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DESIGNING MEASUREMENT OF PH AND WATER TURBIDITY LEVEL BASED ON IOT

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Abstract : *Research on measuring pH and water turbidity levels based on Internet of Things (IoT) is designed to make it easier for laboratory workers to measure acid and alkaline levels and turbidity levels in water in order to provide fast and efficient service to people who carry out water quality tests. This measuring instrument for pH and water turbidity is based on IoT by utilizing wireless technology in the process of transferring data to a database and using the web as the output media for measuring water content. The system development method used in this research is Prototype. The first stage in this method is to listen to the customer as a form of gathering the needs for the tools to be built, then the second stage is to design and make a prototype that is tailored to the needs of the tools that have been defined previously and the third stage is the prototype trial carried out by the customer by adjusting the request and then providing feedback on the tools developed.*

Keywords: *Measuring pH, Water Turbidity Level, IoT, Website.*

Pengukuran tingkat pH dan kekeruhan air berdasarkan Internet of Things (IoT) dirancang untuk memudahkan pekerja laboratorium mengukur tingkat kadar asam dan basa serta tingkat kekeruhan air agar dapat memberikan pelayanan yang cepat dan efisien kepada masyarakat yang melakukan tes kualitas air. Alat ukur pH dan kekerarasan air ini didasarkan pada IoT dengan memanfaatkan teknologi nirkabel dalam proses transfer data ke database dan menggunakan web sebagai media output untuk mengukur kandungan air. Metode pengembangan sistem yang digunakan dalam penelitian ini adalah Prototype. Tahap pertama dalam metode ini adalah mendengarkan pelanggan sebagai bentuk pengumpulan kebutuhan alat yang akan dibangun, kemudian tahap kedua adalah merancang dan membuat prototipe yang disesuaikan dengan kebutuhan alat yang telah didefinisikan sebelumnya dan tahap ketiga adalah uji coba prototipe yang dilakukan oleh pelanggan dengan menyesuaikan permintaan dan kemudian memberikan umpan balik pada alat yang dikembangkan.

Kata kunci*: Pengukuran pH, Tingkat Kekeruhan Air, IoT, Website*

1. INTRODUCTION

Currently, technology has become a part of human life that is used to facilitate daily tasks. The Internet of Things (IoT) has been supported by new information exchange technology, which provides not only People-To-Machine but also Machine-To-Machine (M2M) communications [1-3]. IoT is responsible for requesting information and/or executing commands remotely through hardware with various features and purposes [4].

The role of water for life on earth is very important, every living thing that lives on earth definitely needs water. the availability of water in the territory of Indonesia itself is very abundant because

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most of the territory of Indonesia consists of many islands surrounded by oceans. Water can be said to be polluted or it cannot be known from several parameters, namely, physical, chemical, and biological parameters. Physical parameters include temperature, turbidity, color, and electrical conductivity, number of dissolved solids, taste, and smell. Chemical parameters include pH, dissolved oxygen, CO2, ammonia, nitrogen nitrate, and orthophosphate. Biological parameters include the presence of bacteria, plankton, and so on. The effects of this water pollution have a detrimental impact on the environment, human health, and various living things on earth [5].

The degree of acidity of the air gives a sign of the activity of hydrogen ions in the air. The higher the h + ion concentration level, the more acidic the water, the higher the pH value < 7. The higher the oh- ion concentration level, the higher the h + ion concentration level, the higher the pH value > 7. For pure (neutral) water it is indicated by pH = 7 [6].

Readings of the degree of acidity of the water can be done using a digital pH meter dipped directly in water, and the numeric scale will be read by a digital pH meter. Then the information from the digital pH meter sensor is recorded manually and will later be entered into the database for data processing. This takes time and the staff of the Industry Research and Standardization Center Samarinda (Baristand Industri Samarinda).

Based on the problems described, research was carried out to design measuring instruments for pH and turbidity of water-based on Internet of Things (IoT), which is connected to the internet via wireless to measure the measurement data into a database and then it can be accessed by users via the website.

2. RESEARCH METHOD

In this research methodology, there are several things that must be considered, including the following:

2.1 Prototype Method

The Prototype method is a new paradigm in software development methods where this method is not only an evolution in the world of software development but also revolutionizes the old software development method, namely a sequential system commonly known as SDLC or the waterfall development model [7-9].

