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Water Pressure Data Recording System On Pipes Based On The Internet Of Things Networking

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ABSTRACT

Measurement system technology is increasing along with the development of digital technology. Likewise, the technology for measuring water pressure in pipes is made digitally, although many conventional measurements still exist, such as the flow meter in housing in general. The purpose of this research is to make a tool based on Internet of Things technology, especially water pressure sensors that are installed in various water sources to obtain data in real time to ensure sufficient pressure to push water to the customer. Each water pressure sensor node is monitored from the system dashboard in real time. In this paper, the author offers an IoT-based measurement system for microcontroller technology on a smart pressure meter using a water pressure sensor controlled by the NodeMCU and the pressure bar is calculated then the data is sent to the cloud with the GPRS module. The results will be displayed on the monitoring system dashboard in form of pressure data, volume in the water reservoir. The results of this study are the implementation of DWM IoT technology is able to monitor water pressure at several PDAM nodes by recording data and displaying pressure data in real time graphical form on the DWM IoT dashboard.

Keywords: Android, IoT, NodeMCU, Pressure meter, Water Presure Sensor

INTRODUCTION

Until now, not all water drainage systems applied by PDAMs are equipped with tools to check water pressure automatically. There are many technicians involved for periodic on-site checks. Such conditions will be prone to causing severe damage because the resulting pressure unable to be monitored at any time. Likewise, monitoring the use and distribution of water for the consumer community is frequently problematic. There are several conditions that cause the monitoring process to be hampered in the field of recording process. These conditions include the manual recording process with paper, data manipulation by officers and the habit of officers to delay recording on the manometer (Saraswati & Saputra, 2019). Another basic problem is the water pressure in the pipe which causes unstable water flow or the problem of pipe water leakage. The real condition of not monitoring the water pressure in the pipes sometimes results in water not reaching out the customer (Bruno, De Marchis, Milici, Saccone, & Traina, 2021) and causing massive customer losses and delays in handling problems. Monitoring real conditions at the location requires a good effort by field officers. In general, managers usually identify the source of the problem from user complaints or routine checks. Until now PDAM has used an analog manometer as a tool to record water pressure. Next, an inspection is carried out in the field to find out the facts. Such observation methods are less efficient for solving problems. The research must be conducted to find out the developing technology and having the upgraded technology is important to capture opportunities (Kee, Chee, Ng, & Yao, 2019). The development of information and communication technology is currently monitoring can be done in real time with the help of equipment connected to the internet. One of the current technologies is based on IoT. With this IoT application, PDAM allows for faster actions (Kusuma, Purbakawaca, Pamungkas, Fikry, & Maulizar, 2021).

Problems that often occur in PDAM are pipe leaks, water does not reach the customer, because the control does not work effectively. (Bruno, De Marchis, Milici, Saccone, & Traina., 2021). The number of customers is quite scattered in several areas but the number of officers who cannot monitor every day to all areas. This fact becomes an opportunity as well as a challenge for researchers to present solutions to these problems. Several studies have been produced including by (Muhammad, Leh, Hamid, & Yusoff 2021) who offer technical solutions for detecting pipe leakage using a water flow sensor and a NODEMCU microcontroller that can monitor in real time with the UBIDOTS IoT platform. The system built can detect the presence of the location of the leak. Meanwhile (Tadokoro et al., 2019) uses IoT for monitoring and control of water supply management. As with other researchers, (Che, Omar, Azir, & Kamarudzaman, 2021) was to design an air pipe damage detection tools using a pressure transmitter sensor which can be monitored from a smartphone screen. This tool uses two flowmeter sensors that are placed in positions before and after the pipe damage point to record data on the difference between the incoming and outgoing airflow. The difference in recorded data is sent to a computer system using a TCP/IP network.

Some technologies are developed for monitoring and controlling water pressure based on information technology are quite diverse. The system is designed by implementing Arduino Uno which plays a controlling role and displays it on the system screen or on the website. This equipment is used to monitor and control and record a history of routine daily use (Rosyady, Yulianto, & Warsino., 2021). Meanwhile, the technology initiated by (Kusuma, Purbakawaca, Pamungkas, Fikry, & Maulizar, 2021) uses a microcontroller, a 1.2 MPa liquid pressure sensor and a system that is integrated with a GSM wireless module, an Analog to Digital Converter module with 16-bit resolution, a 128 OLED monitor and a micro SD card.

