WATER QUALITY MONITORING SYSTEM IN VANAME SHRIMP AT TIRTAYASA DISTRICT BASED ON INTERNET OF THINGS

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ABSTRACT

The purpose of this study can help the owner to know water quality conditions such as water temperature conditions, water salinity, water pH and water level, the system can help maintain the level of life and growth of vaname shrimp with the existence of a minimum system used to compare water quality in ponds with quality thresholds good water for vaname shrimp farming so the system will give an early warning to the owner if the quality of water in the shrimp shrimp ponds is poor. The method used is the prototype with the communication process, quick plan, quick design modeling, construction of the prototype and development of delivery and feedback. This system uses SEN0161 sensor to measure pH level, conductivity sensor to measure salt content, DS18B20 sensor to measure temperature, and HC-SR04 ultrasonic sensor to measure water level which is controlled by Arduino Uno microcontroller which is connected to its main component is Raspberry Pi 3. Data sent from Arduino Uno to Raspberry Pi 3, then data is stored on a database server using an internet network via a modem. The stored data can be seen in the Water Quality Monitoring application that has been installed. Based on the results of testing the system that has been implemented, it is found that each sensor has a fairly good level of accuracy so that the system has great prospects and can be used for vaname shrimp culture, the system can provide notifications when the water quality in shrimp ponds is poor.

Keywords : Monitoring, Vaname Shrimp, Internet of Things, Raspberry Pi 3.

1. INTRODUCTION

White shrimp is an alternative activity in increasing fisheries production [1]. Conditions for the implementation of cultivation activities are the existence of cultivated organisms, living media organisms, and containers/places of cultivation. White shrimp (Litopenaeus vannamei) is an introductory shrimp that was officially designated as one of the leading commodities of aquaculture by the Minister of DKP in 2001, and since then the development of aquaculture has been very rapid. Nowadays, white shrimp farming has been commercialized and is developing very rapidly. This is because the shrimp have promising prospects and profits [2]. To produce superior vaname commodities, the maintenance process must pay attention to internal aspects which include the origin and quality of the seed, as well as external factors including the quality of aquatic water, feeding, the technology used, as well as pest and disease control. The quality of the water or the quality of the water used to maintain the vaname shrimp on the farm must be considered. With good water quality, namely water temperature between 28-30 0C, water salinity between 10-30 ppt (parts per thousand), and water pH between 7-8.5, the vaname shrimp will grow and develop properly and will not die easily. [3].

The susukan village is one of the vaname shrimp development areas in Tirtayasa District, Serang Regency, Banten Province. Vaname shrimp cultivation activities are started from hatchery, enlargement to sell directly to consumers. The northern part of Serang Regency has great potential to become a center for vaname shrimp cultivation. The potential is in 15 coastal villages with an area of about 5,000 hectares of ponds [4].

According to an interview with Mr. H. Abdul Jalal as one of the owners of vaname shrimp ponds, there are currently some problems with the process of vaname shrimp cultivation. The main problem that is often found in vaname shrimp production failure is poor water quality during the maintenance period, especially in intensive ponds. High stocking density and high feeding can reduce water quality conditions. This is caused by the accumulation of organic matter because shrimp retain about 16.3-40.87% of protein feed and the rest is discarded in the form of excretion of feed residues, and feces [5]. Therefore, management and monitoring of water quality during the maintenance process is absolutely necessary, for example, to check water temperature, water salinity, water pH, and water level.

One of the problems in the other system is how to monitor pond water quality is done manually, by way of the owner directly monitoring without knowing the exact quality of the water in the pond. Water quality is an important factor in the life and growth of vaname shrimp seeds. Water quality that influences shrimp ponds is water temperature, salinity, and pH of water, and water level. But there are some obstacles in monitoring one of them is distance, because the location of the pond is far from the settlement, so to conduct intensive monitoring everyday experiences obstacles.

