

Internet of Things

## Smart Warning System Prototype DAM

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### ARTICLE INFORMATION

Received: September 28, 2024  
Revised: June 22, 2025  
Available Online: June 26, 2025

### KEYWORDS

IoT  
DAM  
ESP32  
Sensor

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### A B S T R A C T

This study designs a flood detection prototype by measuring water flow speed and water level using a flowmeter sensor, water level sensor, buzzer as a warning device, and ESP32 microcontroller as the controller. The research was conducted through a literature review, collecting data from journals, online articles, and statistics related to sensor technology and ESP32. This research aims to design, develop and test a prototype of an integrated smart early warning system for risk management and mitigation in dam areas. The system is designed to be able to detect potential hazards in real-time, such as sudden increases in water volume, extreme rainfall, potential landslides on dam slopes, or structural damage. Testing ensured that all components functioned as expected, with results demonstrating reliable system performance. This IoT prototype successfully monitored dam parameters in real-time, with an average delay of 42 ms, 84.3 ms, and 73.8 ms, no data packet loss (0%), and stable throughput at 92.6 Kbps, 83.8 Kbps, and 86.2 Kbps.

## INTRODUCTION

Floods are the most frequent natural disasters in Indonesia. Large pools of water can submerge an area. Rainfall and water flow can predict the arrival of floods. However, floods often come suddenly, such as due to storms or leaking embankments, known as flash floods. High rainfall, land surfaces lower than the sea, basin areas surrounded by hills with minimal water absorption, development on riverbanks, river flows clogged with garbage, and lack of land cover in the upper reaches of the river are some of the main causes of flooding. Dams are also one of the places where flooding often occurs [1,2,3]

A dam is a massive construction made of earth, stone, and concrete. Its function is not only to hold and store water, but can also be used to hold mining waste, or store mud and form reservoirs [4,5]. Dams are also important infrastructure in the field of water resources that provide many benefits to the community, dams can also be a solution to dealing with flooding in the surrounding area [6,7,8].

Problems that often arise in the community are floods that often appear suddenly due to the lack of mitigation from the government and preparation of the community itself, so that floods often cause material and immaterial losses which will paralyze the wheels of the economy and cause new social problems in the community affected by this flood disaster.

The solution to the above problems is to mitigate and prepare for all possibilities that occur if a flood occurs, the government can provide socialization and understanding of the causes and effects of the flood itself. If this is done, of

course, all possible losses suffered will be minimized or even prevented. However, this is certainly not enough if it does not combine technology and engineering with the causes of the flood itself.

Floods can be minimized with the help of utilizing existing technology, there are several ways to utilize technology, namely by using IOT, Augmented Reality (AR) and 5G technology. In applying this prototype, the author uses IOT technology as the basis for using a flood warning system.

IOT is a concept that is connected to devices as an internet-based communication media. With IOT, a user can connect and communicate with each other to carry out activities, search, process, and send certain information automatically. How IOT works is by connecting various types of devices such as hardware or software. There are 3 main components in the IOT work system, namely sensors, gateways and clouds.

The sensors used are generally motion sensors, light and others depending on their use, the main purpose of the sensor is to collect data or provide information from information that you want to get. After the sensor has successfully collected data, the gateway component functions to transmit data to the cloud, which is a storage place for data that has been collected by the sensor. The lack of accurate data obtained about the height, discharge and clarity of water causes delays in notification of flood disaster warnings and evacuations by city and regional governments. Therefore, the Smart River System is proposed. The Smart River System is a system that can display water discharge conditions, water levels and rainfall in real time. The Smart River System work series starts from devices that have been installed at river flow points. The device consists of a Microcontroller, Ultrasonic Sensor, Rainfall Sensor, data will be managed through a Microcontroller and sent by a Transmitter consisting of a GSM 4G M2M transmitter circuit and a receiver[9,10,11].

IOT functions as a medium for collecting data, therefore, so that research can be in line with the objectives, a media in the form of a prototype is made. A prototype is a simulation tool for an initial design in the form of a model of a product or tool that aims to test a design or design before mass production is carried out. The prototype can be changed to the system or how it works if it is still not close to the results until improvements can be made and the resulting product can function properly, the reason this prototype was built is the use of appropriate technology and as a basis for making disaster mitigation tools to deal with the possibility of early flooding, this prototype can be a reference for other researchers or related parties to develop the final product of an early warning system.

