Weather Anomaly Early Warning System on Koi Fishpond's Water Quality Using Telegram Bot

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***Abstract*— Koi fish farming is a popular practice in Blitar Regency. Larger ponds are required for cultivating Koi fish seeds, and it is common to use areas such as rice fields for these ponds. However, monitoring water quality in Koi ponds can be challenging, especially during unpredictable weather conditions. To address these difficulties, a study was conducted to develop an early warning system using the ESP32 DEVKIT V1 Module. The system provides real-time monitoring of Koi Pond water quality data through the Telegram app, using sensors to measure temperature, pH, and TDS levels. The data is then transmitted to the Telegram app for display. If the parameters differ from the standard values, the system triggers audio alerts, notifications, and a red LED indicator in the app. The test results show that the system performs well, with maximum recorded values of 31°C for temperature, 306 ppm for TDS, and a pH level of 9.4. The calibration errors for the system are measured at 0.37% for temperature, 0.77% for TDS, and 1.03% for pH. Overall, the system is effective in detecting poor water quality, offering automated alerts and manual control through the Telegram bot.**

***Keywords*— Telegram bot, early warning, LED, pH, temperature, TDS**

I. INTRODUCTION

One type of cultivation that is popular in Indonesia is the cultivation of decorative fish pools, especially koi fish (Cyprinus Carpio). The cultivation of koi fish is still renowned in the international market because of its numerous varieties and appealing color combinations. Furthermore, it has become an increasingly popular and rapidly growing commodity in Indonesia [1]. CV Proklamator Koi Farm is one of the koi fish cultivators in the Blitar region that raises twenty-six types of koi fish in soil ponds located on the rice field. Mr. Tony has been the driving force behind the project, which is located on Jalan Rakai Pikatan in Bulu, Modangan, Nglegok, Blitar District, East Java, since 2008.

Koi fish cultivation in soil ponds requires water that should be free of harmful substances or chemicals that interfere with the survival and quality of the fish [2]. When organic or inorganic chemicals are left in the soil and feed leftovers, they occasionally develop into dangerous substances. The pH level and water temperature should also be used to gauge the pool's water quality [3].

Extreme weather fluctuations or weather anomalies during the transition season are issues that can cause unstable parameters in the koi fish pond's water and can have a significant effect on the productivity of koi fish [4]. Due to the distance between the ponds and the settlement, the farmer cannot always be aware of the water's condition. Some of these characteristics, such as temperature, pH, and TDS (Total Dissolved Solid), water density levels, need to be checked regularly to keep the water in koi pools in good condition for koi fish productivity [5].

However, every monitoring system needs an early warning system (EWS) to know the level of parameters that are detrimental to the threshold measurement of water quality in the pool. In previous studies, early warning systems were needed to know the threshold of water in pools far from surveillance [6].

Based on the problem description and partner survey that has been carried out since a system is required to monitor the condition of the water in the Koi fishpond and provide early warning about the threshold and below-quality of the pool water in a mobile application via a Telegram bot [7]. So prevention and handling can be done right away to reduce the impact of weather anomalies and maintain the quality of pool water to get good quality fish [8]. The Koi pool's water temperature, pH level, and temperature in degrees Celsius are all measured using sensors. A TDS meter sensor is also used to measure electrical conductivity and the amount of organic and inorganic materials in the fishpond water. Additionally [9], ESP32 is necessary for data transmission for users to be notified via smartphones and see it displayed in the Telegram users.

Besides that, another example from research [10] Remote Water Quality Monitoring with EarlyWarning System for Marine Aquaculture discusses the development of remote water quality monitoring systems with early warning systems for seawater farming. The research is still using a website that needs to be opened periodically to monitor water quality and is still unable to know the weather conditions on the system.

Research [11] on the Internet of Things based Water Roughness and Ph Warning System in a Freshwater Aquarium describes a water roughness warning system in a freshwater aquarium using a pH, temperature, and turbidity sensor that sends information through the website. The research is still using websites that must be opened periodically to receive warning notifications.

Research [12] Water Quality Monitoring System on Decorative Fish Seed Cultivation Using Fuzzy Mamdani Internet of Things-based Method to determine water quality levels with temperature, pH, and roughness sensor parameters. The system is limited to only 3 parameters tested and does not use a mobile app.

