

DESIGN OF AN ARDUINO-BASED WATER UTILIZATION MONITORING SYSTEM FOR PUBLIC WATER SUPPLY COMPANIES

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ABSTRACT

This research presents the design and implementation of an Arduino-based water utilization monitoring system tailored for public water supply companies (PDAM) in Indonesia. The system integrates various sensors, including turbidity, pH, temperature, and electrical conductivity sensors, to effectively monitor water quality and usage in real-time. Utilizing an Arduino microcontroller as the central processing unit, the system automates data collection and processing, providing valuable insights into water conditions and consumption patterns. The incorporation of IoT technology and wireless communication modules enables remote monitoring and control, enhancing operational efficiency and user engagement. The device features a water flow sensor and a digital water meter, with data displayed on an LCD screen, allowing users to track their water consumption easily. Additionally, an alarm system alerts users when water usage approaches a predefined maximum limit, promoting water conservation. The findings indicate that the system operates effectively within specified flow rates, demonstrating its potential as a cost-effective solution for improving water management practices in public water supply sectors. Future enhancements may include internet-based monitoring capabilities and backup power solution This research presents the design and implementation of an Arduino-based water utilization monitoring system tailored for public water supply companies (PDAM) in Indonesia. The system integrates various sensors, including turbidity, pH, temperature, and electrical conductivity sensors, to effectively monitor water quality and usage in real-time. Utilizing an Arduino microcontroller as the central processing unit, the system automates data collection and processing, providing valuable insights into water conditions and consumption patterns.

INTRODUCTION

The design of an Arduino-based PDAM water usage monitoring system involves integrating various sensors and communication technologies to effectively monitor and manage water quality and usage. This system leverages the capabilities of Arduino microcontrollers to automate data collection and processing, providing real-time insights into water conditions and usage patterns. The integration of IoT and wireless communication further enhances the system's functionality, allowing for remote monitoring and control. Below are the key components and considerations for designing such a system. System Components Arduino Microcontroller: Acts as the central processing unit, executing commands and processing data from sensors (Pademui et al., 2022) (Osman et al., 2018). Sensors: Includes turbidity sensors for detecting water clarity, pH sensors, temperature sensors, and electrical conductivity sensors to assess water quality (Pademui et al., 2022) (Almojela et al., 2020). Communication Modules: Utilizes GSM modules and wireless sensor networks for data transmission, enabling remote monitoring and alerts (Almojela et al., 2020) (Costa & Emanuel, 2020). Data Processing and Monitoring Data Collection and Pre-processing: Sensor nodes collect and preprocess data, which is then relayed to a central node for further analysis (Almojela et al., 2020). Real-time Monitoring: The system provides continuous monitoring of water quality parameters, ensuring timely detection of any anomalies (Osman et al., 2018). User Interface: Data is displayed on LCD screens and can be accessed via platforms like ThingSpeak or through SMS notifications (Almojela et al., 2020). Automation and Control Water Pump and Valve Control: Automated control of water pumps and solenoid valves to manage water flow and maintain optimal water levels (et al., 2023). IoT Integration: Enables



remote control and monitoring through smartphones and other devices, reducing manual intervention and improving efficiency (Pademui et al., 2022) (Costa & Emanuel, 2020). While the primary focus is on monitoring water quality and usage, the system can also be adapted to address other challenges such as water wastage and resource management. By incorporating additional sensors and control mechanisms, the system can be tailored to specific needs, such as managing water supply in institutional settings or optimizing water usage in residential areas. This flexibility makes Arduino-based systems a versatile solution for various water management applications.

As the population of Indonesia continues to grow, so does the demand for water. Water is essential for daily activities such as bathing, washing, cooking, and other necessities. This is entirely reasonable, as water is a fundamental need for all humans worldwide (Pademui et al., 2022). Water sources can be obtained from various sources, including rainwater, surface water, and groundwater (springs). However, the use of water for consumption in daily life must prioritize clean water. One source of clean water that can be obtained and used by the community is water from the Public Water Supply Company (PDAM), which manages and distributes clean water to the community. This is why we now commonly see water meters in every household that subscribes to the service, whether residential, commercial, or even large-scale industrial customers (Almojela et al., 2020). To date, water usage has not been balanced with public awareness of water conservation. The public remains unaware of the importance of water resources and is unaware of how much water they have already used. During water inspections conducted by the PDAM (Regional Water Supply Company), the process of checking the amount of water supplied to each customer every month is required. During this process, inspections and record-keeping are still done manually by visiting customers' homes directly. This method is inefficient and ineffective, requiring significant manpower and time. The water meters used by PDAM are still analog, making it difficult for customers to access water usage data (Pademui et al., 2022).

