Clean water billing monitoring system using flow liquid meter sensor and SMS gateway

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Abstract. Public clean water company (PDAM) as a public service is designed and organized to meet the needs of the community. Currently, the number of PDAM subscribers is very big and will continue to grow, but the service and facilities to customers are still done conventionally by visiting the customer's home to record the last position of the meter. One of the problems of PDAM is the lack of disclosure of PDAM customers' invoice because it is only done monthly. This, of course, makes PDAM customers difficult to remember the date of payment of water account. Therefore it is difficult to maintain the efficiency. The purpose of this research is to facilitate customers of PDAM water users to know the details of water usage and the time of payment of water bills easily. It also facilitates customers in knowing information related to the form of water discharge data used, payment rates, and time grace payments using SMS Gateway. In this study, Flow Liquid Meter Sensor was used for data retrieval of water flowing in the piping system. Sensors used to require the help of Hall Effect sensor that serves to measure the speed of water discharge and placed on the pipe that has the same diameter size with the sensor diameter. The sensor will take the data from the rate of water discharge it passes; this data is the number of turns of the mill on the sensor. The results of the tests show that the built system works well in helping customers know in detail the amount of water usage in a month and the bill to be paid.

1. Introduction

Public clean water company, PDAM (Perusahaan Daerah Air Minum) as a public service is designed and organized to meet the needs of the community. Water is a basic necessity in everyday life; water has an important role in supporting the prosperity and welfare of society. The availability of adequate water will encourage the development of the development sector in the community. Programs undertaken by PDAMs in both urban and rural areas have the objective of providing services to the community for obtaining clean and healthy water for both domestic and industrial purposes to support economic development and health status of the population. For now, the services provided by PDAM to the community include new installations, repairs, account payments, and others.

However, in the case of water bill payments, PDAM still occupied manual officers to visit each customer's home to check the water meter and provide a monthly bill of water consumption fee to the customer. The water bill payment system until now is still less open and less explanatory in the details of the bill to be paid by the customer. This is because customers can only know the details of the use of
water for one month only on the date of payment of the roll. In addition, customers also get into trouble because they always remember the date of payment of their monthly water account. For if it is too late in making payments, then the PDAM will provide a fine or even stop the distribution of water to customers.

The ease of accessing and knowing the water usage information specified is needed that we make an approach to know the details of water usage and the time of payment of water account easily via short message or SMS. The results of this study are expected to provide benefits especially for customers or users of PDAM water.

Some previous research, among others done in 2011, Dodik Juhanto through the design of information systems payments PDAM Ngawi water account using visual basic and mysql. The researcher designs the information system to facilitate more efficient management and account payments on PDAM Ngawi, collect data with observation, interview & library method then processed using Visual Basic and Mysql. [1].

In 2011, Yudi Wiharto designed an academic information system based on SMS gateway. In his research designed information systems for school academic processing, application programs run on a computer connected to a database, using a mobile phone that is connected via a USB port as a receiver (SMS) and will be responded automatically. [2].

In 2014, Zaratul Nisa Saputri designed a voice recognition application as a controller of UND's Arduino-based electrical equipment. Research conducted has a success rate of about 50% if receiving voice commands from different people. If the command is used in the form of a single syllable, the rate of occurrence is 98.30% [3].

In 2104 Suresh et al conducted a study of fluid monitoring and control flowing through industrial pipelines using a web server, with the help of Hall Effect Flow Sensors connected to the Arduino to measure fluid flow, while raspberry PI controlled the Solenoid Electro-Valve functioning for close and open the valve to control the fluid flow of the pipe. [4].

In 2016, Indera Surya Satria monitors and detects the location of piped water pipe leaks using flow liquid sensor on the network sensor. This research also used Arduino microcontroller based on Atmega328P chip which is used to detect leakage location on pipes by utilizing data of water discharge rate through it and stable working system to find the location of leakage location with maximum distance of 2 meter with water discharge rate 10 liter per minute to be able to determine the location of the leak with the closest detection results. [5]. Another study uses image-based monitoring to regularly check the water meter [6] and real-time monitoring for water pollution [7] also has been referred.