In a study entitled “Water Quality Monitoring System In Vaname Shrimp At Tirtayasa District Based On Internet Of Things” that the prototype built can measure water quality only based on water pH using the SEN0161 sensor and water temperature using the DS18B20 sensor. Where the system has 2 directions of communication, namely the transmitter function and receiver function. As a transmitter function, the system sends the data obtained. The data obtained by the sensor is then processed by Arduino and forwarded to ESP8266-12 which is connected to the internet network so that it can be received by Platform. Then retrieve system data from the platform to be displayed and controlled through menus available on the Web Server. Where the Web is private is not public, which can only be accessed or used by the admin (farmer). The web server can be accessed through a browser that is connected to the internet network [6].

Based on the problems that have been described, it is necessary to build a monitoring system that can overcome water quality problems so that the cultivation of vaname shrimp can run well. Therefore a monitoring system was built which is expected to be able to bridge the problem, namely "Water Quality Monitoring System in Vaname Shrimp Ponds in Tirtayasa District Using the Internet of Things (IoT)".

The research objectives to be achieved from the development of this system are as follows:

1. Helps managers to find out water quality conditions such as conditions of water temperature, water salinity, water pH and water level, so that the owner can monitor from anywhere using a smartphone without the need to come to the pond location to check.
2. The system can help maintain the level of life and growth of vaname shrimp with the minimum system used to compare water quality in ponds with a good water quality threshold for vaname shrimp cultivation, the system will provide an early warning to managers if the water quality in Vaname shrimp ponds are bad.

The software development model used in this study is the prototype method. The software development method uses a prototyping model, because in making this system the user involvement is very high so the system meets the needs of users better. Here is a picture of the prototype method according to Roger S. Pressman [7]:

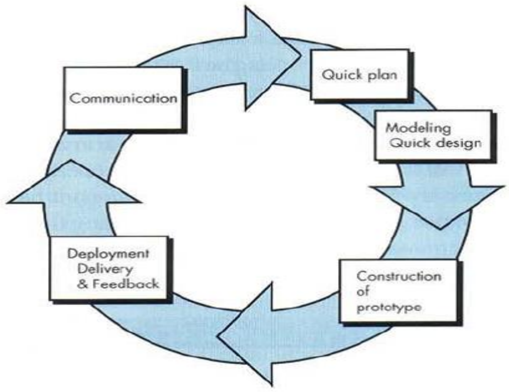

Figure 1 Prototype Model Roger A. Pressman [7]

The stages of the prototype model according to Roger S. Pressman are :

1. *Communication*
   At this stage a communication with the Owner of the Vaname Shrimp Pond about the problems that often occur at the research site. To make a system that suits your needs, it must be known in advance how the system is running in order to know the problems that are happening. Then after that an analysis is carried out to identify all needs and specifications of the needs to be made.
2. *Quick Plan*
   At this stage the prototype design is done quickly by making a temporary design that relates to the wishes of the user in the construction of the system, which is a system that can monitor or monitor water quality in the vaname shrimp ponds.
3. *Modelling, Quick Design*
   At this stage, prototype modeling is carried out. The process of making a design model to assist in making the system. The quick design modeling process is carried out by designing data structures, software architecture and unified modeling language (UML).
4. *Construction of Prototype*
   At this stage prototyping models are evaluated according to user needs based on designs that have been modeled before.
5. *Deployment, Delivery & Feedback*
   At this stage the system is tested by the user. If the user is not satisfied with the current prototype, it will be refined according to the user's needs. The prototype refinement process is repeated until all user requirements are met. If the user is satisfied with the prototype to be developed, the system is developed based on the final prototype.

2. RESEARCH CONTENTS

2.1 Theoretical Basis

The theoretical foundation of the development of this system outlines the basic theories for the system analysis process and supports the process of developing a Water Quality Monitoring System In Vaname Shrimp At Tirtayasa District Based On Internet Of Things with a case study in Susukan Village, Tirtayasa District.