This study offers monitoring of water pressure in the pipes and recording data from measurements on the IoT-based (Stolojescu-Crisan, Butunoi, & Crisan, 2022; Sungheetha & Sharma R, 2020; Yew et al., 2020; Zafar, Miraj, Baloch, Murtaza, & Arshad, 2018) PDAM water source pipeline to be sent to the server and can be seen on the system monitor dashboard display.

LITERATURE REVIEW

PDAM water pipe leakage are a scourge for clean water service providers. Pipeline leakage is a crucial problem because it happens frequently. Various things can trigger the water supply pipe to leak, including old and rusty pipe, affected by a disaster, affected by the projects, and leaking due to pressure from the above soil so that the pipe deforms or breaks. The leakage resulted in a decrease in water pressure so that the distribution of water to customers find obstacles. However, in this section, what is presented is related to how to detect the leakage. Several studies related to this have been carried out by (Muhammad, Leh, Hamid, & Yusoff, 2021) which describes the sequence of events for pipe leakage detection. The flow sensor detects the input signal from the frequency wave when flow in the pipe exist. The NodeMCU microcontroller records data and calculates it as a flow rate value. Next, the data recorded as a flow rate is delivered to the IoT platform for real-time monitoring.

Meanwhile, to ensure the smooth distribution of water, it is necessary to have an average flow rate. Research on measuring flow rate from water reservoirs (Kusuma & Anil, 2018) with components used are sensors, rasbery pi wifi and GPRS. In this article, it is presented that this tool can record measurement results. The purpose of using raspberry pi technology for applications based on IoT. This is possible considering that Raspberry is compatible with IoT technology. All data obtained or obtained is accumulated to Raspberry Pi and processed on an ongoing basis and then sends data to the cloud. Meanwhile, (Bruno, De Marchis, Milici, Saccone, & Traina, 2021) noted the pressure on the water distribution network using a communication type acquisition card as the medium. Meanwhile the technique to obtaining data in the application offered is to use Arduino to convert electrical signals to digital pressure data. Arduino uno collects data obtained from data recording by sensors and sends the data periodically to the cloud.

Today's IoT is a modern communication model that continues to evolve and is used for a wide variety of real-time online applications. IoT is part of various smart system applications, including smart home systems (Ali, et al., 2020), ThingSpeak for monitoring temperature and humidity (Cengiz & Duman, 2022), Internet of Things and ThingSpeak for identifying object segmentation, monitoring temperature and humidity in altitude areas, smart green houses, temperature and humidity server room.

The internet platform in the current digital era is considered a technical matter that has received attention from quite massive developments in various countries in the world. Various conveniences can be obtained by utilizing the internet, including displaying data, analysis results or scientific reports in real time. Great opportunity to solve technical problems related to controlling a device remotely which is currently done conventionally. In addition, internet can support tools that can be integrated into various types of applications such as smartphones, the ability to create task lists and events, collect data, and display it in a cloud environment. The researchers conducted a study and analysis of the use of the internet to connect one device to another which can be monitored from a cellphone or from a PC monitor screen. Several researchers present the results of a survey of emerging Internet of Things paradigms with the aim of providing insight into the models and conducting studies of current key technologies and future challenges with proven solutions. They have presented the Internet of Things as an information and communication technology system in the field of knowledge in the field of Cyber Physical

Systems (CPS), and the Internet of Things has been studied as a new paradigm that covers many fields. Using Internet of Things applications and connect machine learning to applications such as using home devices to save energy and smart city planning and diagnosis in healthcare with advanced computer technology to detect human disease types in real time, (Mohammed, Al-hayanni, & Azzawi, 2021).