Research [13] Planning and Implementation of Monitoring and Controlling of Water Quality in Koi Fish Pools explains the parameters used, namely temperature, pH, and ammonia, and uses the MQTT (Message Queuing Telemetry Transport) protocol as a data transmission medium that is still very inefficient for koi fish farmers.

Research [14] automated monitoring and control systems for koi fish farming with temperature and pH parameters based on the Internet of Things. The system uses temperature and pH parameters that can be monitored using the website. The system is limited to only 2 parameters tested, does not use a mobile application, and cannot give a warning notification of any parameter change in pool water.

In this study, a system of warning of the impact of weather anomalies on the quality of koi fishpond water was created based on early warning using Telegram bots that make it easy for farmers to be quick and responsive to monitoring of pool water quality and handling that is detrimental to the enterprise and threatens the survival of Koi fish. The system uses the ESP32 DEVKIT V1 module as a microcontroller that will then send a warning message via the Telegram application [15]. Data processed from the temperature sensor, pH level, TDS level, and current weather information about the location of the pond will then be sent through the Telegram bot API connected to the Internet, then displayed on the Telegram app. From the readings of such data when the parameter is obtained that the water is not in line with the requirements then the system will send a notification to the telegram application and the sound of the alarm from the Buzzer module will turn on the LED. It is hoped that this system will make it easier for operators to prevent the effects of weather anomalies that interfere with the quality of the koi pool water.

II. METHOD

A. Research Stages

The research involves a structured set of steps to address the problems faced. The initial phase is the identification of problems based on a theoretical basis. Literature studies are carried out to gather information about the main components of the system, such as the ESP32, Telegram Bot, temperature sensors, water pH, and TDS. System specifications, programming, and networking are set at this stage.

Working system planning encompasses device design, including power supply, mechanical design, and component layout. The next step is to design and build a program to connect the ESP32 DEVKIT V1 and the Telegram bot. Data from the sensor is sent via ESP32 to the Telegram bot via the API. Then, the overall system design is done as planned.

Device testing becomes an important step in ensuring scheduled performance. If there's a problem, analyze it and fix it. This step also includes a thorough analysis of program validity and inter-device communication, as well as delay handling. The results of the analysis are used in the research report.

The final phase contains conclusions based on problem formulations, manufacturing processes, results, and analysis. Advice is given for further development. These conclusions and suggestions guide the next steps in system development.

B. Block Diagram System

Block diagram system of weather anomaly early warning system of koi fishpond’s water quality using Telegram bot shown in Figure 1.

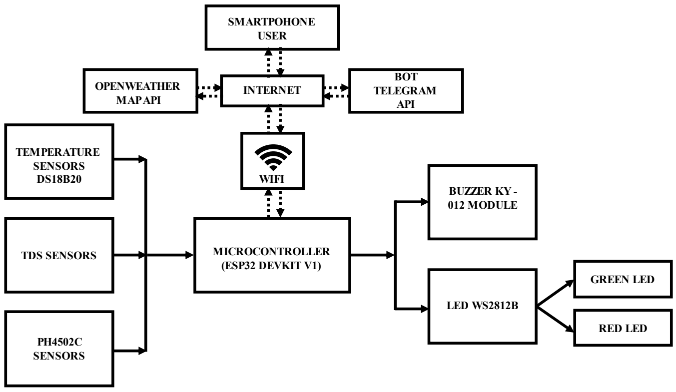

Figure 1. Block Diagram System

The pH sensor works as a reader for the pH level data in the water of the Koi fish tank. The ESP32 is connected to the pH sensor. The microcontroller will receive a continual update of the pH value from the pH sensor reading, which it will subsequently be sent to the Telegram Bot.

The water temperature in the Koi fishpond is read using the DS18B20 temperature sensor. The temperature sensor is connected to the ESP32. The microcontroller will receive the temperature values acquired from the temperature sensor readings and send them along to the Telegram Bot.