2.1.1 Vaname Shrimp

White shrimp is an introductory shrimp that was officially designated as one of the leading aquaculture commodities by the Minister of DKP in 2001, and since then the development of aquaculture has been very rapid. At present the white shrimp culture has been commercialized and is developing very rapidly, due to the increasing demand from both domestic and overseas. Besides Indonesia, countries that have developed white shrimp include China, Taiwan and Thailand. White shrimp has the characteristics of being able to live in the range of 5-45 ppt salinity with optimal salinity of 10-30 ppt; temperature range 24-32 0C with optimal temperature 28-30 0C; able to survive on oxygen 0.8 ppm for 3-4 days but it is recommended DO 4 ppm. water pH 7-8.5; Low protein requirement is 32% with FCR <1.5> [3].

The presence of white shrimp varieties not only increase choices for farmers but also can grow shrimp businesses in Indonesia, but the cultivation of white shrimp is not as easy as imagined. Enlargement activities are an important part of white shrimp culture that must be considered well, because there are failures in white shrimp culture due to negligence in the enlargement process, especially from feed management, air media quality, maintenance, genetic, disease prevention that cannot be avoided [3].

2.1.2 Internet of Things

Internet of Things, or known by the abbreviation IoT, is a basic concept that aims to expand the benefits of internet connectivity that is connected continuously. As for capabilities such as data sharing, remote control, and so on, including real-world objects. For example foodstuffs, electronics, collections, equipment and including living things which are all connected to the local and global network through embedded sensors and always active [9].

In the word Internet of Things there is the word "A Things" is as a subject for example people with heart implant monitors. Farm animals with biochip transponders, a car that has been equipped with a built-in sensor to warn the driver when tire pressure is low. The Internet of Things is most closely related to machine-to-machine (M2M) communication in manufacturing and electricity, oil and gas. Products are built with M2M communication capabilities which are often referred to as "smart" systems. (example: smart farming, smart home, smart grid sensor) [8].

2.1.3 Raspberry Pi 3

Raspberry Pi 3 is the third generation of the Raspberry Pi family. Raspberry pi 3 Model B + is the latest product in the Raspberry Pi 3 series, has 1 GB RAM with a Broadcom BCM2873B0 Cortex A53 64-bit chipset with 1.4GHz speed. This chipset has better temperature management so it can run at full speed for longer before experiencing throttling due to heat. This device uses a dual band wireless connection that supports 802.11ac which is faster than the previous generation and is also equipped with Bluetooth 4.2 / BLE, a faster Ethernet network, and the ability to do PoE through a separate HAT PoE. Raspberry Pi 3 also has 4 USB ports, 40 pin GPIO, Full HDMI port, Ethernet port, Combined 3.5mm audio jack and composite video, Camera interface (CSI), Display interface (DSI), Micro SD card slot (Push-pull system , different from the previous one pressed), and VideoCore IV 3D graphics core [9].

2.1.4 Arduino

Arduino Uno is a microcontroller board based on the ATmega328 datasheet. It has 14 input pins of digital output where the 6 input pins can be used as PWM outputs and 6 analog input pins, 16 MHz crystal oscillator, USB connection, power jack, ICSP header, and reset button. To support the microcontroller to be used, it is enough to simply connect the Arduino Uno Board to the computer using a USB cable or electricity with AC to DC adapter or a battery to run it [10].

2.1.5 PH Sensor SEN0161

SEN0161 pH sensor is a sensor that can measure the acidity and basicity of a solution. The main working principle of the pH meter is located on the sensor probe in the form of a glass electrode by measuring the amount of H3O + ions in solution. The tip of the glass electrode is a 0.1 mm thick glass layer that is round (bulb). This bulb is paired with an elongated non-conductor glass or plastic cylinder, which is then filled with HCL solution (0.1 mol / dm3). In the HCL solution, submerged a long, silver electrode wire formed on the surface of AgCl-balanced compounds. Constant amount of HCl solution in this system makes the Ag / AgCl electrode has a stable potential value [11].

2.1.6 Salinity Sensor

Salinity is the level of salinity or the level of salt dissolved in water. Salinity sensor is a water salinity sensor, has an analog signal output calibrated with a complex salinity sensor. The working principle of the salinity sensor is based on the electrical conductivity of water. In its measurement, the salinity sensor uses the nature of water, which is water as a good conductor of electricity. For example in measuring sea water salinity, it is known that sea water contains a lot of impurities such as sodium chloride, magnesium chloride, calcium chloride and so on. Chlorine ions help in conduction and hence this impurities increase water conductivity [12].