In figure 1 it can be explained the stages in Prototyping are as follows:

1. Listening to Customers
   The system needs to be collected by listening to requests from customers. To create a system that suits your needs, you must first know how the system is running and then find out what problems occur.
2. Designing and Making Prototypes
   At this stage, the design and manufacture of a system prototype are carried out. Prototypes that are made are tailored to the system requirements that have been previously defined from customer or user requests.
3. Trial
   At this stage, the prototype of the system is tested by customers or users. Then do an evaluation of the deficiencies of the test process against the needs. The developer then returns to

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listening to requests or evaluation results from customers to improve the existing prototype.

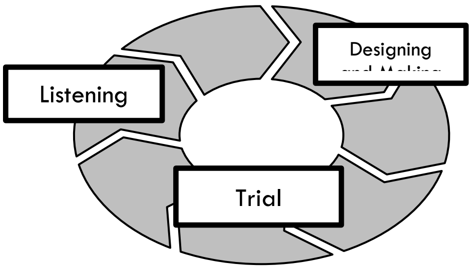

Figure 1. *Prototype Model*

2.2 Design

Design or design is the first step in the product or systems engineering development phase. The design is a series of procedures for translating the analysis results of a system into a programming language to describe in detail how the system components are implemented. [9].

2.3 pH Degree of Acidity

The degree of acidity or pH is used to express the level of acidity or base that a substance, solution, or object has. pH stands for Power of Hydrogen. In figure 2, generally, a normal pH has a value of 7 whereas if a pH value> 7 indicates the substance has alkaline properties, while a pH value <7 indicates acidity. A pH of 0 indicates a high degree of acidity, and a pH of 14 indicates the highest degree of basicity [10].

The normal pH value for groundwater is usually between 6 and 8.5. The pH threshold value for water according to Permenkes No. 492 / Menkes / Per / IV / 2010 is 6.5 - 8.5 [11]. Water with a low pH (<6.5) is acidic, contains low solids, and is corrosive. Water with this condition contains iron, and so on. This can cause damage to the transmission pipe, in addition to causing a sour taste, stains on clothes, stains on toilets, etc., as well as having a bad impact on health. Meanwhile, water with a high pH (> 8.5) is alkaline. The water does not have a bad impact on health but can cause problems in the form of an alkaline taste in the water.

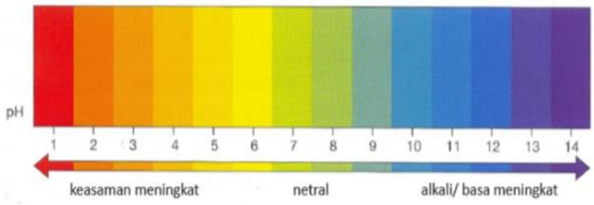

Figure 2. Acidity Scale (pH)

2.4 Water Turbidity

In figure 3 it can be explained that the numerical value indicating the turbidity level is based on the interference of suspended materials in the path of light through the sample. This value does not directly indicate the amount of suspended material, but it does indicate the possibility of consumer acceptance of the water. Turbidity is not a dangerous characteristic of water, but it is disliked because of its appearance. To make water satisfying household use attempt to almost completely remove the substances that cause turbidity [12].

There are 3 methods of measuring turbidity:

1. Nephelometric method (FTU or NTU units of nephelometric turbidity). The nephelometer method is an indirect turbidity measurement. The intensity of light scattering caused by the air sample with the intensity due to the standard air suspension under the same conditions. The higher the intensity of the light scattering, the higher

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the scattering of the rays. Therefore, it is ideal for low turbidity measurements.

2. Hellige Turbidity method (silica turbidity units).
3. Visali method (Jackson turbidity unit).

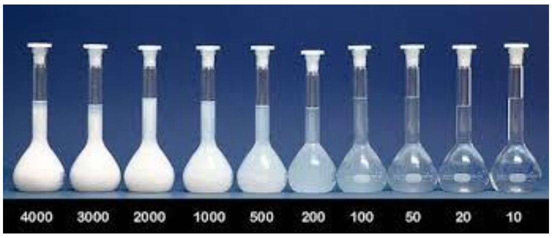

Figure 3. NTU Water Turbidity Standard

2.5 Hardware

Hardware is also called hardware is all physical parts of a computer, and is distinguished by the data that is in it or that operates in it, and is distinguished from software that provides instructions for hardware in completing its tasks. Computer hardware can also be interpreted as a tool designed to receive and process data. Each of the hardware contained in the computer has its own task so as to produce a complete and working computer system [13].