The Koi fish pool's turbidity value is read from the data by the turbidity sensor (TDS). The ESP32 connects with the temperature sensor. The database will get the most recent updates to the hardness values derived from the hardness sensor readings once they have been delivered to the microcontroller and microprocessor. The microcontroller used is the ESP32 DEVKIT V1, which is responsible for acquiring the results and processing the data from the sensor reading, which is then transferred throughout the Internet network with previously present Wi-Fi components on the ESP32. The user will be the one to receive data that has been processed by the microcontroller, transmitted via the Internet network, and then received by the Telegram API before being sent by the database while receiving data from the sensor component. As a warning when the sensor parameters exceed the limit or are less than the normal limit.

C. Flowchart System

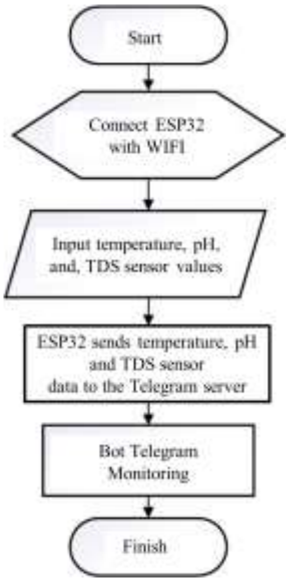

Figure 2. Monitoring System Flowchart

The operational system for tracking temperature, pH, and TDS sensors is shown in Figure 2. The input on this device is linked to the internet via the Wi-Fi network so that it can deliver information that the Telegram bot will receive. The gadget will read and send data to the server on the Telegram bot once the connection is made. The system will alert the server if the temperature, pH, or TDS sensor readings alter the data values, as seen in Figure 3.

The device reads the sensor parameters after the temperature, pH, and TDS sensor inputs are already connected to the Internet and visible on the Telegram bot. Data will only be delivered to the system if the sensor parameters fulfill the requirements, and the Telegram bot will issue messages as a warning when the parameters do not meet the requirements.

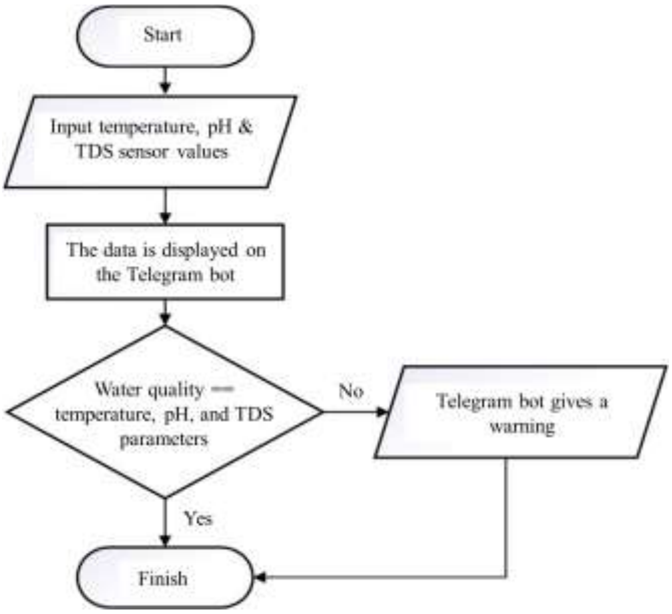

Figure 3. Warning System Flowchart

D. Software Planning

The Telegram bot app's instant message capability is used to develop an early warning-based warning system. Getting a token API or authentication code used to operate the Telegram bot is the first step in implementing the feature. Figure 4 illustrates the process for obtaining the token API code and storing data on the Telegram system servers.

Figure 4 outlines the procedures for obtaining the Telegram bot token and putting it in the system database. Users must have the Telegram app downloaded on their cellphones to purchase tokens. Users can add @BotFather to get tokens. Following that, the token will be saved in the Telegram system's database to be used as a medium for Telegram message notification.

In addition to tokens, it is also important to know the Telegram user ID used by the network administrator. To obtain a User ID, the administrator must start a chat with @BotFather. From the chat, a user ID will be obtained, which will then be stored in the database.