From this, the author conducted research and designed a prototype tool that would detect the possibility of flooding. The method that the author will use is by calculating the current speed and the height of the water tide. The prototype tool that will be designed by the author will use a flowmeter sensor to read the current speed, a water level sensor to see the possibility of overflowing water, a buzzer as a notification and use an ESP32 microcontroller as the controller of the prototype tool.

## **METHOD**

### ***Conceptual Framework***

The conceptual framework structure that will be used to complete the smart dam research is as shown in the following figure:

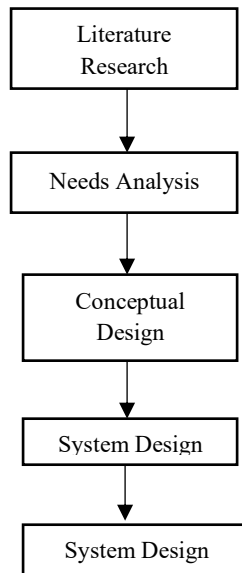


Figure 1. Conceptual framework structure

Based on the conceptual framework above, the discussion at each stage can be described as follows:

1. Literature research to collect information in the form of secondary data obtained from scientific articles and journals.
2. Needs analysis to design this smart dam prototype includes the use of an ESP32 microcontroller, Ultrasonic Sensor, Waterflow Sensor, and Relay. Use of Blynk as a user interface to monitor water levels and flood alert levels.
3. Conceptual design to obtain structural images and relationships between parts or components in a system.
4. System design Designing a system on the Smart Dam prototype includes hardware and software design. At this stage, it will be determined how the device will be connected to the IoT network and connected directly to the Blynk application.
5. After the hardware and software have been developed, this testing stage is to form a complete smart dam system. This system will then be tested to ensure that all features and functionality are running properly.

**General Architecture**

The general architecture in this study is by designing a block diagram to obtain a picture of the structure and relationship between parts or components in a system. The block diagram can be seen in the following image:

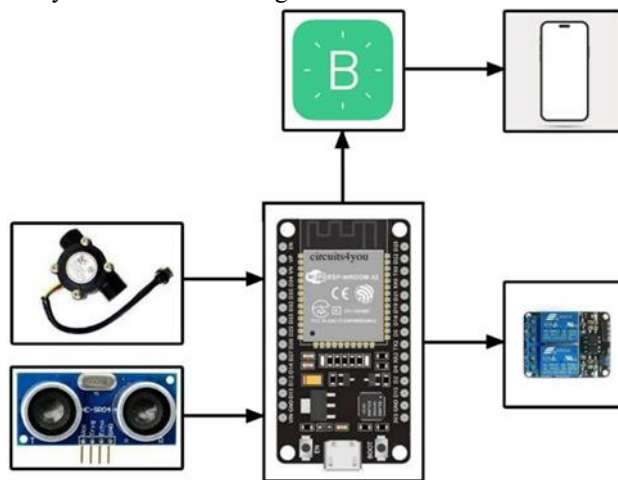


Figure 2. Block Diagram

Based on Figure 2. is the application of the Internet of Things to the dam monitoring system. This stage produces the flow of the component system that will be used. Ultrasonic sensor as a sensor that can detect water level. Waterflow sensor as a sensor that can detect the water discharge. 2 channel relay as an output that will later be connected to the LED strobe

and Buzzer as a sign of an impending flood. Blynk will display an interface to the user so that they can monitor the height, water discharge, and alert level when a flood occurs.

## RESULTS AND DISCUSSION

### Tool Test Results

Testing was conducted to ensure that all system components function according to expected specifications. This testing included checking every element of the tool, from sensors to the main controller, to ensure that the data collected was accurate and that the system could transmit information correctly. The test results showed that the tool operated properly, with every component working as it should to provide accurate and reliable results. The image below shows the completed tool, showing the overall configuration and installation of the components.