2.6 Internet *of Things*

Internet of Things can be defined as the ability of various devices that can connect and exchange data through the internet network. IoT is a technology that allows for control, communication, collaboration with various hardware devices, which are given an exclusive identity and the ability to relocate data via the internet network. So, it can be said that the Internet of Things (IoT) is when we connect things (things) where certain objects have the ability to transfer data via networks that are not operated by humans to the internet [14].

Internet of Things (IoT) is a structure in which objects, people are provided with an exclusive identity and the ability to move data through a network without requiring human-to-human direction, i.e. source to destination or human-to-computer interaction. [15].

2.7 Arduino Uno

Arduino is a microcontroller-based prototype software that is flexible and open-source, the hardware and software are easy to use. This device is a service for people who are interested / take advantage of the microcontroller practically and easily. For those using this board, it will be easy to control, for controller designers it will be easier to make prototypes or implementations [16].

In Figure 4, it seems that the Arduino UNO has 14 digital inputs/outputs (6 outputs for PWM), 6 analog inputs, a 16 MHz ceramic crystal resonator, USB connection, adapter socket, ICSP header pins, and a reset button. This is what is needed to support the microcontroller easily connected with a USB power cable or AC to DC adapter power supply cable or also a battery.

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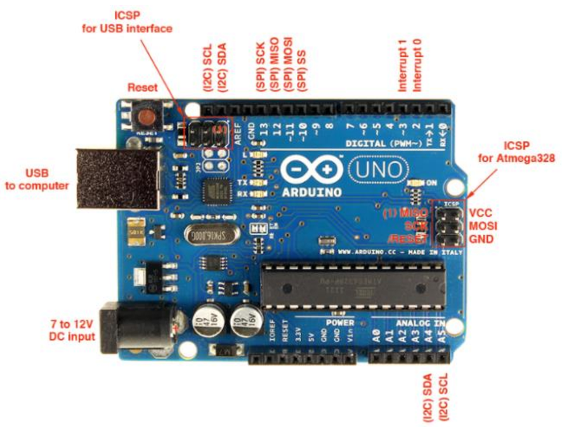

Figure 4. Arduino Uno

2.8 *Flowchart*

The flowchart is a description of the results of thinking in analyzing a problem on a computer. A flowchart is a diagram showing the flow of data through an information handling program or system and the operations imposed on the data at important points along the path. The flow chart uses annotations and symbols, for example, squares, rhombuses, lanes, and ovals to represent operations. The lines and arrowheads used are connected to these symbols to show the direction of data flow from one point to another as a graphical diagram showing a program or other system, a flow chart is useful as a helper tool to show how the flow of the proposed program works and as a means to understand the operations in a program [17].

3. RESULTS AND DISCUSSION

3.1 Overview

The prototype for measuring the pH and turbidity level of this water was built referring to measuring the acidity and alkalinity (pH) and the level of turbidity in water using an analog pH sensor and a Turbidity sensor, with NTU as a measurement unit for water turbidity and pH for water acidity. The output of the sensor displays the pH level and water turbidity level of the sample measured via an LCD display and a web that is accessed via a browser.

By using IoT-based technology, the process of measuring pH levels and air turbidity levels that were previously carried out manually can be replaced with automatic measurements using sensors, namely by immersing the pH and Turbidity sensors into a container containing the test sample water, the sensor. will measure and emit light. The LED and capturing the light reflection are then read and placed on the Arduino Uno system, then through a wireless module connected to the Arduino Uno, the measurement data can be synchronized online into the database, so that the measurement results appear on the LCD screen and the web and the output is in the form of information. pH level and air turbidity.