In this study, we used the Flow Liquid Meter Sensor to retrieve data from the flow of water that flows on the pipe. This sensor uses the help of hall effects sensor in it to measure the speed of water discharge and placed on the pipe that has the same diameter size with the sensor diameter. The sensor will retrieve data from the rate of water discharge through which it is the number of turns of the mill on the sensor. The goal is to provide information in the form of water debit data used, payment rates, and payment grace periods using SMS Gateway to the customers.

2. Method
The general architecture of this study can be seen in Figure 1.
2.1. Hardware
In hardware side, it is necessary to set the tools used and the process of taking data using sensors then sent to Arduino, then Arduino process on the data then send it to the customer billing information system using the help of Raspberry Pi.

The process starts from the water through the meter which then flows to the flow liquid sensor that has been installed in the pipe, the sensor will take data from the flow of water flowing in the pipe through the flow liquid sensor, the data will be obtained in the form of analog signal will be sent to Arduino for the process.

Arduino then receives data sent flow liquid sensor, the data received in the form of analog signal and then in the process into a digital signal, the water debit data that has been received being then sent via the internet to the customer billing information system to in though so that the tariff can be set to customer of PDAM. Data is sent using Raspberry Pi already connected to Arduino to help connect to the internet network.

2.2. Customer Billing Information System
Process data sent via the internet will then be accepted customer billing information system, the data will be directly entered into the databases of data users of water, then the data is sent to the billing system to keep the tariffs on the wear based on the amount of water discharge used, then the data will be sent back to be summarized into the database as billing data and PDAM water usage. The billing data will be sent back to the billing system for sending at the end of each month through the process of sending customer billing data.

Submission of Billing Data Customer charges via SMS Gateway automatically to each customer at the end of the month in the form of PDAM water utility bill. SMS gateway delivery through BTS operator and directly into the mobile phone of each PDAM customer in the form of water debit data in use, payment rates and payroll time data.
2.3. Application System

The application system of customer billing statement to be built is a web-based application system using PHP. The web server used is a web server that will be built alone. This web server will serve as a place of service and data processing between Arduino, database, and client. The web server will receive the water debit data sent by the PC. This water debit data will then be stored in the database and ready to be processed to be represented back to the client in graphical form. These graphs will be displayed in a certain time interval and will always be updated automatically every second as long as the Arduino sends the water debit data to the system. The process of processing water debit data ready to be represented back to the client will always be done either when the client access the web server or when the client is not accessing the web server.

The client will access a web page on the web server to monitor, and only the specific client gets permission to access the page. This page will contain water debit information through the pipe and will always be updated automatically every second with no need for the client to refreshing the web page. In addition, this web page client can also add customer data or delete customer data and clients can also find out the total bill of water usage from the previous month.

The data used in this study is data obtained directly from the sensor. Arduino will receive data from the sensor which is the number of turns of the mill inside the sensor due to the flow of water through the sensor. The number of turns of this windmill is then processed using equation 1 so that obtained data of water debit passing through the sensor every second.

\[
Q = \frac{n}{c}
\]  

(1)

Where Q is the water discharge, n as the number of turns of the windmill and c is the calibration factor having a value of 7.5 depending on the type of sensor used.

After the water debit data through the sensor then the data will be monitored and conducted reporting the amount of water discharge. Any Arduino water discharge data will be sent to the server directly connected to Arduino via raspberry pi. This data is then sent to the web server and ready to be represented to the web client in the form of graphs and tables that are updated automatically every second and the client can see the amount of water discharge used and the total cost that needs to be paid.

Based on the results of monitoring obtained, every second of data discharge water that comes out will be stored in the database with the user in every month. Then on every 2nd weeks of each month, the flowing water flow data will be accumulated from the usage in the previous month. Then on a predetermined date, the subscriber will receive an SMS Gateway containing the total water usage for that month and a number of tuition that the customer must pay.

2.4. Design

The liquid meter flow sensor is placed between two pipes as can be seen in Figure 2.