For this reason, the author sought to design a device capable of digitally monitoring water usage. This device will enable users to easily track their water consumption. This device is designed using a Water Flow Sensor flowmeter and a water meter to measure the flow rate of water entering the pipes. The measurement data will be processed using an Arduino Uno. The processed data will be displayed on an LCD (Liquid Crystal Display). Additionally, the system includes a buzzer that serves as an indicator or warning that water usage is approaching the maximum limit.

LITERATURE REVIEW

The design of an Arduino-based water utilization monitoring system for public water supply companies can significantly enhance real-time data collection and management. By integrating various sensors and IoT technology, such systems can provide efficient monitoring of water quality and usage, ensuring compliance with safety standards and optimizing resource management. **System Components** **Microcontroller:** The core of the system is typically an Arduino microcontroller, such as the ATmega2560, which processes data from multiple sensors (Hongchun et al., 2017). **Sensors:** Key parameters monitored include pH, turbidity, temperature, and electrical conductivity, which are essential for assessing water quality (Almojela et al., 2020). **Data Transmission:** Data is transmitted wirelessly to a remote server or cloud platform, allowing for real-time monitoring and alerts via SMS or dashboards (GJ et al., 2024). **Benefits** **Cost-Effectiveness:** These systems are designed to be low-cost compared to traditional monitoring methods, making them accessible for public water supply companies (Osman et al., 2018). **Real-Time Monitoring:** Continuous data acquisition enables immediate corrective actions when water quality deviates from acceptable standards (Nagaraju, 2025). **IoT Integration:** Incorporating IoT technology allows for remote access and enhanced data analytics, improving decision-making processes (GJ et al., 2024). While the advantages of Arduino-based systems are clear, challenges such as sensor calibration, data security, and the need for technical expertise in deployment and maintenance remain critical considerations for public water supply companies.

METHOD

The tools and materials used in the design of Arduino Uno-based PDAM water usage monitoring consist of hardware and software, including:



Table 1. Hardware Requirements

| No | Name | Function |
|----|----------------|--|
| 1 | Laptop/PC | As a place to run applications in tool design |
| 2 | Arduino Uno R3 | As the programming brain and storage place for programs that have been created |
| 3 | Flowmeter | As a water flow meter |
| 4 | Water meter | As a water flow meter |
| 5 | LCD | Displaying Arduino output results |
| 6 | Buzzer | As an information notification |
| 7 | Jumper cable | As a connector between one component and another |
| 8 | Container | As a source and reservoir for water |

Software required in the research are:

Table 1. Software Requirements

| No | Name | Function |
|----|-----------------------|---|
| 1 | IDE Arduino | Used to write program code, compile, and upload programs to the Arduino board |
| 2 | Library Arduino | Used to facilitate Arduino programming |
| 3 | Simulator Electronics | Used to design and simulate electronic circuits before implementation. |
| 4 | Compiler | Programming and loading program code onto the Arduino board |

This stage is carried out to design the tools that will be used to conduct this research. The design is carried out after obtaining information from references that have been read and obtained. The tool design is as follows:

a. Design of water flow sensor (flowmeter)

This stage is carried out to create the device that will be visible after the software design is completed. The hardware design involves several stages, including the design of the flowmeter installation, the design of the water meter sensor installation, and the overall design of the device. The first design carried out is the design of the flowmeter reading installation. The design is as shown in the following figure:

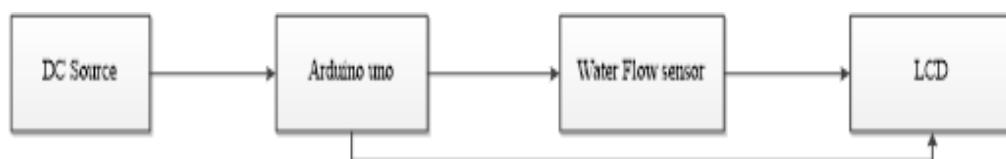


Figure 1. Schematic Design

Based on Figure 1 above, it can be seen that there are several components used. The DC source is a DC voltage source that functions as the voltage source that will be used as the input voltage for the Arduino. The Arduino Uno is first programmed using a PC/laptop, and once the program is complete, it is uploaded to the Arduino Uno board. The Arduino Uno also functions as the driver for the water flow sensor and LCD to operate according to the programmed instructions. The water flow sensor here functions as a reader of the water flow rate and will be displayed on the LCD. On the LCD, the water flow rate consumption in cubic meters (m³) and the water consumption cost in Indonesian Rupiah (Rp) will be displayed.