3.2 Discussion

1. Listening to Customers

Listening to customers or users is the first step that must be taken to identify the format of the entire software, determine all requirements, and an outline of the system that will be created so that it can be used as a definite measure of the limits of success. the product to be used. The stages of listening to customers include:

1) Requirement Analysis

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Requirement analysis is to understand the real needs of the new system and develop a system that is adequate for these needs. This process includes various things that are needed in a system.

a. Functional Analysis

At this stage, it explains that the prototype of measuring pH and water turbidity levels consists of pH and Turbidity sensors to measure the pH and turbidity levels of water in the chemical laboratory, where Arduino UNO ATMega 328 acts as a data processor that has been obtained from the pH sensor and Turbidity, which is then the measurement data from the sensor is displayed via the LCD (Liquid Crystal Display) and also through the Wi-Fi module ESP8266 the measurement data is sent and stored to the MySQL database so that the sensor data can be accessed directly by the user via a website that has been designed using a browser, this makes it easier for users to control and input data by remotely.

1. Non-Functional Analysis
   (a) Hardware
      1. Acer V5-471G Laptop
      2. Arduino Uno ATMega 328
      3. Analog pH sensor
      4. Analog Turbidity sensor
      5. ESP8266 Wi-Fi Module
      6. Arduino Uno I/O expansion sensor shield module
      7. Jumper Cable
   (b) Software
      1. Windows 10 Pro 64-bit Operating System
      2. Arduino IDE
      3. Visual Studio Code
      4. Fritzing
      5. Xampp
      6. Browser

2) System Analysis

In the system analysis, there are several special conditions that complement the pH meter and the water turbidity level, including:

a. This tool produces variable numbers due to the limited ability of the pH and Turbidity sensors.
b. This tool produces an output in the form of the pH and turbidity levels of the water via LCD and web.
c. Synchronization of measurement data into the database is carried out with the Wi-Fi module installed on the Arduino and connected directly to the internet. The measurement results can be directly displayed on the web page without manual data entry beforehand.

2. Designing and Developing Prototypes

In this stage, the results of the needs analysis are poured into a design that will describe the system being created.

1) Block Diagram

Based on figure 5, it can be explained to make a prototype for measuring pH and water turbidity levels using this IoT-based Arduino, first install a pH sensor, Turbidity sensor, and Wi-Fi module to Arduino using a jumper cable. The two sensors become the process of entering measurement data. After the sensors process each data, it will then be processed to the Arduino Uno microcontroller. Furthermore, the

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measurement data is displayed via the LCD as the first output, then Arduino will send the measurement result data to the database via the Wi-Fi module which functions as an HTTP client to make requests to the server. After the data is received or inputted into the database, the data can be visualized via the web that has been stored on the webserver for user access.

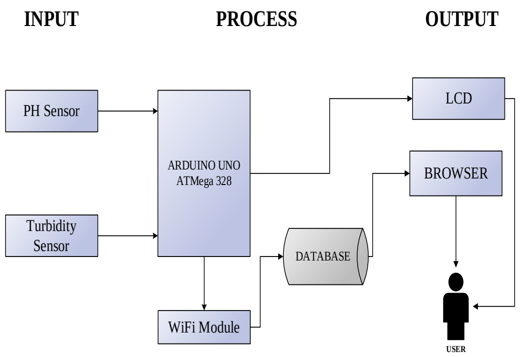

Figure 5. Block Diagram

2) System Flowchart

In figure 6 is explained that in measuring pH and water turbidity levels using an IoT-based Arduino, the first process is the process of initializing or declaring the pH sensor and Turbidity sensor variables. Furthermore, the two sensors will take measurements of the water. Then the sensor measurement data will be sent and processed on the Arduino Uno microcontroller, after the data is processed, the data will be displayed as output in the form of information.