2.1.7 Ultrasonic Sensor HC-SR04

Ultrasonic sensor is a sensor that works based on the principle of sound wave reflection and is used to detect the presence of a particular object in front of it, the frequency of its work in the area above the sound wave from 40 KHz to 400 KHz. The ultrasonic sensor consists of two units, the transmitter unit and the receiver unit. The HC-SR04 ultrasonic distance sensor is a 40 KHz sensor. HC-SR04 is an ultrasonic sensor that can be used to measure the distance between the barrier and the sensor. 2 The main components as its constituent are the ultrasonic transmitter and ultrasonic receiver ... The function of the ultrasonic transmitter is to emit ultrasonic waves with a frequency of 40 KHz then the ultrasonic receiver captures the results of ultrasonic waves that strike an object. The ultrasonic wave travel time from the transmitter to the receiver is proportional to 2 times the distance between the sensor and the reflecting plane [13].

2.1.8 Temperature Sensor DS18B20

DS18B20 temperature sensor is a component that can change the amount of heat into electrical quantities so that it can detect symptoms of temperature changes in certain objects. Temperature sensors take measurements of the amount of heat / cold energy produced by an object so that it allows us to know or detect the symptoms of temperature changes in the form of analog and digital output. This sensor works with a one-wire / one-wire communication protocol and has the ability to detect temperatures from -10 to +85 degrees Celsius [12].

2.2 System Analysis

System analysis can be defined as the decomposition of a whole system into its component parts with a view to identifying and evaluating existing problems, obstacles that occur and the expected needs.

2.2.1 Problem Analysis

The development of a Water Quality Monitoring System In Vaname Shrimp At Tirtayasa District Based On Internet Of Things uses Raspberry Pi as a microcontroller, as well as a mobile and website based application as an interface so that it makes it easy for the owner. Based on the results of research that has been done, there are several problems that occur in Vaname shrimp ponds, as follows:

1. Poor water quality during the maintenance period, especially in intensive ponds. High stocking density and high feeding can reduce water quality conditions. So that the impact of reduced levels of vaname shrimp harvest.
2. Pond water quality monitoring is done manually, by way of the owner to monitor directly without knowing the exact quality of the water in the pond. Water quality is an important factor in the life and growth of vaname shrimp seeds. Water quality that influences shrimp ponds is water temperature, salinity and pH of water, and water level. However, there are several obstacles in monitoring one of them, namely distance, because the location of the pond is far from the settlement, so to conduct intensive monitoring every day experiences obstacles.

2.2.2 Architecture System Analysis

The system architecture is a Water Quality Monitoring System In Vaname Shrimp At Tirtayasa District Based On Internet Of Things will communicate with Raspberry Pi which is bridged by the webservice using data exchange using JSON, the following is an image of the Architecture Design System Analysis.

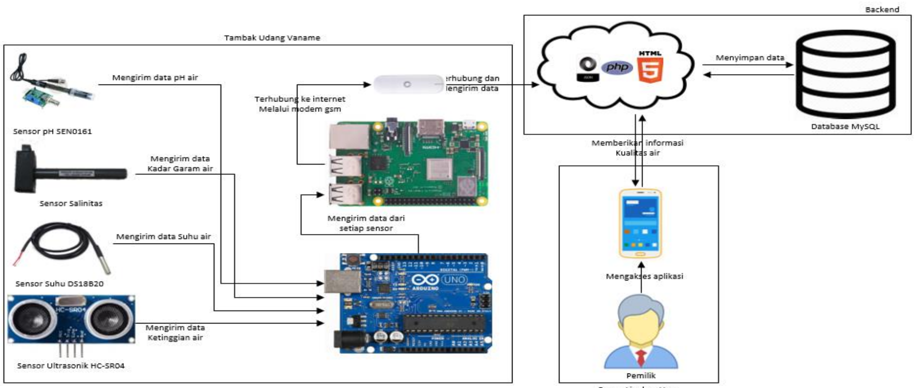

Figure 2 Arshitecture System

The following is an explanation of the architecture of the development of a Water Quality Monitoring System In Vaname Shrimp At Tirtayasa District Based On Internet Of Things, as follows:

1. Android application will be used by the owner, the owner can see the state of water pH, water salinity, water temperature, and water level. The owner can also set water quality thresholds.