The rapid development of Internet of Thing technology in the digital era opens wide opportunities for real-time monitoring and control systems. This technology is a new networking technology that enables remote viewing and surveillance of any physical device by attaching its electronics, software, sensors, actuators, and connectors. They offer a surveillance and vision system for the cyber-physical layer that allows them to be accessed in real time. This network offers the proposed real-time Arduino-based surveillance system. Their system consists of two sides of the Arduino-based system, namely the consumer side and the grid side. From the user's point of view there is a power sensor to measure the power used by the user, and on the grid side it is used by a power quality monitoring sensor which functions as a tool to measure power quality. In addition, Arduino as a microcontroller on both sides, the Global System for Mobile (GSM) module is used to transfer data between the two sides. Monitoring and controlling cloud-based big data on smart grids is also thoroughly discussed. Their proposed system suggests using workstations as cloud controllers and local area networks as connection media. Meanwhile, ThingSpeak is an open access data platform on the Internet of Things that allows users to collect data stored in the cloud, perform data analysis and visualization with MATLAB, and drive connected device reactions. ThingSpeak is widely used for surveillance systems for various applications such as tank monitoring systems, Arduino based air monitoring systems, temperature and humidity monitoring systems, environmental monitoring systems, ionosheric monitoring systems, intelligent surveillance systems, room air condition monitoring systems and demand side management of autonomous microgrid systems. From a literature study, IoT-based systems that use ThingSpeak are generally developed using hardware consisting of sensors, microcontrollers, and wi-fi modules. Some very limited literature focuses on IoT in simulation and modeling. The popular IEEE test network topology has been modified to support real-time communication with the IoT platform of the open-source ThingSpeak used for cloud computing, (Zikri, Yuniarti, & Lestari, 2022).

Arvind et al, (2022) also stated that ThingSpeak is an Internet of Things platform that allows users to collect data, visualize objects, analyze data directly, and react according to orders. ThingSpeak is an open-source application launched in 2010 by ioBridge. This technology helps someone build an Internet of Things system without the need to set up additional servers. Data collection is done using REST API or MQTT. Data analysis and visualization is performed using MATLAB analytics.

Internet of Things is the latest technology in the data communication model in today's digital era where objects in everyday life that are installed with electronic equipment, microcontrollers, transmitters, and receivers of digital communications, are controlled through appropriate protocols. The protocol is like a communication network with each other and with the users, making it an integral part of the internet cluster. This technological concept aims to make the internet more and more popular. Furthermore, by facilitating interaction with various devices such as, home applications, CCTV, sensors, machines, monitors, vehicles, etc. This cutting-edge technology model is truly applicable in areas such as home, industrial automation, agriculture and fisheries, medical assistance, mobile health care, elderly assistance, intelligent power management, smart grid, automobiles and more. Today, this concept is increasingly being described as an environment of people connected to objects, not just Machine to Machine. It is because of the breadth of this concept that many platforms have emerged to connect heterogeneous objects over the Internet. It is difficult to provide IoT solutions for different smart things from many manufacturers due to the lack of standards such as communication and interconnect protocols. Therefore, a new development model relying on the cloud user interface has been proposed. Many other sources, such as ThingSpeak, allow users to manage data in different formats and share their data from different sources. ThingSpeak is an open-source data based platform using cloud technology. This technology enables online data collection, analysis with MATLAB, and activation using open APIs including leading IoT platforms. The sensor data collected in each channel contains 8 fields that can accommodate different types of data, one status field and three site fields. Apps like TimeControl (automatically perform actions at predefined times using ThingSpeak app), TweetControl (Twitter listening and real-time interaction), React (react when channel data is compatible with certain conditions), TalkBack Reaction Measurement (Murad, Bakar, Azizan, & Shukri, 2021).

The Internet of Things describes a network of physical objects connected to sensors, software and other technologies to exchange data on the Internet with other devices and systems. Driven by the convergence of technologies, real-time analytics that allow them to share information in real-time without the involvement of humans, machine learning, sensors, and embedded systems, the evolution of things is happening. The Internet of Things is enabled by wireless sensing networks, control, and automation systems such as home automation, building automation and healthcare systems. Physical objects can share and collect data with minimal human intervention through low-cost computing, mobile and cloud technologies. Every interaction between connected objects can be recorded, monitored, and managed by digital systems, (Dabbakuti, Jacob, Veeravalli, & Kallakunta, 2022).

Meanwhile (Kurniawan, Sulitiadi,& Ristiono, 2021) in research using the internet of things for two channels on ThingSpeak. First Channel 'Status Sensor & Servo', on that Channel there are six 'fields' consisting of air humidity, air temperature, three humidity sensors, and servo direction. The data on the Status Sensor Channel is a data packet sent by the Raspberry Pi 3 Model B+. Second Channel 'Status Watering', in this channel there is only one field consisting of data sent by the Smartphone application. The built system can be used to monitor air humidity, air temperature and soil moisture from a smartphone monitor.