b. Overall system design

This design will discuss the overall system to be created in this study. The following is an overview of the overall system to be created in this final project, as shown in the image below:

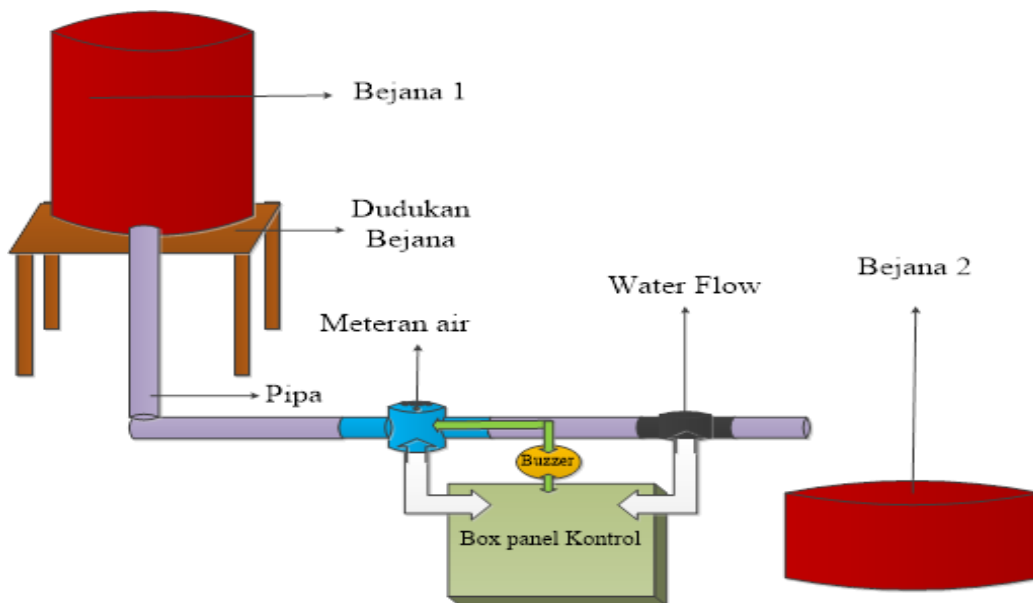
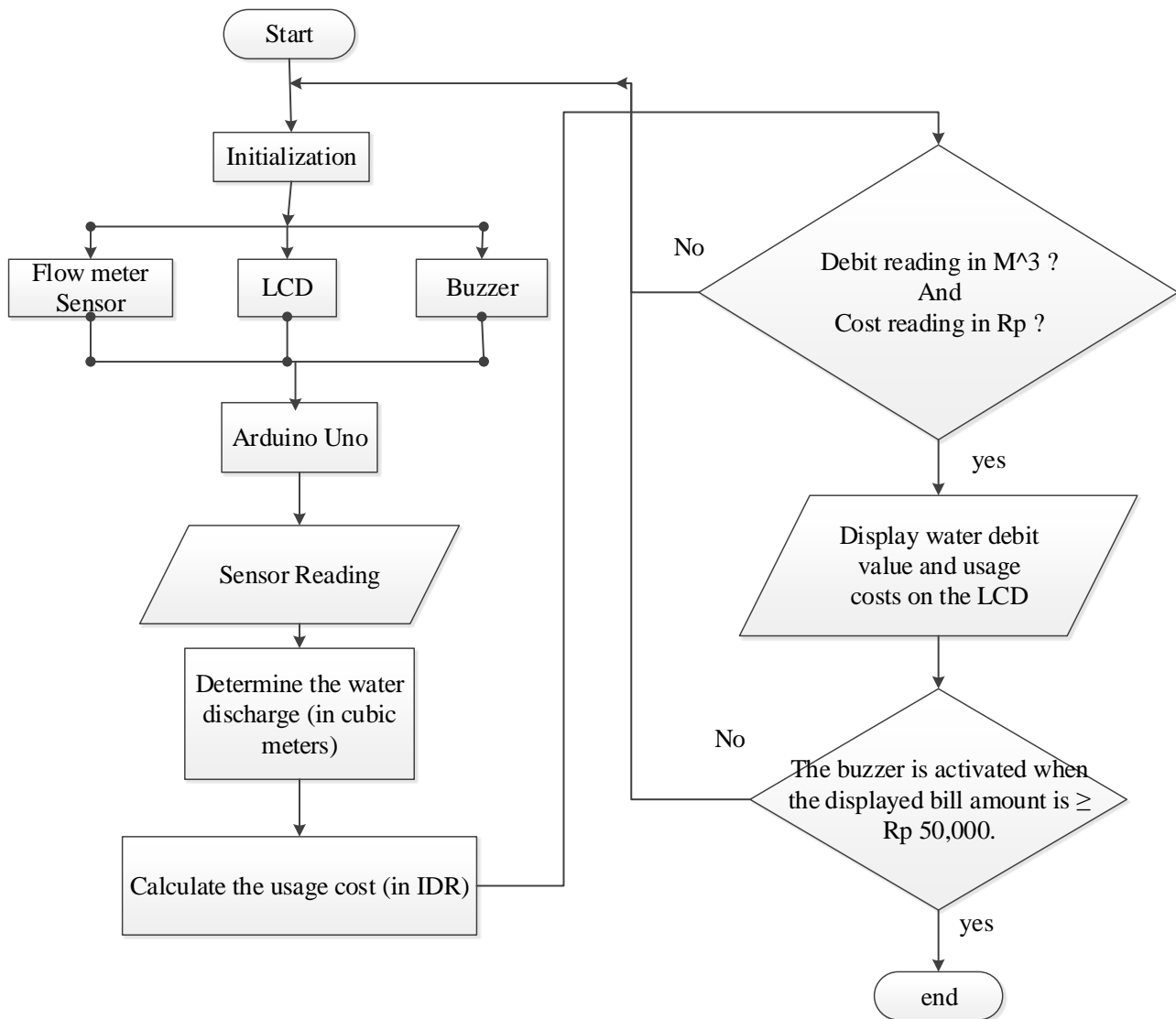