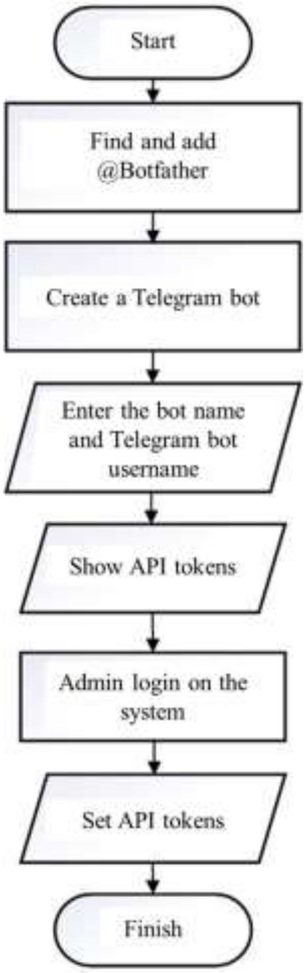

Figure 4. Telegram Bot Creation Flowchart

III. RESULTS AND DISCUSSION

A. Hardware System Creation Process

The following is the outcome of the development of several mechanical warning systems for the impact of weather anomalies on the quality of water in Koi fishponds based on early warning using a Telegram bot loaded in the form of electrical networks inside the box with a project-size of 18.5 cm × 11.5 cm × 6 cm. The ESP32 DEVKIT V1 microcontroller serves as the system's data processor.

The design of this warning system includes 3 cable probes from the temperature sensor DS18B20, the TDS sensor, and the PH4502C sensor that are used to detect the quality of pool water. A buzzer module that emits a sound when the pool's water quality parameters change is also included in the box project's inside.

The system power source consists of a battery, along with a micro jack power connector that uses an adaptor and a charger to recharge the battery. For data processing, there is also an ESP32 DEVKIT V1 microcontroller. There are 8 LED stripes on the box's interior, and there are 12 LED strips that serve as warning indicators and are colored red and green. When the characteristics of the pool's water quality significantly change, the indicator turns red rather than green.

B. Software System Creation

Several features display pool water quality conditions with the commands /start, /ceksuhu, /cektds, /cekph, /cuaca, and /stop in the Telegram bot system. Through the sensors sent by the ESP32 microcontroller, these commands will show the desired parameters for monitoring pool water quality. @BotFather, a free bot creation service offered by Telegram, is used to create the Telegram bot system. Here are the outcomes of the Telegram bot system's design as a water quality monitor and warning system for Koi fish farmers.

The Telegram bot menu of the early warning system on koi fishpond's water quality is explained here. Results of using BotFather to create a Telegram bot: The reason BotFathers was chosen for this study is because of how simple it is to manufacture Telegram bots using it. Numerous Telegram bot features, such as bot profiles, descriptions, quick menus, and so on, can be readily configured. Initial display of Koi Warning's bot: The name of the bot that we have is indicated in this view.

Page display /start: The /start menu view displays the bot's introduction, a description of its features, and a list of its available menus. Parameter monitoring command display: this menu's /temperature, /cektds, /cektds, and /cuaca commands display plenty of commands for each sensor parameter. From this menu, users may quickly check water quality factors such as temperature, TDS, pH, and the current weather. Display alert notification: Users will be informed when parameters change because of weather anomalies that affect the water quality of Koi fishponds.

C. Weather Information on Telegram Bot

With the command /cuaca, the Telegram bot has a function that displays the current weather. When farmers are outside the city, they can notice the weather that occurs at the location of the Koi fishponds. Utilizing the OpenWeatherMap Weather API, weather data is produced. Due to its simplicity in the development process, where users merely need to establish an account and search for the API code that is later placed into the program, OpenWeatherMap was chosen for this study.

Once an OpenWeatherMap account has been created, the website's API is used to retrieve weather information, which will then be presented on the Telegram bot as location, temperature, humidity, and weather conditions in the form of JSON. The ESP32 microcontroller must then process it before the JSON data can be transmitted to the Telegram bot.

The API menu key is used as a connector between the ESP32 DEVKIT V1 microcontroller and OpenWeatherMap. The API Key is obtained through the profile menu, My API Keys.

The API Key must be entered into the program to integrate with and retrieve data from OpenWeatherMap.

D. Hardware Test Results

Temperature sensor DS18B20 was tested by giving 3.3 Volt power to activated and processed data. Sensor DS18B20 was used available library to calculate the temperature, to simplify the creation process. The calibration results of the DS18B20 temperature sensor and the thermometer are shown in Figure 5.