2. API is used as sending data from raspberry pi to Android apps.
3. GSM modem is used to connect raspberry pi to the internet network.
4. Raspberry pi is used as the server and main control of the system, as a data processor generated from sensors via Arduino.
5. Arduino is used as a converter of sensors that will enter the Raspberry Pi.
6. Water pH sensor using SEN0161, this sensor data is used to measure water pH in vaname shrimp ponds.
7. Water salinity sensor uses salinity, this sensor data is used to measure water salinity in vaname shrimp ponds.
8. Water temperature sensor uses DS18B20, this sensor data is used to measure water temperature in the Vaname shrimp ponds.
9. Water level sensor uses Ultrasonic HC-SR04, this sensor data is used to measure the water level in the Vaname shrimp pond.

2.2.3 Data Communication Analysis

Data communication is a very important thing in the development of an application. Because without data communication, an application that is built will not be able to run properly. Data communication used in the Water Quality Monitoring System In Vaname Shrimp At Tirtayasa District Based On Internet Of Things is communication between Raspberry Pi with sensors via Arduino and Raspberry Pi with Android applications. Here is a picture of data communication flow.

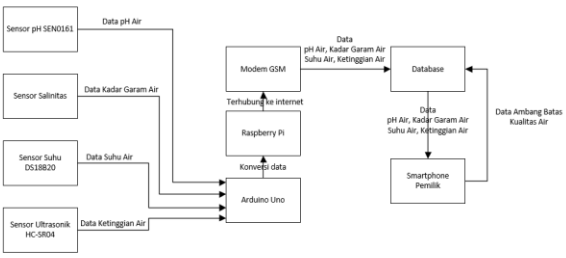

Figure 3 Data Communication Flow

The following is an explanation of the data communication flow :

1. All sensors send data to the Raspberry Pi via Arduino.
2. Raspberry Pi sends data from sensors via Arduino to the Android application in real-time or periodically.
3. The owner can set the water quality threshold in the Vaname shrimp pond.
4. Raspberry Pi will send an early warning via the android application if at any time the minimum system detects water quality beyond the threshold specified by the owner.

2.2.4 Non Functional Requirements Analysis

Analysis of non-functional requirements describe the system requirements that will affect the behavior of the system to be built, including user needs, analysis of hardware and software requirements as material analysis of shortcomings and needs that must be met in the design to be applied.

2.2.4.1 Hardware Analysis

The hardware that will be used is based on the minimum requirements that must be met:

1. Smartphone hardware for owners.
2. Raspberry Pi 3 B + hardware for the main server and controller in the vaname shrimp ponds.
3. Arduino Uno hardware as a converter of each sensor.
4. GSM Modem hardware.
5. Hardware pH sensor SEN0161.
6. Hardware Salinity sensor.
7. Hardware Temperature sensor DS18B20.
8. Hardware Ultrasonic sensor HC-SR04.

2.2.4.2 Analysis of Paid Devices

Software requirements analysis is an analysis process that emphasizes the aspects of software utilization. Following is a table of specifications for the minimum software requirements for smartphones that will use the system.

Table 1 Minimum Smartphone Software Specifications

Software	Minimum Requirements
Operating system	Android v 5.0
Network Signal	H+
RAM	512 MB

The following is a table for the minimum requirements for software specifications on Raspberry Pi that will use this application.

Table 2 Minimum Software Specifications

Software	Minimum Requirements
Operating system	Raspbian Stretch with desktop and recommended software 2019-04-08
Browser	Chrome
Phyton	Python 2.7.15
Bahasa Pemograman	Python
VNC Viewer	Viewer Raspberry Pi

2.2.4.3 Analysis of User Needs

User analysis is intended to find out who are the users involved and their characteristics so that the level of user experience and understanding of the system can be known. The following is an analysis of user needs. The following table shows the system user needs.