Figure 2. Sketch of the Overall System Prototype

Based on Figure 2, the overall sketch of the system to be developed in this study is shown. In this study, two vessels are used. Vessel 1 is assumed to be the water source, which is then distributed to subscribing users, while vessel 2 is the water storage tank connected to the PDAM meter, where vessel 2 is assumed to represent the load or water consumed by customers. The water flow sensor in the system functions as a sensor to read the flow rate of water being consumed. The sensor readings are displayed on an LCD screen. The information displayed on the LCD includes the water flow rate used and the cost in Indonesian rupiah (Rp). Additionally, the system includes a control panel box, which houses several components: a project board, an Arduino Uno, and an LCD screen, all assembled within a single box. The control panel box is the core of the reading and control functions of the system being developed in this research. Additionally, the system includes a buzzer that functions to provide notifications about water usage. The notification is in the form of an alarm sound indicating that water usage is nearing the maximum limit. The alarm notification is set in the program at a value of Rp 50.00, and when water usage reaches this value, the buzzer will sound. The function of installing the buzzer is to warn users to conserve water moving forward. To see how the device to be created in this study works, refer to the following image:



Gambar 3. Flowchart System

Figure 3 above clearly illustrates how the device to be created in this study works. All procedures involved in creating the water usage monitoring system are described, from programming, sensor reading, the reading process, how the results are to be displayed, to completion.

RESULT

Based on Figure 4a above, it can be explained that the device assembly uses a white container that is considered as the water source to be channeled through the installed pipes. A laptop is used as a power supply to power the Arduino Uno. The water flow reading through the flowmeter sensor can be directly viewed on the programmed LCD display. The first buzzer will sound softly when the rupiah value reaches Rp. 50.00, indicating that water usage is nearing the maximum limit. With the first alarm sounding, users can be more economical in their water usage. The second buzzer sounds quickly when the rupiah value reaches Rp. 60.00, indicating that usage has reached the maximum limit. Based on Figure 4b above, it can be explained that reading the water flow rate through a water meter requires precision in recording the values on the meter. The water flow rate must be recorded every time the needle on the meter rotates. Figure 4c shows how the device is assembled. Water flow readings using a flowmeter sensor can be seen directly on the programmed LCD display.

Meanwhile, readings using a water meter require careful recording of the values on the meter. Water flow readings must be recorded every time the needle on the meter moves.



Figure 4. Assembling the Equipment using a Flowmeter

DISCUSSION

From the design of the device and the results obtained, the following suggestions are made for further development of the device:

- 1) For further development in the process of monitoring water usage, it is recommended to use an internet-based system, such as connecting to software like WhatsApp or Telegram.
- 2) For further development, it is recommended to create a switching power supply so that the device can still function even if there is a power outage.

CONCLUSION

After testing and collecting data from the design that has been created, the following conclusions can be drawn:

1. The design of the Arduino Uno-based PDAM water usage monitoring device has been successfully created.
2. The YF-B1 flowmeter will work well at water flow rates of 1 to 7 liters per minute.
3. The water meter will function properly within a flow rate range of 1 to 8 liters per minute.

4. The alarm serves as a notification that water usage is nearing the maximum limit, enabling users to conserve water usage.

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