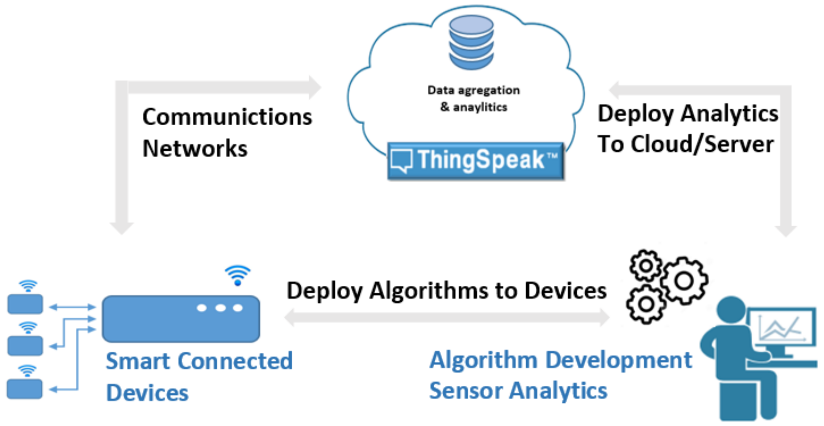
ThingSpeak is a free web platform for collecting and storing data from sensor records on the internet which is quite useful for developing Internet of Things applications. ThingSpeak Webservices provides facilities for analysis and visualization of data in the form of graphs processed with MATLAB. ThingSpeak can receive data from various hardware devices such as Arduino, Raspberry Pi, BeagleBone Black, and other hardware devices. The main elements contained in Thingspeak are data field channels, location fields, and status fields. Therefore, ThingSpeak has been widely used in several jobs in the field of IoT (Nasution, Muchtar, Seniman, & Siregar, 2021), Thingspeak for simulating and modeling control systems and monitoring electricity usage, electrocardiogram signal monitoring systems, smart community monitoring systems and IoT for health control (Jawad & Fahad, 2022).

RESEARCH METHOD

The method used in this study is the research and development method. Previously implemented equipment to monitor the pressure in the water pipe from the reservoir using human power. While in this research, Internet of Things-based technology is developed. Several sensors are used to record data in real time connected to the internet and stored in the cloud using ThingsSpek technology. The system development model is carried out using the waterfall model which consists of the following stages: Feasibility Study, Requirements Analysis, Design, Coding and Unit Testing, Integration, System

Implementation and Testing, and Maintenance. This method is designed to replace human intervention in the process of recording pressure on site in real time. The difference between the research offered and previous studies lies in measuring the pressure in the water pipe which is applied to various water sources. This is important because the pressure data from the source will be the reference information for planning the next water distribution. In this scientific article, the system offered has the goal of designing a tool that can intelligently measure water pressure in a pipe based on IoT technology. A device that can monitor water pressure in a pipe located at a source. This proposed system is designed by considering the energy consumption of the IoT sensor nodes. Figure 1 shows in general the connectivity between components and data flow from sensors to the cloud and then received or read by several connected equipment from the system model offered. This system integrates smart meter equipment and Arduino Uno into the data processing module NodeMCU 8622(Dwitama A. P., 2021) (Ramady & Mahardika, 2021; Prasetyo, Litanianda, Fadelan, Yusuf, & Sugianti, 2022) to be sent to the GPRS module (Liu, Tian, Hou, & Gao, 2018; Qiu, Zhu, & Liang, 2019; Dehua, Pan, Bo, & Zeng, 2012). This running technology is equipped with solar cell panels as a power source for mobile Wi-Fi types. The main idea or concept of this technology is that if there is a flow of water passing through the pressure sensor, the magnetic rotor rotates at a varying speed of the rotor, adjusting the speed of the flowing water. Then the sensor reading data will be sent to the NodeMCU8622 sensor data processor and then sent to the clout using the GPRS module. The system built will read a collection of data sent in the cloud and stored in the database server. Furthermore, the system processes incoming data from various pressure mater node locations to the database server. A collection of several sensor nodes installed in the water source pipe and the system processes data and displays the dashboard. With this process the system can monitor the water pressure in the pipes from sources in real time from the monitoring head office. The system block diagram is built as shown in Figure 1.