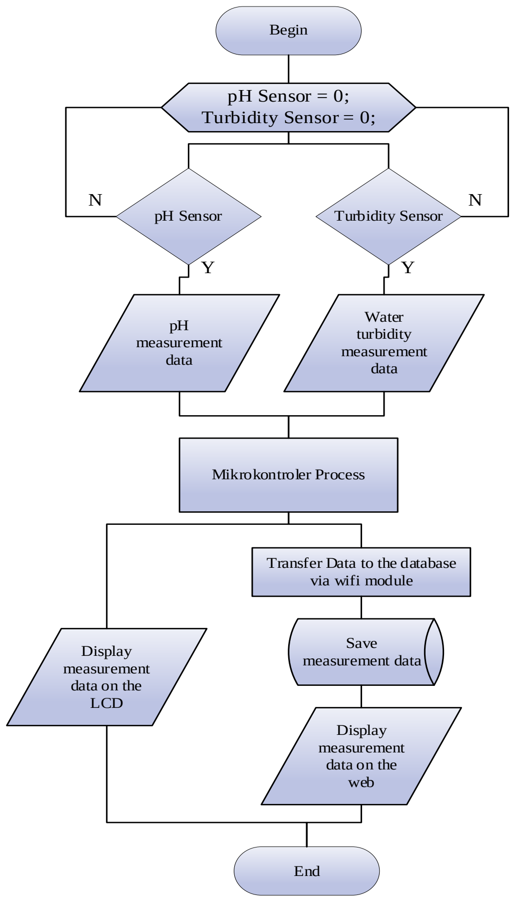

Figure 6. System Flowchart

3) Database Structure

Figure 7 is explained a design created and used to find out what tables are needed and contain data that will be stored and updated later. The following tables related to dynamic systems.

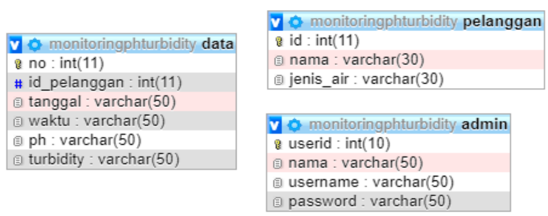

Figure 7. Database Structure

3. Prototyping

At this stage, the prototype of the tool is based on a previously made design and is based on the needs of potential users.

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1) Hardware

The hardware used for measuring pH and water turbidity using IoT-based Arduino is Arduino Uno, analog pH sensor, analog Turbidity sensor, Wi-Fi module, LCD, and computer/laptop. PH and Turbidity sensors as sensors for measuring objects, Arduino Uno as a microcontroller device to process and process data on objects that have been measured, a Wi-Fi module as a connecting device to the internet, LCD as an output device for measurement results, and a computer/laptop as a display of measurement results.

In figure 8 it can be explained that the components contained in this tool consist of several connected components.

a. Arduino Uno
b. Analog pH Sensor
c. Analog Turbidity Sensor
d. Wi-Fi Module
e. LCD

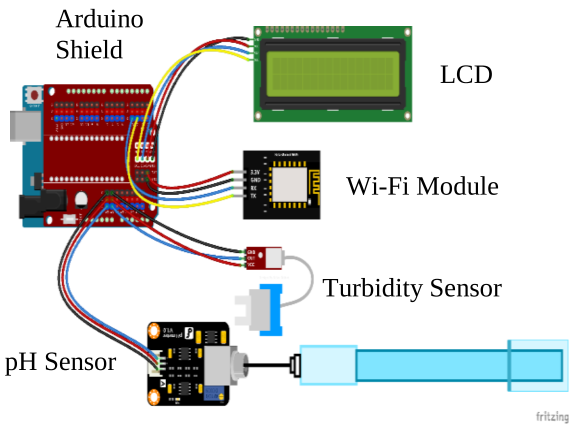

Figure 8. pH Measuring Instruments and Water Turbidity Levels Schema

The Wi-Fi pin module components are connected to the Arduino shield pin as shown in Table 1.

Table 1. Configure Wi-Fi Module Pin to Arduino

WI-FI MODULE PIN	*ARDUINO SHIELD PIN*
3.3 V	+3V3
GND	GND
Rx	Pin 3
Tx	Pin 2

In table 2 shows the pH sensor pin components connected to Arduino shield pin.

Table 2. Configure pH Sensor Pin to Arduino

PH SENSOR PIN	*ARDUINO SHIELD PIN*
VCC	VCC
GND	GND
OUT	A0

In table 3 shows the turbidity sensor pin components connected to Arduino shield pin.

Table 3. Configure Turbidity Sensor Pin to Arduino

TURBIDITY SENSOR PIN	*ARDUINO SHIELD PIN*
VCC	VCC
GND	GND
OUT	A1

In table 4 shows the LCD pin components connected to Arduino shield pin.