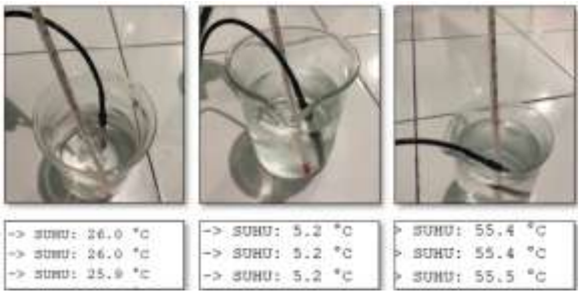

Figure 5. Temperature Sensor Test

Based on the results of the sensor tests described above, it is possible to infer that the DS18B20 sensor functions properly. Using the following equation, determine the temperature sensor test error value.

$$\text{error}(\%) = \frac{\text{read value - measured value}}{\text{measured value}} \times 100\%$$

Read values were obtained from the temperature sensor DS18B20 display and the measured values were obtained from the manual thermometer as the reference.

TABLE I.
TEMPERATURE SENSOR TEST RESULT

No	Liquid	Thermometer (°C)	Temperature Sensor(°C)	% *Error*
1	Room water temp	26	26,0	0%
		26	26,0	0%
		26	25,9	0,3%
2	Icy water	5	5,2	0,4%
		6	6,3	0,5%
		8	8,0	0%
3	Warm Water	54	54,2	0,3%
		55	55,4	0,7%
		55	55,5	0,9%
Average				0,37%.

Based on the results of the tests in TABLE I, the temperature sensor demonstrates a good ability to measure temperature in a variety of conditions, from cold to hot. In the normal water temperature test, three experiments were conducted to determine the difference between a thermometer and a temperature sensor. The temperature sensor can measure a temperature of 26°C according to the value shown by the thermometer. Under these conditions, no error is detected, so the error value is 0%. When measuring the temperature of the water in cold conditions, the temperature sensor reads the temperature at 5.2°C, whereas the temperature meter shows a value of 5°C with a difference of 0.2 °C and an error value of 0.4%. When measuring the temperature in warm conditions, it reads a temperature at 54° C, while the temperature sensors show a temperature value of 54.2 °C, with a differential of 0. 2°C and error values of 0. 3%. The difference in temperature values at 0.1°C or 1°C in subsequent measurements is due to the time it takes for the thermometer and temperature sensor to reach the maximum temperature in such conditions—the time required to reach different maximum temperatures. However, despite such differences, the average error value is still quite small at

0.37%. This shows that the temperature sensor works well in measuring temperature.

The TDS sensor is tested by applying a 3.3 Volt voltage and immersing it in a variety of fluids with varying TDS values. In its measurement, the sensor employs an analog output that is transformed into an ADC value. It is vital to remember that these sensors have a temperature limit of 55°C. No manual calculations were performed in this test because a sensors library is available that makes it simple to use. The results of the compatibility test between TDS sensors and TDS meters are shown on Figure 6.

Figure 6. TDS Sensor Test Result

The sensor testing results above suggest that the TDS sensor can function properly. TABLE II can then be used to determine the error value of the TDS sensor test.

TABLE II.
TDS SENSOR TEST RESULT

No	Fluid	TDS Meter (ppm)	TDS Sensor (ppm)	% Eror
1	PDAM Water	159	158	0,6%
		166	166	0%
		169	168	0,5%
2	Le Minerale Water	90	91	1,11%
	Cleo Water	110	109	0,9%
	Aqua Water	127	125	1,5%
3	River Water	231	229	0,8%
		245	244	0,4%
		266	264	0,7%
		Average		0,77%

In TDS sensor testing, there was no use of graphic plot calibration to obtain predictive values. This is because the TDS sensor used has a library on the Arduino IDE software, so the sensor can read TDS values according to the standard set.