Figure 1. Bloc Diagram of Water Pressure Data Recording System on Pipes Based On The IoT Networking



Smart connected devices, in this study the integration of several sensors that are used for monitoring in real time are pressure gauge sensors, water level sensors and flow rate sensors. Each sensor is connected and processed using the NodeMCU ESP8622. The NodeMCU ESP8266 wifi module serves as internet connectivity to embedded applications. In this case, the TCP/UDP communication protocol is used to connect to the server/client. Read the water pressure in the water reservoir pipe online using a pressure gauge sensor. The sensor used has a measuring power of 0-12 bar. Meanwhile, to read the water level in real time in the reservoir, a water level sensor is used. Then to measure the water discharge in real time, the Sensor e ultrasonic flowmeter is used. Each sensor records in real time.

Data aggregation and analytics with Thingspeak, the collection of some of the data sent by each sensor is accommodated and then processed at thingspeak. The thingspeak module is used to process the data that has been sent so that later it can be analyzed for the purposes of monitoring water pressure, water level in the reservoir and available water discharge. The data read by each sensor will be sent to the data processor at Nodemcu ESP8622 and then sent to the cloud/server using the 4G wifi network. The system that is built will read the data set sent to Claud and stored on the database server. Furthermore, the system processes incoming data from various pressure mater node locations to the database server. Collection of several sensor nodes that are installed on the pipes in the water source and the system processes data and displays on the dashboard. With this process, the system can monitor the water pressure in the pipes from sources in real time from the central monitoring office.

Algorithm development sensor analytics, building algorithms and coding for data analysis of water pressure, flow rate and water discharge that has been recorded from every connected sensor in NodeMCU using codes of C++. Finally display the results of the analysis in ThingSpeak. This algorithm is built on the server and displayed on the dashboard system. The data displayed is the movement of water pressure, water volume and height in real time. This analysis is needed to determine in real time the condition of the water supply in the reservoir. Accurate information will assist the management in serving customers, controlling and monitoring supplies, and water adequacy. In addition, the results of the analysis can be used as.

System Implementation, the implementation of the proposed method can be divided into two main parts: hardware and software implementation. The hardware includes a microcontroller, water pressure sensor, water level sensor, water discharge sensor and wifi. The NodeMCU microcontroller processes the data captured by the sensor and then sends the data to the ThingSpeak Platform using the 4G wifi network. Hardware components that have been assembled into a hardware system offered. Basically, hardware is programmed using NodeMCU software, writing code and uploading it to NodeMCU. Meanwhile the software part is the development of the C++ algorithm on NodeMCU for reading and recording data from each sensor that is processed by the NodeMCU ESP8622. Delivery of the collected data obtained from the sensor section is uploaded to the database online via the Thingspeak platform using the 4G network to be stored in the cloud. In addition, algorithm development was also carried out on the dashboard system side with Python language to display processing and analysis results in the form of line graphs.

RESULTS

In this section, the results of the performance of the development of a system built to monitor water pressure based on the internet of things are presented. The pressure sensor attached to the pipe works well in recording pressure data which is then uploaded to the cloud via GPRS. DWM sensors Monitoring water pressure in real time based on Internet of Things and Thingspeak technology in pipes using several sensor readers can work well. This is proven by the sensor embedded in NodeMCU which can be read by NodeMCU ESP8622. The reading results are then processed by Nodemcu ESP8622 and continued to the cloud using the 4G network. Data is processed with ThingSpeak then the results of data processing are translated by software on a computer and the results are presented in tabular form (Table 1) data and graphics. Then the data is stored in the data server, or the data is directly processed and the results are displayed on the monitoring system dashboard. The result of the system offered is the output curve generated by ThingSpeak for monitoring purposes. Several curves are used to monitor water conditions such as pressure, volume, and water level in the reservoir at different places and on different days. The data used was taken during monitoring in September and October 2022.

In this section, one sample node is taken from several DWM nodes, namely PDAM Binangun District, Blitar Regency. Data collection was carried out on September 20, 2022, from 00:09:14 to 23:54:14 with a total of 77 data records. Record data by the pressure sensor as shown in Table 1. It is recorded when the data is recorded and the pressure that occurs in real time. The result is that the system can record flawlessly for 24 hours. The system built can display data processing in graphical form which makes it easy to understand field conditions in real time. This section also shows a graphical visualization for the minimum pressure is 1 bar, the maximum pressure ranges from 8-9 bar and the average is 4-6 bar. The monitoring results are presented from 00:09:14 to 00:09:15. The graph (Figure 1) shows that recorded pressure ranged above 8 bar steadily and decreased to near 0 bar at 11:24:14-11:39:14 and again approached 10 bar at 12:24:14 -17:09:14. The pressure returned to nearly 0 before 18.00 WIB until 05.24.14 the next day. Overall, the water pressure recording system in pipes based on the internet of things built can work to record data, send it to the cloud, analyze and display it on a monitor.