Table 3 Analysis of User Needs

User	Specification
Owner	The owner of a vaname shrimp pond. It can use a smartphone with the Android operating system. It can use an Android-based application..

2.2.5 Functional Requirements Analysis

Functional requirements analysis describes the process of activities that will be applied in a system and explains the needs of the system.

2.2.5.1 Use Case Diagram

The use case diagram is modeling for system behavior to be made. To describe the relationship that occurs between actors with activities that occur in the system. The objectives of the use case modeling include defining the functional and operational needs of the system by defining the scenario of the use of the system to be built. From the results of existing application analysis, the use case diagram for this application can be seen in the following figure.

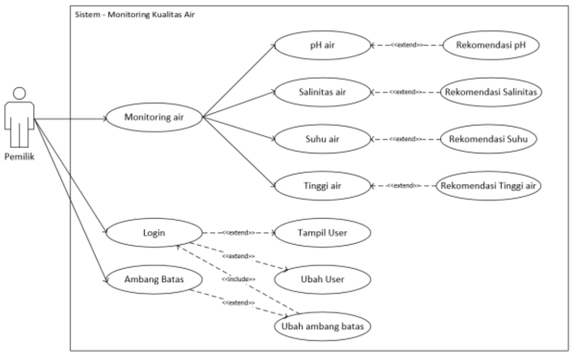

Figure 4 Use Case Diagram

2.2.5.2 Class Diagram

Class Diagram is a description of the structure and relationships of each object that runs on the system. In this diagram illustrated the attributes and methods that are in each class. The class diagram description of the development of a vaname shrimp pond water quality monitoring system based on the Internet of Things can be seen in the following figure.

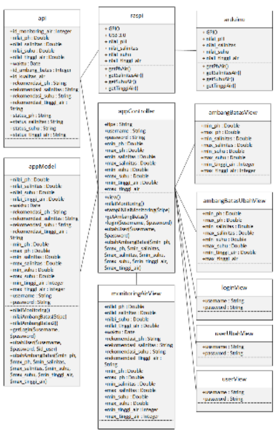

Figure 5 Class Diagram

2.2.6 Database Analysis

Database design is the stage to map the conceptual model to the database model that will be used. Database design is divided into two, namely the relation scheme and table structure design.

2.2.6.1 Relation Schema

A relation scheme is a series of relationships between several tables in a database system. In the following figure, an explanation of the database series on this system can be seen as follows:

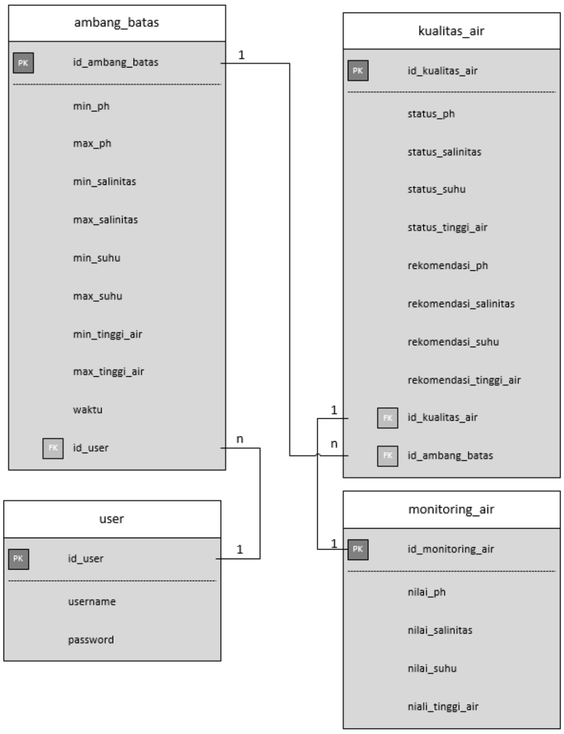

Figure 6 Relation Schema

2.3 System Testing

System testing is the most important thing that aims to find errors or deficiencies in the information system being tested. System testing is intended to determine the performance of information systems that have been made following the objectives of information system design. The type of testing carried out includes Testing Functionality and Usability.