Based on the test results, the TDS sensor has worked well after being tested using three types of water with different TDS values. The difference in TDS values between measurements using TDS meters and TDS sensors is not very significant, so the error values obtained are also relatively small. In the measurement of PDAM water, the TDS meter shows 159 ppm, while the TDS sensor gets 158 ppm with an error value of 0.6%. TDS measurements on packaging drinking water are carried out for as many as three brands of beverages with each showing packaging beverage value 1 of 90 ppm for the TDS meter and 91 ppm For TDS sensors, Packaging Beverage 2 of 110 ppm to TDS meter and 109 ppm To TDS Sensors with error rate of 0.9% and Packing Beverages 3 of 127 ppm TDS Meter and 125 ppm TO TDS Sense with error ratio of 1.5%. As for measuring TDS with river water, the TDS meters give 231 ppm while the TD sensor gives 229 ppm value with an error rating of 0.88%. With the average error value on TDS test sensors of 0.77%.

The pH sensor must first be calibrated before it can be tested. During the pH sensor calibration process, the precision of the data on the PH sensor is modified to detect the level of acidity in the water. Calibration is performed by manually adjusting the initial condition to neutral with pH 7. The sensor module's ends are linked to the metal, and the voltage at pH 7 is measured using the Arduino monitor series. If the read pH value on the monitor series is not exactly 7, the blue potentiometer can be rotated with a bucket to adjust the pH value to 7. Figure 7 shows voltage values as viewed through the monitor series.

Figure 7. pH Sensor Calibration

After successfully calibrating the sensor, the voltage value at pH 7 was determined to be 2.49 V. To guarantee that the pH sensor can read circumstances accurately, we must first determine the voltage value associated with pH 9.18. This can be accomplished by utilizing a pH buffer with the same pH value, as seen in Figure 8.

Figure 8. Calibration of The Buffer Solution pH 9.18

After the sensor is calibrated with a pH buffer solution of 9.18, a voltage of 2.18 V is processed. Once the voltage values of both pH conditions are known, they can be implemented into the Arduino IDE program with the following equation.

$$\text{pH 9} = 2{,}18 \text{ V}$$
$$\text{pH 7} = 2{,}49 \text{ V}$$

$$\text{pH Volt} = V_{ref}/4095 \times \text{ADC value} = 3.3/4095 \times \text{ADC value}$$
$$\text{pH step} = (\text{pH 7} - \text{pH 9})/2$$
$$P_o = 0{,}9018\left(7+\left(\frac{pH\ 7 - pH\ Volt}{pH\ step}\right)\right) + 0{,}7915$$

The equation can then be implemented into the Arduino IDE program.

Once the equation is uploaded to the microcontroller, a new pH sensor is ready to measure the acidity of a liquid. The sensor was then calibrated using three different buffer solutions, each having a pH value of 4.01 (acid condition), 6.86 (neutral condition), and 9.18 (base condition). The test is carried out as shown in Figure 9.

Figure 9. pH Buffer Solution Test

The pH sensor, which measures the degree of acidity, will then use the Telegram bot to display its measurement value on the previously set-up prototype. The calibration results of the sensor show that the PH4502C sensor can work quite well according to the acidity conditions of a fluid.

TABLE III.
PH SENSOR TEST USING PH BUFFER

No	Liquid	pH Buffer	pH Sensor	Calibration Results	%Error
1	Aquades Water	4,01	3,5	3,95	1,49%
			3,66	3,98	0,74%
			3,56	4,0	0,24%
2	Aquades Water	6,86	6,9	7,01	2,14%.
			6,9	6,82	0,58%
			6,7	6,78	1,16%
3	Aquades Water	9,18	9,2	9,09	0,99%
			9,0	9,15	0,32%
			9,7	9,02	1,74%
			Average		1,03%

From the test results of the pH sensor shown in TABLE III, it can be concluded that the PH4502C sensor has a limitation in measuring the pH when the pH value is at 4.01. This limitation is due to the maximum ADC value of the sensor PH450, which reaches 4095. After calibration, the prediction values are implemented into the program code so that the sensor can read the calibrated pH values immediately without having to perform manual calculations. Calibration results show that when reading the pH buffer value of 4.01 the sensor can read its value at 3.95 after calibration, compared with the prior calibrations where the value read the sensor is 3.5. The error value obtained from this calibrate is 1.49%. Next, on the pH Buffer with a value of 6.86 performed triple tests with the sensor result can read the value at 7.01, 6.82, and 6.78 after calibrated with predictive values, with the error values respectively of 2.14%, 0.58%, and 1.16%. When calibrating three times by using the buffer pH of 9.18 each sensor could read it to 9,09, 9,15, and 9,02 with error values of 0.99%, 0.32%, and 1,74%. The average error value received on the sensor after calibration is quite small, which is 1,03%.

