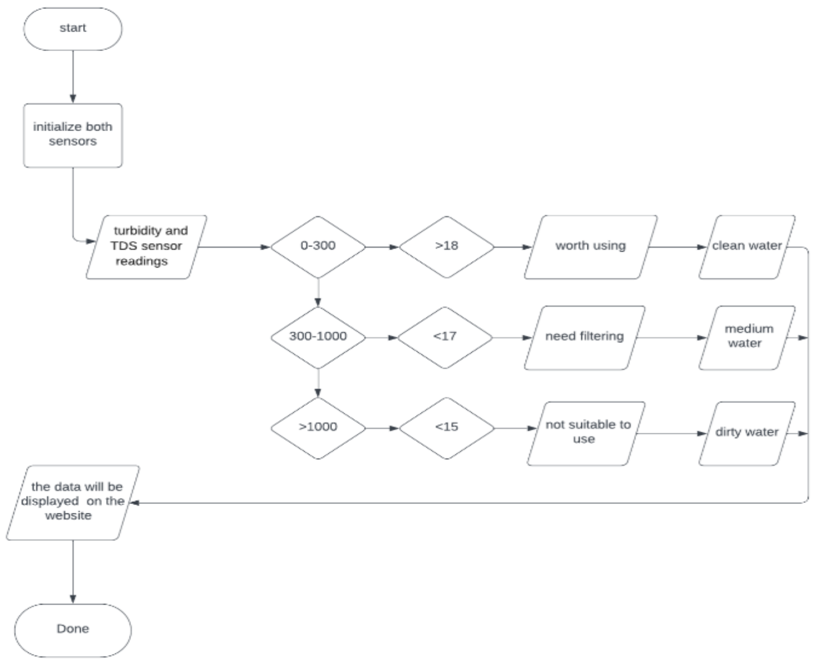


**Figure 6.** Rule-base Sensor Flowchart

Schematic of the Turbidity sensor circuit and TDS (Total Dissolve Solid) sensor sent from the website connected to the ESP32 which will use a Wireless Fidelity (WiFi) connection which is forwarded and processed in a simple website display that can be accessed on multiplatform as shown in Figure 7.

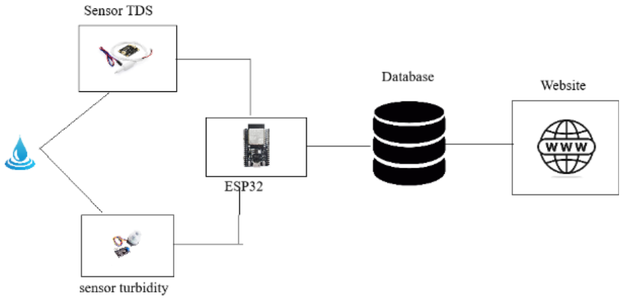


**Figure 7.** Schematic

The explanation in Figure 7. is the design process of the research tool. The first step taken was to place the Turbidity sensor and TDS (Total Dissolve Solid) sensor strategically and accurately detect the water concentration. This sensor is connected to the ESP32, a microcontroller which has the ability to collect data from the sensor and manage communication via a Wi-Fi network. Furthermore, after the water sample data has been successfully collected, the information will be sent via a Wi-Fi connection to the local server. On the server side, the data is processed through a further process which will be displayed on the website. The website display is in the form of a value table, status, and effect table as well as suggestions, and a visual graphic table relevant to water concentration. The results of designing this tool can provide useful information in detecting water in housing complexes. In the website display, the collected data can be easily accessed and understood by users regarding the value intensity of clean water, and provides broader benefits in making appropriate decisions or actions related to water quality conditions in the community.

The monitoring website that is designed displays several display menus including monitoring as a login page like figure 8, main display, water data display, and real-time graphic display like figure 9. The designed graphic display displays clean water graphs and dates in real time. The monitoring table display is a supporting display to display system results in more detail on the overall results. The monitoring table uses 6 tables consisting of ID, date, time, PPM, TDS (total Dissolve Solid), Turbidity, information table and status table that shows the results that have been processed by the system within a certain period of time shown in figure 10.