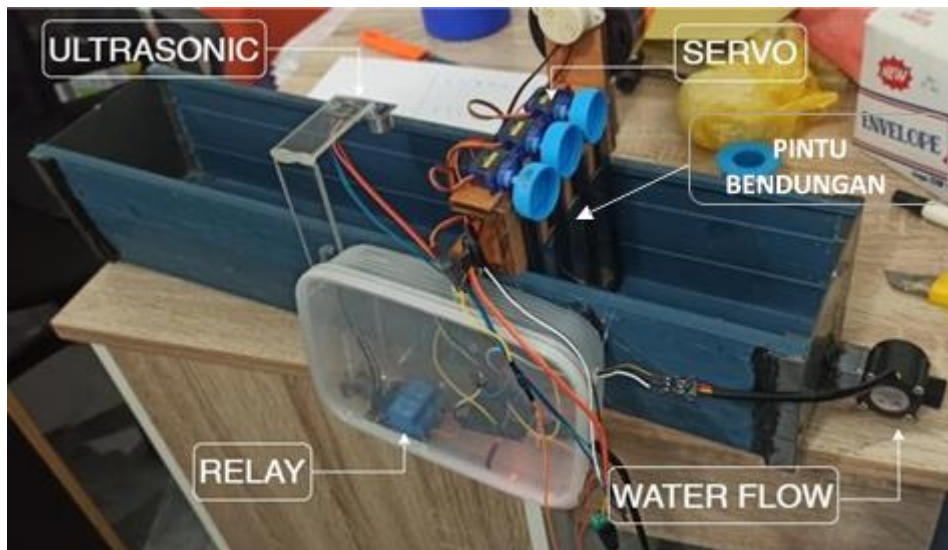


Figure 3. Tool Test Results

The following table presents a functional analysis of the prototype smart warning system of the dam system, showing the role of each component in various operational states. Each state, from water level monitoring to water discharge management and alert conditions, is described to assess the extent to which components such as ESP32, ultrasonic sensors, water flow sensors, relays, servos, and the Blynk platform function according to the system design.

First experiment in normal water surface condition.

Table 1. Table of Functional status of the tool

Experiment		Under normal circumstances					
Trial Date		Wednesday, September 11, 2024					
No.	Status	ESP32	Ultrasonic	Waterflow	Relay	Servo	Blynk
1	Water Level	✓	✓				✓
2	Water Discharge (Liter)	✓		✓			✓
3	No	✓	✓				✓

In the "NO" status condition in the IoT-based dam early warning system prototype, the water level is detected below 3 cm using an ultrasonic sensor connected to the ESP32 microcontroller. At this stage, the relay functions as an LED and buzzer controller, but in the "NO" condition, both are inactive. The servo is used to control the dam gate, where servo 1 moves 90 degrees, while servo 2 and 3 remain at 0 degrees. Data related to water level and water discharge are displayed via the Blynk application, including sending notifications with the text status "NO".

### QoS Testing

At this testing stage, the tools and systems are tested to ensure that the functions and objectives of the research are achieved as expected. The testing technique used involves Wireshark software and the Quality of Service (QoS) method to measure system performance. The focus of this test includes measuring delay, throughput, and packet loss when sending data from the prototype to the blynk application. By using Wireshark, this test aims to assess how quickly the system responds. The data obtained comes from three tests with different time durations, namely 5 minutes, 10 minutes, and 15 minutes. The following table shows the results of the Quality of Service test using the Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON) standardization.

Table 2. QoS Test Results

Testing	QoS	Results	Index	Category Typhon
Testing 1 (5 Menit)	Delay	42 ms	4	Best
	Throughput	92,6 Kbps	3	High
	Packet Loss	0,03 %	4	Best
Testing 2 (10 Menit)	Delay	84,3 ms	4	Best
	Throughput	83,8 Kbps	3	High
	Packet Loss	0,02 %	4	Best
Testing 3 (15 Menit)	Delay	73,8 ms	4	Best
	Throughput	86,2 Kbps	3	High
	Packet Loss	0,01 %	4	Best

The following is an explanation of table 2 as follows:

Test 1 lasted 5 minutes:

1. Delay: The delay value in Test 1 was 42 ms, which is categorized as "Best". This indicates that the time required for data to move from one point to another in the network is relatively short.
2. Throughput: The throughput value in Test 1 was 92.6 Kbps, which is categorized as "High". This indicates that data transfer during the test went very well.
3. Packet Loss: The packet loss value in Test 1 was 0.03%, which is the optimal result. This indicates that no data packets were lost during the transfer process.