Table 4. Configure LCD Pin to Arduino

LCD PIN	**ARDUINO SHIELD PIN**
VCC	+5V
GND	GND
SDA	SDA
SLC	SLC

2) Software

The software used for measuring pH and water turbidity using IoT-based Arduino is Arduino IDE, Fritzing, and Visual Studio Code.

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Arduino IDE as a text editor to write code and connect to the Arduino board to upload programs and also to communicate. Fritzing as an application to create a series of hardware paths. Visual Studio Code is a code editor used to develop websites using the HTML, CSS, and PHP programming languages.

3) Tool Work Process

The work process of this tool begins with powering the Arduino by 5V via an adapter or USB port. After Arduino gets power, all components connected to Arduino via jumper cables are ready for use. Furthermore, the pH sensor and Turbidity sensor have received power from the 5V pin of Arduino and are ready to be used to measure acid, base, and turbidity levels in the water. Furthermore, the pH sensor and Turbidity sensor are immersed in the water sample to be tested. After the two sensors work, the sensor measurement data is obtained. The sensor measurement data is transferred to memory at Arduino for processing. Furthermore, the data after being processed by Arduino will be transferred into output. The first output of this prototype tool is via an LCD.

From Arduino, measurement data is sent via the LCD serial and the measurement results are displayed on the LCD screen. The second output of this prototype tool is a web interface. The measurement result data that has been processed by Arduino will be sent to the database via the online Wi-Fi module. The Wi-Fi module here has a role to make requests to the server as an HTTP client then the server responds so that data can be received and stored in the database. Furthermore, the data that has been stored in the database can be called through a browser by typing the domain name / IP address from the web. After that, the data immediately appears on the web browser page in the form of information on the pH level and the turbidity level of the water sample in the form of a percentage, and there is also a table to recap the measurement data as well as a chart to see the graph of the object measurement data.

4) Output

Figure 9 is a picture of a series of tools that have been packaged in a plywood box equipped with foam so that the set of tools remains neatly organized and not easily scattered. This tool is ready to use.

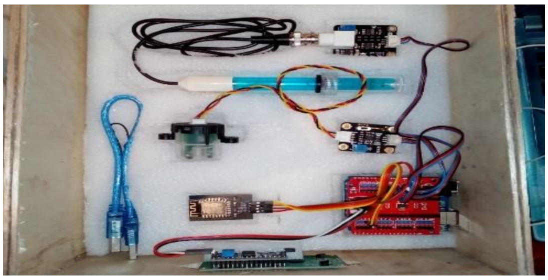

Figure 9. Tool Components

In Figure 10 is the process of immersing the pH sensor and the Turbidity sensor into the water sample container for measurements.

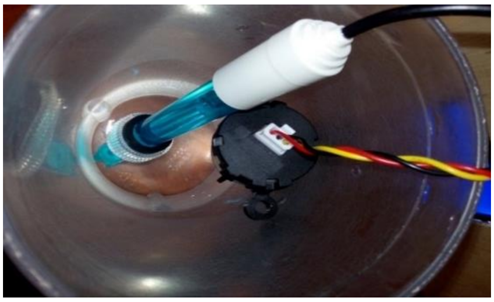

Figure 10. The Sensor Is Dipped In The Water Sample

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Figure 11 is an LCD display of the measurement results of the water sample. The LCD displays the pH level results on the first line and the second line displays the water turbidity level (NTU).

Figure 11. Output Display On LCD

Figure 12 shows the admin login page interface. There is an input form containing the Baristand Industri Samarinda logo and a username and password that must be entered for the admin authentication process as a website manager.

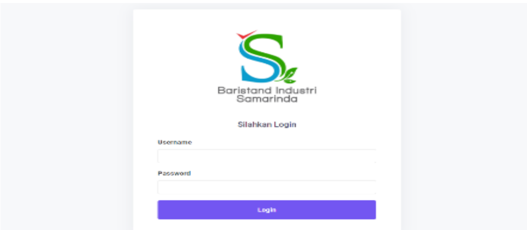

Figure 12. ***User Interface Login Admin***

Figure 13 shows the homepage of the website, the measurement results for pH levels and water turbidity levels. There is a sidebar containing Dashboard, Table, and Chart content to provide navigation to users. Then there is a box tile that contains information on the name of the customer, type of water, pH, and clarity and there is an input form at the bottom to enter the name of the customer and the type of measurement sample water.