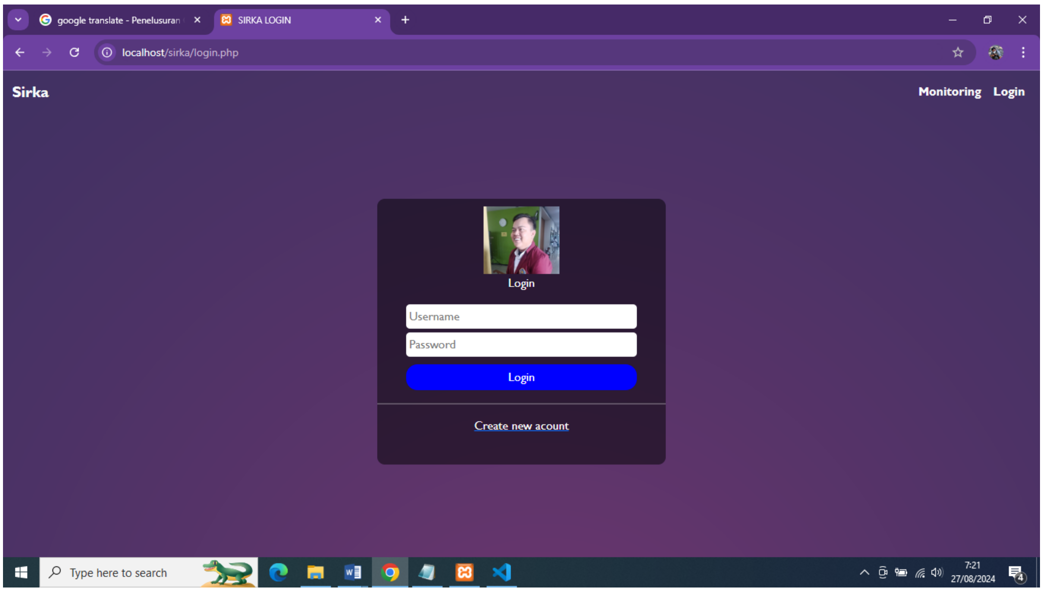


**Figure 8.** Login Interface

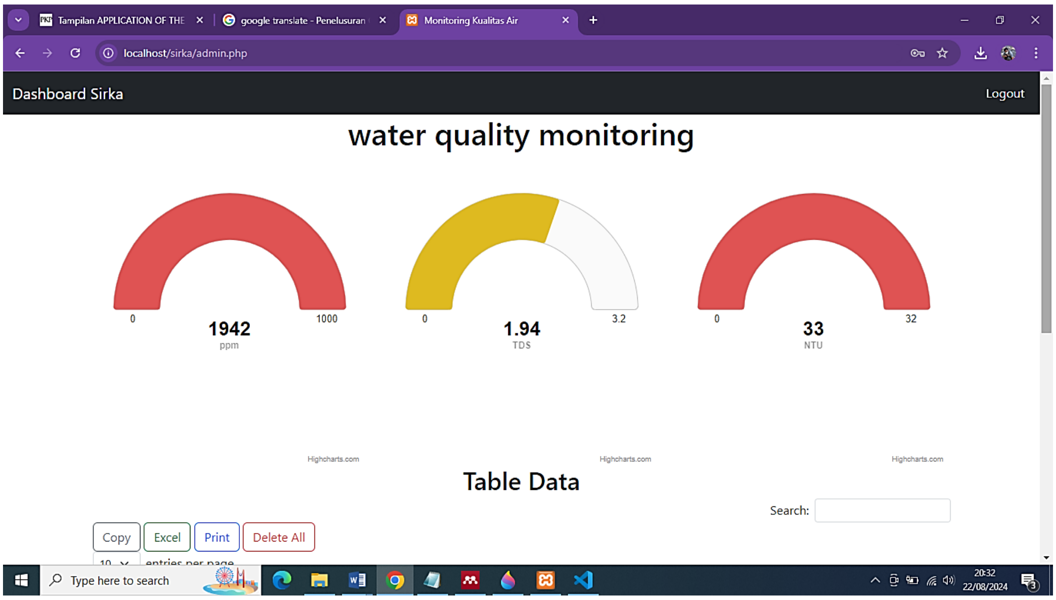


**Figure 9.** Website Display

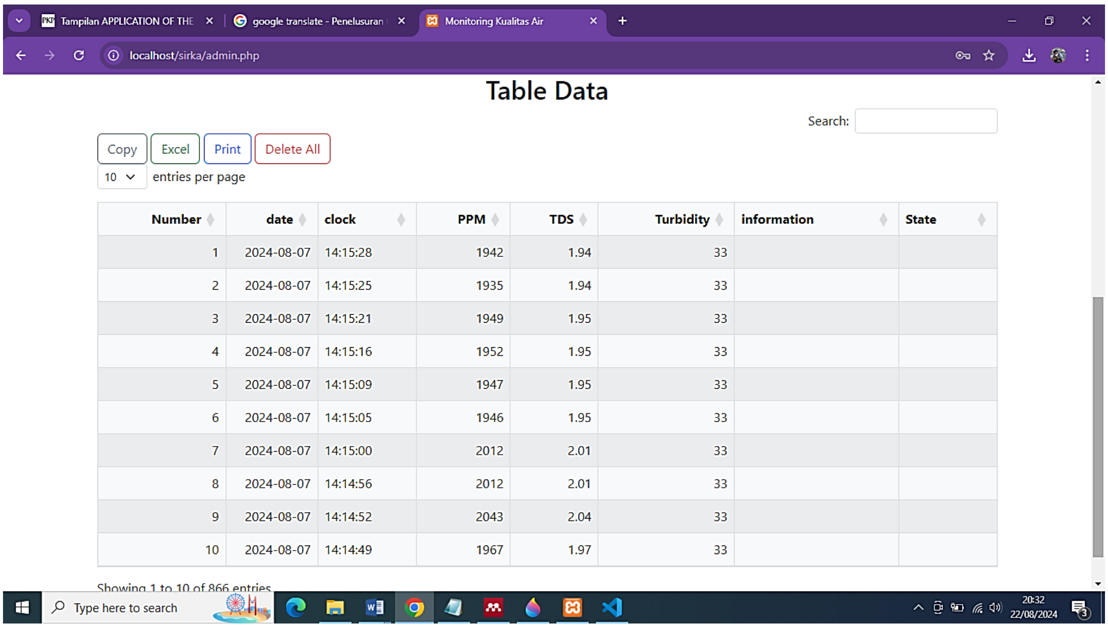

Table Data

Search:

Copy | Excel | Print | Delete All

10 entries per page

| Number | date | clock | PPM | TDS | Turbidity | information | State |
|---|---|---|---|---|---|---|---|
| 1 | 2024-08-07 | 14:15:28 | 1942 | 1.94 | 33 | | |
| 2 | 2024-08-07 | 14:15:25 | 1935 | 1.94 | 33 | | |
| 3 | 2024-08-07 | 14:15:21 | 1949 | 1.95 | 33 | | |
| 4 | 2024-08-07 | 14:15:16 | 1952 | 1.95 | 33 | | |
| 5 | 2024-08-07 | 14:15:09 | 1947 | 1.95 | 33 | | |
| 6 | 2024-08-07 | 14:15:05 | 1946 | 1.95 | 33 | | |
| 7 | 2024-08-07 | 14:15:00 | 2012 | 2.01 | 33 | | |
| 8 | 2024-08-07 | 14:14:56 | 2012 | 2.01 | 33 | | |
| 9 | 2024-08-07 | 14:14:52 | 2043 | 2.04 | 33 | | |
| 10 | 2024-08-07 | 14:14:49 | 1967 | 1.97 | 33 | | |