As for the sound indicator activated on the buzzer module KY-012, the sound of the indicator will be heard when the parameters of the sensor are higher or lower than the specified value. These indicators are shown below:

a. The buzzer module will illuminate up to three times, signaling a change in the parameters governing water quality, whenever the temperature sensor DS18B20 displays a temperature value greater than 29.
b. A change in the parameters governing water quality will be indicated by the buzzer module lighting up to three times when the temperature sensor DS18B20 displays a temperature value of less than 10.
c. The buzzer module may illuminate up to three times in response to a TDS sensor reading of 400 or above, signaling a change in the parameters governing water quality.
d. The buzzer module will illuminate up to three times, signaling a change in the parameters governing the water quality if the pH sensor registers a pH value higher than 8.5.
e. The buzzer module will illuminate up to three times if the pH sensor detects a pH value below 4, which denotes a change in the water quality parameters.

Values from each temperature sensor, TDS, pH, and buzzer module are used in the WS2812B LED testing. The total number of available LEDs is 20, of which 12 LEDs in the colors green and red and 8 LEDs in the system box are located outside the system. Red denotes the presence of anomalies or changes in sensor values, whereas green shows that the system is functioning smoothly, as shown in TABLE IV.

TABLE IV.
LED WS2812B TEST

Test No.	Temp. Sensor	TDS Sensor	pH Sensor	Green	Red
1	26	228	4,01	On	Off
2	25	356	4,23	On	Off
3	30	267	3,9	Off	On
4	27	234	4,61	On	Off
5	27	355	6,71	On	Off
6	24	456	5,8	On	Off
7	25	245	3,9	Off	On
8	21	578	4,92	On	Off
9	26	670	5,7	On	Off
10	29	256	6,9	On	Off

E. Software Test Results

When the ESP32 DEVKIT V1 has an internet connection, weather data testing utilizing the OpenWeatherMap website can start. When a user taps the command /weather on the Telegram app, weather information can be delivered to the Telegram bot. By using the location ID, the ESP32 will respond and obtain information from the Weather API that includes the current weather, temperature, humidity, and location data set.

This test tries to determine the discrepancy between the temperature recorded on a thermometer and the weather temperature displayed on the OpenWeatherMap website. The city of Malang was selected as the test's location. The outcomes of this test, which was run up to ten times, are displayed in TABLE V.

TABLE V.
WEATHER INFORMATION TEST

No	Time (WIB)	Weather Temp. (°C)	Thermometer Temp. (°C)	Error
1	07.00	18	19	5.26%
2	08.00	20	20	4.00%
3	09.00	21	21	4.00%
4	10.00	25	24	3.85%
5	11.00	25	26	3.85%
6	12.00	29	30	3.57%
7	13.00	28	29	3.45%
8	14.00	26	27	0.00%
9	15.00	26	27	0.00%
10	16.00	24	24	0.00%
		Average		2.80%

The telegram bot was made simple with menu /start, /ceksuhu, /cektds, /cekph, /cuaca, dan /stop. Based on the testing that has been done on the /start menu, it can be concluded that the /start menu button can be used to receive information quickly and conveniently about additional menu options. Testing on the option /ceksuhu has shown that the menu /cuaca option provides accurate information about the water temperature in the pool. TDS levels in the water well can be seen by pressing the /cektds menu button. The menu option /cekph can also be used to show the pH value of the pool water. The menu/weather button can also precisely display the current temperature, humidity level, and weather at the pool site. The /stop menu button also effectively disables the warning system.

F. Overall System Test

On the designed system, a test was carried out that included testing the accuracy of temperature sensor sensors DS18B20, TDS sensors, and PH4502C sensors by comparing using standard measuring instruments such as thermometers, TDS meters, and pH buffers and then testing the accuracy of weather information through the Open Weather Map website with real weather on the site. QoS testing to test the performance of the delay parameters, packet loss, and data transmission throughput from ESP32 with the Telegram bot. The resulting output is a notification sent through Telegram bot messages, the sound from the buzzer module, and the LED strip light on. The Telegram app has features to monitor water quality and display up-to-date weather information from the pool location. The overall system test result is shown in TABLE VI.