Test 2 lasted 10 minutes:

1. Delay: The delay value in Test 1 was 84.3 ms, which is categorized as "Best". This indicates that the time required for data to move from one point to another in the network is relatively short.
2. Throughput: The throughput value in Test 1 was 83.8 Kbps, which is categorized as "High". This shows that the data transfer during the test went very well.
3. Packet Loss: The packet loss value in Test 1 was 0.02%, which is the optimal result. This indicates that no data packets were lost during the transfer process.

Test 3 lasted 15 minutes:

1. Delay: The delay value for Test 1 was 73.8 ms, which is categorized as "Best". This indicates that the time required for data to move from one point to another in the network is relatively short.
2. Throughput: The throughput value in Test 1 was 86.2 Kbps, which is categorized as "High". This indicates that the data transfer during the test went very well.
3. Packet Loss: The packet loss value in Test 1 was 0.03%, which is the optimal result. This indicates that no data packets were lost during the transfer process.

### ***Blynk Display***

Testing of the IoT-based smart dam system that has been designed can be obtained from the reading results of the ultrasonic sensor that measures the water level and the waterflow sensor that reads the water discharge. The servo motor can be activated under certain conditions based on this data. The Blynk website display can be seen in the following image.

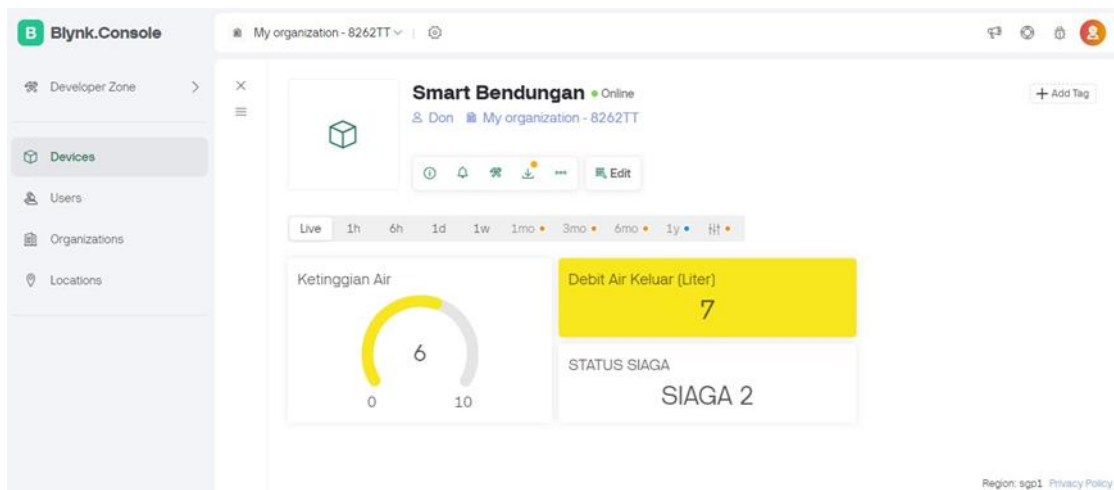


Figure 4. Blynk website view

The display is also made in a mobile application. Here is a picture of the blynk display on a smartphone.



Figure 5. Blynk application view

## **CONCLUSION**

The following conclusions can be drawn by the author after conducting research on the IoT-based smart dam digitalization system. The prototype of the smart warning system was successfully created using Internet of Things (IoT) technology.

This system is able to detect critical parameters relevant to real-time dam monitoring. Testing shows that the delay value varies depending on network conditions and transmission distance. The average delay recorded was 42 ms, 84.3 ms, and 73.8 ms, which are still within reasonable limits for IoT applications with real-time response times. The system successfully demonstrated excellent performance with a packet loss of 0%. This indicates that all data packets were successfully sent without significant data loss, ensuring the reliability of data transmission. The results of the throughput

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