2.3.1 Black Box Testing

Black box testing focuses on whether the software built meets the requirements mentioned in the specifications. Tests carried out by running or executing units, then observed whether the results of the units tested whether following the business process or not.

2.3.2 Black Box Testing Scenarios

Software testing scenarios for users of monitoring systems for temperature, humidity and vegetable crop recommendations can be seen in the following table.

Table 4 Testing Scenarios

Test Case	Testing Details	Type of Testing
Login	Login	*Black Box*
Monitoring pH air	Look at ph water monitoring	*Black Box*
Monitoring Salinitas air	Look at monitoring water salinity	*Black box*
Monitoring Suhu air	Look at monitoring water temperature	*Black box*
Monitoring Tinggi air	Look at monitoring High water	*Black Box*
View Ambang Batas	Look at threshold data	*Black Box*
Ubah Ambang Batas	Change the threshold data	*Black Box*
Ubah User	Change user data	*Black Box*

2.3.3 Black Box Testing Results

Testing is done by testing each process for possible errors that occur. The following results of tests that have been carried out can be seen in table 5.

Table 5 Test result

Cases and Test Results (Correct Data)			
Action / Data Enter	Which are expected	Observation	Conclusion
Enter all input fields that correspond to the database	Displays to the main page	Displays to the main page	[√] Accepted [ ] Rejected
Cases and Test Results (Incorrect Data)			
Action / Data Enter	Which are expected	Observation	Conclusion
Enter all input fields that do not match the database	Displaying the words 'wrong username or password'	It says 'wrong username or password'	[√] Accepted [ ] Rejected
Leave the input field blank	Displays icon error information with the word 'username or password is required'	An error information icon appears in each field with the words 'Username or Password is required'	[√] Accepted [ ] Rejected

2.3.4 Conclusion Black Box Testing

Based on the results of Black Box testing that has been done, it can be concluded that functionally all processes in the Water Quality Monitoring System at Vaname Shrimp Ponds have been running as expected.

2.4 Hardware Component Testing

Installation of tools has been carried out on the IoT hardware implementation. To find out if the equipment is running according to the original design, a test is needed.

2.4.1 Testing the pH Sensor SEN0161

The testing of the SEN0161 water ph sensor is done by comparing the value received from the sensor with a ph meter. The measurement results can be seen in table 6.

Table 6 Test Results for the SEN0161 pH Sensor

Trial	Sensor Data Measurement (p1)(ph)	Conventional Measurement Tools (p2)(ph)	Measurement Difference Abs(p2-p1)/p2 x 100%
1	7,2	7,5	0,04000%
2	7,1	7,4	0,04054%
3	7,2	7,4	0,02703%
4	7,2	7,4	0,02703%
5	7,3	7,4	0,01351%
6	7	7,2	0,02778%
7	3,9	4,2	0,07143%
8	4,3	4,6	0,06522%
9	3,8	4,2	0,09524%
10	4,1	4,2	0,02381%
The average percentage of error			0,04316%

Figure 7 Testing the pH sensor SEN0161

Based on the test data in table 6 it can be assumed that the SEN0161 pH sensor has an average error percentage of up to 0.04316%. Based on these data the SEN0161 pH sensor can be said to be accurate.

2.4.2 Testing the Salinity Sensor

Salinity sensor testing is done by comparing the value received from the sensor with a refractometer. The measurement results can be seen in table 7.

Table 7 Salinity Sensor Test Results

Trial	Sensor Data Measurement (p1)(ppm)	Conventional Measurement Tools (p2)(ppm)	Measurement Difference Abs(p2-p1)/p2 x 100%
1	25,7	26,5	0,03019%
2	25,1	26,4	0,04924%

3	25,4	26,4	0,03788%
4	25,6	26,4	0,03030%
5	25,8	26,4	0,02273%
6	25,8	26,2	0,01527%
7	25,4	26,2	0,03053%
8	24,3	25,6	0,05078%
9	24,7	25,2	0,01984%
10	25,1	25,2	0,00397%
The average percentage of error			0,02907%

Figure 8 Salinity Sensor Testing

Based on the test data in table 7 it can be assumed that the salinity sensor has an average error percentage of up to 0.02907%. Based on these data salinity sensors can be said to be accurate.