TABLE VI.
OVERALL SYSTEM TEST RESULTS

Time (WIB)	Telegram Bot				Notification		Delay (s)		
	/ceksuhu	*/cektds*	*/cekph*	*/cuaca*	LED	Buzzer			
Saturday, July 15th 2023									
7.00	19	257	7,4	bright	Green	off	2	2	2
12.00	29	260	7,9	bright	Green	off	3	2	3
16.00	23	259	7,3	cloudy	Green	off	2	2	2
Sunday, July 16th 2023									
07.00	20	267	8,2	bright	Green	off	2	2	2
12.00	28	269	8,0	bright	Green	off	2	3	4
16.00	23	266	7,8	cloudy	Green	off	3	3	2
Monday, July 17th 2023									
07.00	22	270	8,5	bright	Green	off	2	2	2
12.00	31	272	8,2	bright	Green	off	1	2	1
16.00	26	271	8,0	cloudy	Green	off	2	2	1
Tuesday, July 18th 2023									
07.00	19	277	8,6	bright	Green	off	2	3	2
12.00	29	280	8,8	bright	Green	off	3	2	3
16.00	25	284	8,0	cloudy	Green	off	3	3	2
Wednesday, July 19th 2023									
07.00	20	280	8,0	bright	Green	off	2	2	2
12.00	29	285	8,5	bright	Green	off	3	3	2
16.00	26	284	8,5	cloudy	Green	off	2	3	3
Thursday, July 20th 2023									
07.00	19	280	8,4	bright	Green	off	2	2	2
12.00	29	288	8,8	bright	Green	off	2	3	2
16.00	23	293	9,1	cloudy	Red	on	2	2	2
Friday, July 21st 2023									
07.00	20	302	9,4	bright	Red	on	2	2	2
13.00	28	306	9,0	bright	Red	on	4	3	3
16.00	24	305	9,1	cloudy	Red	on	3	2	4

The entire test of the device was carried out in the week, of July 15th, 2023, to Friday, July 21st, 2023. Measurements are carried out from 07.00 WIB to 16.00 WIB with the period of each measurement three times a day. The purpose of this test is to check whether this tool is already working as expected and what is needed by the koi farmer.

Every day, the pool water quality can be checked via a smartphone with the help of the Telegram app. Users can check the changes in pool water quality without having to go directly to the ponds.

According to tests conducted on Saturday, the water quality was normal, and the average pond temperature was between 24 and 25 °C. When there are modifications to the settings, such as on Thursday and Friday, Telegram notifications will be delivered. Due to erratic weather patterns brought on by the sun's heat, which also affect the pH of the swimming pool, the pH of the pool has increased. Until the cultivator acts, the buzzer will light up and the LED light will become red.

The temperature over the seven-day test ranged from 31°C, which was the highest value, to 19°C, which was the lowest. Water's pH ranges from 7.3 to 9.4, with 9.4 being the highest. The highest and lowest rates are 306 ppm and 257 ppm, respectively. Testing on sensor data delivery delays likewise revealed no appreciable variations in accuracy in line with the 88.4 ms QoS test.

IV. CONCLUSION

The results of the design of the warning system for the impact of weather anomalies on the water quality of Koi fishponds are based on early warning using a Telegram bot running by displaying the parameter values of each sensor and giving warnings. By showing the average pool water temperature of 24.5°C, the water density (TDS) of river water of 277.44 ppm, and the average pH of 7.95. Uncertain weather affects water parameters. The quality of the pond water is influenced by the weather in the pond, with the temperature parameter most affected being when the hot weather temperature is at 31°C and the cold weather temperature is at 19°C. The pH sensor has an error value of 1.03%, the temperature sensor is 0.37%, and the water density sensor (TDS) is 0.77%. In packet loss testing, delay and throughput have already achieved good results. With an average value of 8.28%, the delay is 37.182 ms, and the throughput is 272.06 kbit/s.

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