Figure 2. Flow liquid meter installed on water pipe
Arduino has several pins that serve as a place of data processing and power, on this system pins are used for processing data sent from the sensor. The liquid meter flow sensor will be connected to the digital pin 2 to receive data from the sensor, GND pin and 5V pin as power for the sensor, as in Figure 3.

![Figure 3. Arduino Meter Sensor and Flow Flow](image)

Pi Raspberry is a microcomputer module that also has a digital output input port such as a microcontroller port. Raspberry Pi is used on Arduino to connect to PC using serial data. To obtain serial data from Arduino for raspberry pi using CP 2102 (USB serial) exchanger. This module will be stacked on the Arduino as shown in Figure 4 and Figure 5.

![Picture 4. Raspberry Pi and Arduino Mini Pro](image)  
![Figure 5. Prototype design](image)

3. Results and discussion
At this stage we tested how much water flows during the specified time and the amount of bill that must be paid by registered customers. A display of the test results based on the length of the water flowing at the sensor fluid flow meter. Earlier, calibration was made between the numbers in the water meters and the numbers in the sensor to make it easier to find out if there was a running stream of water. The results of this test showed a system that works for 5 minutes, 10 minutes, 15 minutes, 20 minutes and 25 minutes. The 5-minute test can be seen in Figure 6. In figure 6 the value on the meter before running for 10 minutes is 1744 and the value on the meter after 10 minutes is 1952.6. So in 10 minutes, there are 208.6 liters of water flowing through the water meter. Furthermore, the value of the sensor before and after 10 minutes is shown in figure 7.

![Figure 6. Value of Meters (a) Before and (b)After 5 Minutes](image)
Figure 7. Sensor Value Before and After 5 Minutes

In figure 7, the value of the meter sensor before running for 5 minutes is 1187 in accordance with the calibration value that has been inserted so that the sensor and meter values are the same. While the value of the sensor after 5 minutes is 1291.1. So in 5 minutes, there are 104.1 liters of water that flows through sensor flow liquid meter. The results of the 5 minutes, 10 minutes, 15 minutes, 20 minutes and 25 minutes tests are shown in table 1.

Table 1. Sensor Flow Liquid Meter Based on Time

| No | Time (Minute) | Calibration (ltr) | Meter (ltr) | Sensor Value (ltr) | Gap (ltr) |
|----|---------------|-------------------|-------------|-------------------|----------|
| 1  | 5             | 1187              | 1291.4      | 1291.1            | 0.3      |
| 2  | 10            | 1294              | 1502.5      | 1502.3            | 0.2      |
| 3  | 15            | 1505              | 1817.9      | 1817.7            | 0.2      |
| 4  | 20            | 1820              | 2237.2      | 2237              | 0.2      |
| 5  | 25            | 2240              | 2752.5      | 2752.3            | 0.2      |

Based on the results of long time testing when used for 10 minutes, 15 minutes, 20 minutes and 25 minutes there is a difference of 0.2 and 0.3 liters of water. This is because the wheel rotates on the flow liquid meter is different from the rotation found in the water meter which is still read manually. And in this test, it shows if the tool will produce the same difference in one-time use.

On this test will display test results based on SMS Gateway can be sent according to the registered customer's phone number. Based on the tests that have been done, the amount of water used in SMS is obtained according to the data sent by the operator provider used. Example of SMS Gateway display successfully posted on the system seen in Figure 8.

Figure 8. SMS Gateway Display Successfully Delivered Through The System To Customers

Figure 9. SMS Gateway View On Customer Mobile

In figure 9 there is a suitability of the message contained in the system with the contents of the message contained in the mobile phone for each registered customer.
4. Conclusion

Based on the testing and reporting system of customer bill based on water consumption using flow liquid meter, it is concluded that the built system can help the customer to know in detail the amount of water usage in the month and the bill to be paid. In the built system there is a difference of water liter that exits the sensor and the meter. And the contents of the SMS gateway received by the customer according to the contents of the message contained in the system.

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