Table 1. Water pipe pressure data in September.

Rec	Time	Pressure	Rec	Time	Pressure
1	00:09:14	0,19	40	12:39:14	8,68
2	00:24:14	0,12	41	13:24:16	7,67
3	00:39:16	0,20	42	13:39:14	7,22
4	00:54:14	0,14	43	13:54:14	7,26
5	01:09:14	0,19	44	14:09:14	7,47
6	01:24:14	0,12	45	14:24:14	7,53
7	01:54:15	0,13	46	14:39:14	7,19
8	02:09:14	0,24	47	14:54:14	8,13
9	02:24:14	0,15	48	15:09:14	8,19
10	02:39:14	0,16	49	15:24:14	8,3
11	02:54:14	0,08	50	16:24:14	7,67
12	03:09:14	0,13	51	16:39:14	7,22
13	03:24:14	0,13	52	16:54:14	7,74
14	03:39:14	0,15	53	17:09:14	7,64
15	03:54:14	0,14	54	17:24:14	0,13
16	04:09:14	0,13	55	17:39:14	0,20
17	04:24:14	0,18	56	17:54:14	0,21
18	04:39:14	0,24	57	18:09:14	0,11
19	04:54:15	0,20	58	18:24:14	0,15
20	05:09:14	12,92	59	18:39:14	0,17
21	05:24:15	8,72	60	18:54:14	0,19
22	05:39:15	8,51	61	19:09:14	0,22
23	05:54:15	8,51	62	19:24:14	0,18
24	06:09:15	8,16	63	19:39:14	0,20
25	06:24:14	7,85	64	19:54:14	0,14
26	06:39:14	7,64	65	20:09:14	0,15
27	06:54:14	7,67	66	21:09:14	0,12
28	07:09:14	7,57	67	21:24:14	0,13
29	07:24:14	7,99	68	21:39:14	0,1
30	07:39:14	8,09	69	21:54:14	0,06
31	07:54:14	7,92	70	22:09:14	0,12

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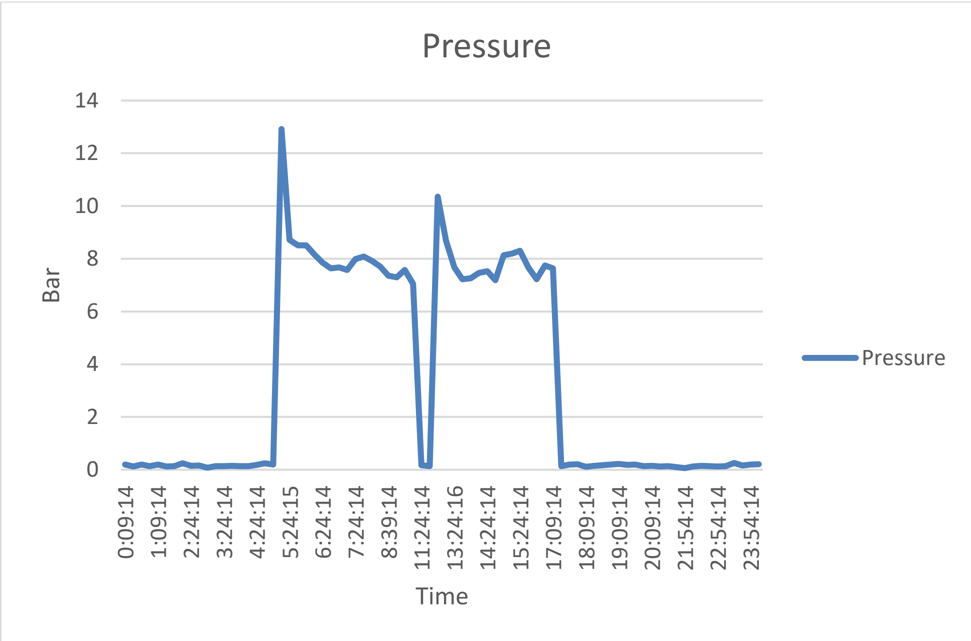
Rec	Time	Pressure	Rec	Time	Pressure
32	08:09:14	7,71	71	22:24:14	0,15
33	08:39:14	7,36	72	22:39:14	0,13
34	08:54:14	7,29	73	22:54:14	0,12
35	09:54:14	7,57	74	23:09:14	0,14
36	10:39:15	7,05	75	23:24:14	0,25
37	11:24:14	0,17	76	23:39:14	0,16
38	11:39:14	0,13	77	23:54:14	0,19
39	12:24:14	10,35	78	00:09:15	0,21

