Mobile application design of smart water supply chain based on IoT: A case study in Indonesia

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Abstract. Some areas in Indonesia often lack clean water even occur drought if the dry season strikes. However, several other regions of Indonesia have pure water abundance despite the dry season. Based on this problem, the authors aimed to design a mobile application of a smart water supply chain based on the Internet of Things (IoT) for admin and users. The app was Control Your Water (C_Water) application. The app developed aimed not only to detect water shortage quickly but also to accommodate online water purchasing. By installing sensors in the water reservoirs, the admin could find out the supply of clean water in the tanks. Information obtained from the sensor will go to Microcontroller, then the Microcontroller will send it to the database via Wifi. The mobile application displayed information based on data in the database. The authors proposed a data backup process to prevent data loss. The authors designed a water reservoir consisting of positions of ultrasonic sensors and a division of water level. The result of this research finds that this design helps the government (admin) to overcome the problem of real water shortages that occur in Indonesia.

Keywords: mobile application, smart water supply chain, IoT

1. Introduction

Water is one of the primary needs in daily life [1]. Many human activities require water, such as washing, cooking, drinking, and others [2]. In carrying out the events, we need clean water. At the same time, the need for clean water in the world is increasingly scarce [3], [4]. The scarcity of clean water is increasingly felt when the dry season comes. The problem becomes a challenge for the government to pay attention to the availability of clean water for the region, especially if approaching the dry season. The scarcity of clean water in regional areas can also occur due to the absence of a system used to monitor the availability of clean water itself.

Many ways to overcome the problem of scarcity of clean water, one of them is by utilizing technological advances. The rapid development of technology such as sensors, Microcontroller (Arduino), cloud, and mobile applications is an important capital to help facilitate human activities in everyday life. These activities include: contacting aquaponics through a mobile app [5], controlling plants with a mobile application for parents [6], design mobile application for increase the visitor museum [7], automatically managing rice fields [8], monitoring in agriculture [9], measuring water quality [10], or regulating use water to prevent scarcity [11], manage the system in campus [12] and many others. Besides, by linking the technologies above can produce a system to reduce the scarcity of...
clean water based on IoT [1]. Using sensors, we can find out information on the availability of clean water or lack of clean water in regional areas. Then by using Microcontroller, we can control the sensor. Cloud functions to store data from Microcontroller [13]. Meanwhile, it retrieves and displays data from the cloud using a mobile application [14] or website [3]. The design of a mobile application is an important thing before making a mobile application to display data. For example, research of the mobile application design for a museum aims to increase museum visitors through gamification methods [7].

A case study on a clean water supply monitoring system was carried out in Indonesia. Indonesia often lacks clean water moreover drought if the dry season comes. However, not all areas in Indonesia experience a shortage of clean water when the dry season comes. Several areas in Indonesia still have plenty of clean water, even in abundance in the dry season. Clean water shortages in Indonesia often occur because no system monitors the supply of clean water in the reservoirs of each region and the local government's difficulty in finding out which areas are currently experiencing shortages of clean water or which areas have spilled clean water.

Based on the case study above, the scenario that the authors propose is to install sensors in the reservoirs of each region. With this sensor installed, we can get information about the supply of clean water in an area. Here we use ultrasonic sensors [14]. Then we use Microcontroller to control the sensor [3]. Then the information from the sensor will be stored on the Firebase system. Firebase system is a NoSQL database that functions to store information from sensors. Then C_Water, as a mobile application, is used to display information from sensors by accessing the database [15]. The mobile app not only provides information about water but also helps the government provide clean water in areas that lack clean water based on the nearest location with sufficient clean water supply. The reason the authors chose these technologies is that they are easy to obtain, and the prices are quite affordable. The novelty of this paper, the C_Water developed aims not only to detect water shortage quickly but also to accommodate online water purchasing. By connecting the above technologies, we can produce a mobile application used to control the IoT-based clean water supply. The authors hope a design application can be implemented to help the local government take action for areas with potential shortages of clean water based on information obtained from C_Water. That way, it can overcome the problem of lack of clean water moreover drought that occurs in certain areas in Indonesia.

2. Literature review
In this review, the literature discusses several studies related to IoT based smart water. Ritonga and Jati's research, entitled "Automatic Arowana Raiser Controller Using Mobile Application Based on Android," discuss IoT, cloud, and mobile applications to automatically control and feed Arowana through mobile apps. The sensor used is an ultrasonic sensor and a DS18B20 temperature sensor. Then also use a four-way relay and servo motor and webcam. All of the above tools can be connected and produce a system that is AURORA. AURORA uses cloud geekiness to control all devices. Then displayed via a mobile application [13].