2.4.3 Testing DS18B20 Temperature Sensor

DS18B20 temperature sensor testing is done by comparing the value received from the sensor with a water temperature thermometer. The measurement results can be seen in table 8.

Table 8 DS18B20 Temperature Sensor Test Results

Trial	**Sensor Data Measurement (p1)(°C)**	**Conventional Measurement Tools (p2)(°C)**	**Measurement Difference Abs(p2-p1)/p2 x 100%**
1	35,6	35,4	0,00565%
2	34	35,0	0,02857%
3	33,9	35,9	0,05571%
4	35,1	36,4	0,03571%
5	34,3	35,6	0,03652%
6	35,8	36,2	0,01105%
7	34,7	35,2	0,01420%
8	35,7	36,5	0,02192%
9	35,4	36,4	0,02747%
10	35,4	36,2	0,02210%
The average percentage of error			0,02476%

Figure 9 Testing the DS18B20 Temperature Sensor

Based on the test data in table 8 it can be assumed that the temperature sensor has an average error percentage of up to 0.02476%. Based on these data the DS8B20 Waterproof temperature sensor can be said to be accurate.

2.4.4 Testing of Ultrasonic Sensors HC-SR04

Testing of the HC-SR04 ultrasonic sensor is done by comparing the value received from the sensor with a conventional water level meter. The measurement results can be seen in table 9.

Table 9 Ultrasonic Sensor Testing Results HC-SR04

Trial	**Sensor Data Measurement (p1)(cm)**	**Conventional Measurement Tools (p2)(cm)**	**Measurement Difference Abs(p2-p1)/p2 x 100%**
1	115	116	0,00602%
2	118	119	0,00591 %
3	115	116	0,00602%
4	118	120	0,01176%
5	118	120	0,01176%
6	124	125	0,00571%
7	126	128	0,00561%
8	108	110	0,0125%
9	109	110	0,00625%
10	119	121	0,01169%
The average percentage of error			0,00832%

Figure 10 Testing of Ultrasonic Sensors HC-SR04

Based on the test data in table 9 it can be assumed that the ultrasonic sensor has an average percentage of errors up to 0.00832%. Based on these data ultrasonic sensors can be said to be accurate.

2.5 Beta Testing

Beta testing was conducted to determine the evaluation of the water quality monitoring system software on the vaname shrimp ponds that were built using the interview method. The interview was conducted to Mr. H. Abdul Jalal as the owner of a vaname shrimp pond to find out the extent to which the system that was built can solve the problems that have been explained in the previous sub-chapter. From the results of the interview, it can be concluded whether the system built is following the objectives or not.

Table 10 Beta Testing Results

Question	Answered
Can the system help the owner in monitoring water quality?	Yes, Very helpful
Has the monitoring tool designed already helped the owner in measuring water quality?	Yes, Very helpful
Is the monitoring tool suitable for use in vaname shrimp ponds?	Yes, but the display is made more user-friendly
Our monitoring tools that have been built useful?	Yes, Very helpful
What do you think if the water quality measurement tool is now replaced with a water quality monitoring tool that has been built?	Possible yes, as long as the equipment already has a calibration certificate and is easy in terms of maintenance

3. COVER

3.1 Conclusion

Based on the results obtained in the research and preparation of this thesis and adjusted to its purpose, the following conclusions are obtained:

1. Based on the test results the system can assist the owner in monitoring water quality, namely water pH, water salinity, water temperature, and water height.
2. Monitoring results can be automatically entered into the system as expected.
3. Based on the results of testing the use of a SEN0161 pH sensor to measure the pH of water, it still has to be calibrated periodically to improve the accuracy of the measurements.

3.2 Suggestion

Authors' suggestions that can be conveyed in this study are as follows:

1. Because ph and salinity sensors have weaknesses, it is necessary to use ph and salinity sensors to get accurate and practical measurements.
2. Further research needs to be done to develop a better form of sensor design to be suitable for use by users.

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