In this section, one of the monitoring results is presented in graphical form from 00:09:14 to 23:54:14. as shown in Figure 2. The graph shows that the recorded pressure ranged from above 8 bar stably from 04:24:14 to 10:00:00 and decreased to close to 0 bar from 11:24:14 to 11:39:14 and again approaching another 10 bars at 12:24:14 -17:09:14. The pressure returned to near 0 before 18.00 WIB. until 05:24:14 the next day. The graph that forms this basin occurs when the water pump is turned off so that no pressure is recorded in the system. This graphic display can answer management needs to monitor water usage by customers in real time. This graphical visual becomes input to the management that users use water around 04:00:00 to 17:09:14 hours. Meanwhile, at certain hours, the number of customers accessing water is relatively small. Meanwhile, at 18:00:00 to 23:54:00 the use of water is relatively small, close to 0.

Figure 2. DWM IoT pressure monitoring graph



DISCUSSION

The water pressure recording system in the pipe using a data reader sensor can work well. Recording is done. This is evidenced by the sensor being able to send data to NodeMCU8622. The reading results are then processed by NodeMCU and continued to the cloud using GPRS. Then the data is stored on the data server, or the data is directly processed, and the results (Table 1) are displayed on the dashboard monitoring system in graphical form (Figure 1). These results prove that the sensor data records data as well as the registrar, but the advantages of the sensor in recording are timely and precise without manipulation. Meanwhile sending data to the cloud from sensors via GPRS along with NodeMCU8622 is also running as expected. Likewise, the software that is built to be able to display tables and graphics on the monitor in real time runs according to design. The ability of this system to answer the problems that have been presented in the introduction regarding the need for equipment that can monitor the pressure of the supplying water in the reservoir pipe in real time can be fulfilled.

Next, a graph of real data processing is presented according to the conditions at the location. In Figure 1 the curve starts from a flat position at a pressure of around 8 bar then decreases to near 0 bar and rises again at 8 bar. This anomaly can be explained as follows: The curve at position 0 bar is when the pump is off so there is no pressure, or the pressure becomes 0 bar. So that the display on the system dashboard monitor shows a pressure anomaly that is in the 0-bar position compared to the conditions before and after. However, when the pump is on, the system displays the amount of water pressure that occurs. The curve showing 0 bar is important information for management. With information like this, it appears that there has been a loss of pressure so that action can be taken as soon as possible. This is a positive impact of implementing DWM IoT technology which can record pressure data in real time.

In addition to this information, based on this data, information is obtained about customer behavior in using water during community activity hours. Meanwhile, the highest usage was recorded at 12.92 bars at 05:09:14 and at 12:24:14 at 10.35 bars. The information anomaly was found at 11 - 12 o'clock, i.e., the pressure was close to 0 bar. The facts show that if the pressure is close to 0 bar, it means that customer activity is low, or the customer does not have access to water. This correlation shows that around 11.00-12.00 most customers do not access PDAM water.

CONCLUSION

The implementation of DWM IoT technology is able to monitor pressure in several PDAM nodes by recording data and sending it to the server via the GPRS module. The system is able to display pressure data in graphical form on the DWM IoT dashboard. DWM IoT technology can produce information in real time so that monitoring becomes more efficient than the previous process which was carried out by scheduled monitoring by officers.

The implementation of DWM IoT technology is able to monitor customer behavior, especially regarding information on water usage at certain times, namely between 05:00 and 17:00. Peak usage per day and low water usage can be detected in real time which is very useful for PDAM management.

The implementation of DWM IoT technology is able to streamline the resources of control officers who usually carry out conventional checks at locations replaced by monitoring systems in real time.

This research can be developed further on pipe leak detection in real time based on the internet of things to facilitate equipment damage control and minimize delays in damage information and minimize losses due to water leaks.

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DECLARATION OF CONFLICTING INTERESTS

The authors involved in this article have no conflict of interest in the articles presented. Likewise, we do not write part or all this article which is being or has been submitted to other seminars or journals.

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