Showing 1 to 10 of 866 entries

**Figure 10.** Table Data

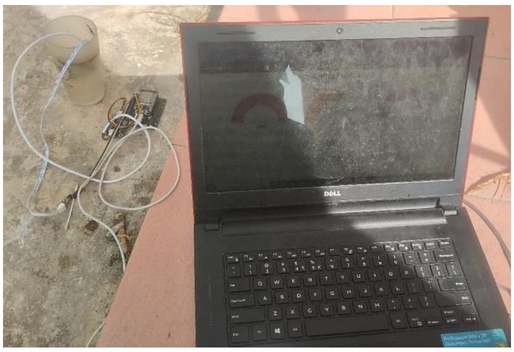

**Figure 11.** Microcontroller system application

Figure 11 shows the application of the Microcontroller system, the site monitoring process starts reading all the information sent by the clean water detection. If done this way, the data will be the same as the TDS (Total Dissolve Solid) sensor data and the Turbidity Sensor can send water quality values via the ESP32 microcontroller which is connected to the internet. The microcontroller can display the date. , hours, ppm, TDS (Total Dissolve Solid), Turbidity, description, and status of the water and the device system sends information to the monitoring system website after viewing The website tracking page is created to make it possible in such a way to connect to the monitoring system tool.

**Table 1.** Water Analysis System

| ID | Clock | PPM | Turbidity | TDS | Information | State |
|---|---|---|---|---|---|---|
| 1 | 08:17:25 | 270 | 0,27 | 16,1 | Good to use | Clean water |
| 2 | 08:17:22 | 234 | 0,23 | 16,08 | Good to use | Clean water |
| 3 | 10:10:18 | 190 | 0,19 | 15,98 | Good to use | Clean water |
| 4 | 10:43:06 | 59 | 0,06 | 12,37 | Good to use | Clean water |
| 5 | 12:18:03 | 335 | 0,34 | 16,11 | Need filtering | Medium Water |
| 6 | 12:58:00 | 343 | 0,34 | 16,09 | Need filtering | Medium Water |
| 7 | 14:17:56 | 348 | 0,35 | 16,08 | Need filtering | Medium Water |
| 8 | 15:17:53 | 355 | 0,36 | 16,09 | Need filtering | Medium Water |
| 9 | 15:17:39 | 330 | 0,33 | 16,13 | Need filtering | Medium Water |
| 10 | 16:21:06 | 304 | 0,3 | 16,08 | Need filtering | Medium Water |
| 11 | 18:10:32 | 287 | 0,29 | 16,1 | Good to use | Clean water |
| 12 | 22:02:29 | 276 | 0,28 | 16,13 | Good to use | Clean water |
| 13 | 23:58:25 | 270 | 0,27 | 16,1 | Good to use | Clean water |
| 14 | 09:17:22 | 234 | 0,23 | 16,08 | Good to use | Clean water |
| 15 | 10:49:29 | 276 | 0,28 | 16,13 | Good to use | Clean water |
| 16 | 13:18:25 | 270 | 0,27 | 16,1 | Good to use | Clean water |
| 17 | 14:57:22 | 234 | 0,23 | 16,08 | Good to use | Clean water |
| 18 | 23:37:29 | 276 | 0,28 | 16,13 | Good to use | Clean water |
| 19 | 23:47:25 | 270 | 0,27 | 16,1 | Good to use | Clean water |
| 20 | 09:25:09 | 657 | 0,66 | 16,5 | Need filtering | Medium water |

The turbidity sensor and TDS (Total Dissolve Solid) sensor are placed when inserting it into the water, producing an output that displays in real-time a sequence of water quality data input by the turbidity sensor and TDS (Total Dissolve Solid) sensor every 3 second interval. These results show that the PPM is 276, TDS (Total Dissolve Solid) is 0.34, and Turbidity is 16.08. This system is capable of accurately and periodically detecting the specified clean water quality.

## IV. CONCLUSION

This research presents a monitoring system combined with a Turbidity sensor and a TDS (Total Dissolve Solid) sensor. The Turbidity sensor and TDS (Total Dissolve Solid) sensor take the results of the water quality which are then processed by the ESP32 to be forwarded to a website display and provide real-time tables. The system process is very simple, namely by taking data on water quality in the Khayangan Residence Cepu housing complex using sensors, the results of which can then be monitored via the website and it works well, equivalent to a PPM measurement of 276, TDS (Total Dissolve Solid) is 0.34, and Turbidity is 16.08. With this system, it is hoped that people will find it easy to use clean water quality with efficiency

## ACKNOWLEDGEMENT

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can be useful and add insight to knowledge both for the author himself and for those in need..

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