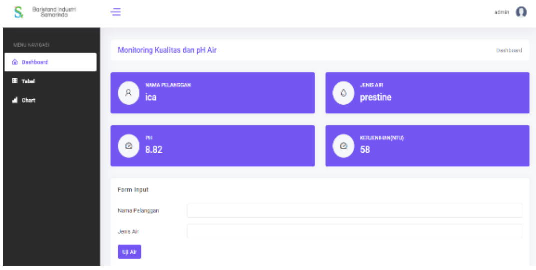

Figure 13. User Interface Dashboard Web

Figure 14 is a table page display. This page contains information on the data summary of the name of the customer, and the type of water along with the date, time, and results of previous pH and Turbidity sensor measurements. There is also an Export Data feature. This feature can be used by users if they want to print a measurement result data report.

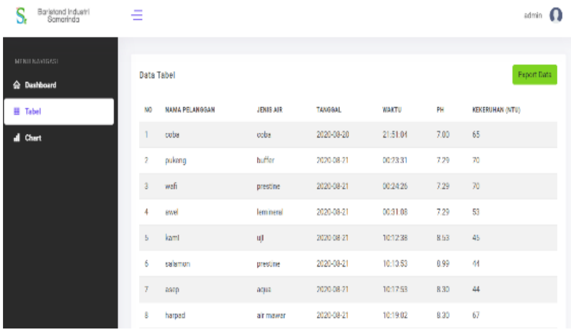

Figure 14. User Interface Table

Figure 15 is a chart page display. From this display, the user can find out the range or interval of measurement data from the pH and Turbidity sensors which are packaged in graphs. This makes it easy to see the increase or decrease that occurs in the measured data.

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Figure 15. User Interface Chart

5) Comparison of pH Sensor Measurement Results

The results of the comparison were obtained from testing the pH sensor of the water by taking pH sensor data from the sample. Table 5 shows some of the pH sensor data carried out on the device.

Table 5. Comparison of pH Measurement Results

Solvent Type	pH Sensor Value	pH Meter	Error	Error Average
Aqua	7	7	0%	0,38 %
Pristine	8	8,9	0,9%	
Toner	4,5	5,0	0,5%	
Le Mineral	7	7,01	0,1%	
Coffee	6,3	6,7	0,4%	

6) Comparison of Turbidity Sensor Measurement Results.

The comparison results were obtained from testing the Turbidity sensor which was carried out by taking Turbidity sensor data to the sample. In table 6, some of the Turbidity sensor data is displayed on the device.

Table 6. Comparison of Water Turbidity Measurement Results

Solvent Type	***Turbidity Sensor Value (NTU)***	***Datasheet***	***Error***	***Error Average***
Pristine	45.0	40.0	0.5%	0,8 %
Tea	59.0	50.0	0.9%	
Coffee	90.0	80.0	1%	

4. Prototype Evaluation

At this stage, we ask for customer/user opinion regarding whether the prototype built is in accordance with the user's wishes or not, if not then we make changes to suit the user's wishes. Table 7 below shows the feedback given by the user.

Table 7. User *Feedback*

No.	***Date***	***Feedback***
1	28 July 2020	Calibrate the sensor
2	30 July 2020	Improve web UI
3	11 August 2020	Added data export feature

4. CONCLUSION

Based on the descriptions that have been explained and the discussion regarding the design of pH measuring instruments and water turbidity levels using IoT-based Arduino, the conclusion to answer the formulation of these problems is to make a prototype of this tool required 5 main components, i.e, Arduino Uno as the main hardware microcontroller, analog pH sensor as water pH sensor, Turbidity analog sensor as water turbidity level sensor, LCD as

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direct output, Wi-Fi module as data sender to the server.

From this research, a prototype product for measuring pH and water turbidity levels was produced using a simple, precise circuit based on IoT to simplify the process of measuring pH levels and water turbidity levels. The prototype tool made is a measuring tool and monitoring system for pH and turbid water that can be accessed through the website. From the test results from the first to the sixth stage, the prototype measuring instrument for pH and water turbidity using the IoT-based Arduino works well.

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