Kalochristianakis et all, in a study entitled "HOLISTIC: an IoT System for Resident Water Recycling Based on Open Source Technologies," designs and implements IoT for the process of recycling water in housing. In its development also uses sensors and to control these sensors using Arduino Nano Atmega and using Raspberry for a mini server system to store data and display it via a web application [16]. Gupta Aditya et all, in a paper entitled "Need of Smart Water Systems in India," explains the use of ever-increasing sensors and water Information and Communication Technology (ICT) to prevent water shortages that occur in India in the future. Preventing water scarcity in the future in India, the authors create a Smart Water System to reduce wasteful water use and reduce water use in agriculture [4].

Sokratis Kartakis et all, in a paper entitled "WaterBox: A Tested for Monitoring and Controlling Smart Water Networks" by utilizing sensors, Arduino, and actuators, the authors produce Smart Water to control and monopolize water tanks. Then automatically control the water pump [17]. In Nardo et all, developed a method, namely Water Networking Partitioning (WNP) and software, namely: SWANP (Smart Water Network Partitioning) to prevent leakage and improve water quality [18].
Then in a study conducted by Priyen P. Shah at all, entitled "IoT based Smart Water Tanks with Android Application," aims to monitor water levels in the reservoir using IoT and mobile applications. In this paper, the authors integrate sensors, firebase, and Arduino and produce a mobile app to monitor the water level in the reservoir. In this paper, ultrasonic sensors are used to capture information about water levels. Then this information is saved to firebase, which acts as a database. The mobile application then displays information by accessing its database [1] — research conducted by Malche and Maheshwary, also monitoring the level of water in tanks. The monitoring process also uses Arduino and sensors and databases. However, the results of the monitoring are displayed on the web. In this paper not only design but also implement the design results [19].

A study conducted by Mazharul Islam Nayeem and Mahfida Amjad, entitled "Water Automation for Water Pump Controllers using Android Application - Review," utilizes a mobile application to control the water pump, which is to turn on or turn off the water pump. Besides, through the mobile application, it can also detect water levels and water leaks [20]. A study conducted by Pareena Jariyayothin et all, in a paper entitled "IoT Backyard: Smart Watering Control System," utilizes IoT and a mobile application to automatically water plants in their yards. This paper was utilizing two sensors, namely the Moisture sensor (YL-69) and the Ultrasonic sensor (HR-SR04). Moisture sensor (YL-69) is used in measuring soil slope. Moreover, to measure the water level using an Ultrasonic sensor (HR-SR04), Arduino is used to control the two sensors. In this paper, it is using the NoSQL database to store information from the two sensors above. Then the mobile application to display information by accessing its database [14].

Then the research conducted by Krishna Kanth entitled "An Effective Water Quality and Level Monitoring System using Wireless Sensors through IoT Environment" utilizing IoT developments to measure water quality and monopolize water levels. In this study, three sensors are used: a Gas sensor to measure acidity, Temperature sensor to measure temperature, and a Turbidity sensor to measure water level. This paper will display information obtained from sensors using the web using wireless networks [2]. Research conducted by Norang Aphiratsakun in a paper entitled "AU Water Level Process Control System" utilizes the development of IoT and mobile applications to control the water level. It can also control water pumps through a mobile application. In this paper, the MPX2010DP Motorola sensor is used to control the water level in the reservoir. Also, this paper uses amplifiers to store information from the sensor. Then the mobile application will display the water level by accessing the amplifier [21].

3. Proposed method
At the first opportunity, the authors explain the architecture of the proposed system. The architecture can be seen in Figure 1.
Figure 1 shows that the tools needed are sensors, Microcontroller, internet, database, and mobile applications. The sensor required is an ultrasonic sensor. Before the authors explain the architecture of a mobile app, the authors first explain the architecture of the proposed system in Figure 1. The water reservoir in each area will be installed ultrasonic sensors. Then the ultrasonic sensor will read and convey information about the state of the water reservoir. The information will be forwarded to the internet using WiFi. Data will be saved to the database and backed up. After the data is stored in the database, the mobile application will access it easily. Then display data information on each water reservoir through a mobile application called C_Water. Before users use the C_Water application, several steps must be done first, as follows:

- After the user and admin download the C_Water application, the next step is for the user and admin to log in. The login process is done by inputting a username and password. User and admin who do not yet have a username and password will do the registration stage first.
- The registration process is divided into two, namely the registration process for the admin and the registration process for the user. In the admin registration process, the admin enters the full name, email, username, password, and submit other requirements, such as already having a water reservoir that has been installed with an ultrasonic sensor. If the admin does not have a water reservoir installed by the sensor, the official can install it. After the submission process is successful and the admin receives a notification in the email stating the registration process was successful, the registration process for the admin was finished. Subsequently, the registration process for the user. Users need to fill in the fields for name, email, password, username. Then the user receives a notification in an email stating the registration process was successful, then the registration process for the user has finished.
- After the registration process completes, it will return to the login screen, requiring the user to log in with the username and password attribute. If the login process is successful, the user will get information about the state of the clean water.
4. Results and discussion

4.1. Water reservoir design

The authors make a water reservoir design in Figure 2. The officers implant an ultrasonic sensor in the water reservoir.

![Figure 2. Water Reservoir Design](image)

In Figure 2, the authors divide the water reservoir into five levels. Level 1 if the water in the water tank is the same or less than 2000 L. Level 2 if the water in the water reservoir is the same or less than 4000 L. Level 3 if the water in the water reservoir is the same or less than 6000 L. Level 4 if the water in the water reservoir is the same or less than 8000 L. Level 5 if the water in the water reservoir is the same or less than 10000 L. The ultrasonic sensor will read information about the water level according to its level and the information through Microcontroller will be sent to the database through the internet. The information will be display on the mobile application.

4.2. Design of C_Water application

Admin and users who have successfully registered and logged in will then enter the home page of the C_Water application. This can be seen in Figure 3 for admin and in Figure 4 for users. Figure 3 shows the display for admin after doing the registration process.
Figure 3, C_Water Application of Admin

Figure 3 section a, shows the main view. In the main view, there are three parts, namely Home, Income, and Settings. When the admin presses the Home button, a new page appears showing the Home view; this view can be seen in Figure 3 section b. Where on the Home screen, there are six pieces of information, namely the location of the admin, the name of the water reservoir, the price of water level per liter in the water reservoir, the value of water, and the on or off button. In the location section of the admin, it will be displayed automatically by Google Maps. Then for the name of the water reservoir, the admin gives his name and the price of water per liter. Here the cost of water per liter is IDR 4,000.00. Then there is the price of a trip where one kilometer is charged IDR 2,000.00. Then for the water level and the displayed water value is the information sent by the sensor through Microcontroller to the database. Then the mobile application displays information from the database. Finally, there is a button off and on, where the switch off or on is useful for receiving user orders or not. If the admin has an off button, the admin cannot accept user orders. Moreover, vice versa, if the admin select a button on the admin, it can accept user orders.

Then when the admin presses the Settings button, a new page will appear that shows the Settings view, this view can be seen in Figure 3 section c. In this section, the admin can change the name of the water reservoir and change the price of clean water per liter. On this page, there is also a logout button, which can be used by the admin if you want to exit the application. Then when the admin presses the Income button, a new page will appear showing the Income view, this view can be seen in Figure 3 section d. Where in this section, there are four pieces of information, namely, the location of the customer, the amount of clean water ordered, and the method of payment. At the location of the reservation, it will be displayed automatically by Google Maps based on the customer's location. The amount of clean water ordered comes from the request of the customer, and then the total price to be paid automatically appears. There is only one payment method, cash. On this page, there are also two
buttons, namely, accept and reject. If the admin presses the reject button, the admin cannot fulfill the user's request. However, if the admin presses the accept button, a dialog box will appear, asking if you are ready to go? As in Figure 3, part e. If the user presses the no button, then the admin cancels the user's order. However, if the user presses the Yes button, maps will appear to go to the order location, as shown in Figure 3 section f. This map shows information about the time required and the distance to the customer. In this example, the user orders 3 Liters, then the total price to be paid is (3 Liters X IDR 4,000.00) + (3 km X IDR 2,000.00) = IDR18,000.00.

Figure 4 shows the display for the user after the registration process.

Figure 4 section a, shows the main display. In the main view, there are three parts, namely Home, List, and Settings. When the admin presses the Home button, a new page appears showing the Home view; this view can be seen in Figure 4 section b. On the home display, there are four information, namely the user's photo, user name, user email address, and location of the user. In the location section of the user, it is automatically displayed by Google Maps. Then for the user's photo, the user's name and email address will be displayed based on what the user has entered. Then when the user presses the Settings button, a new page will appear that shows the Settings view, this view can be seen in Figure 4 section c. In this section, the user can change the attributes on the settings page, namely name, email address, username, and password. On this page, there is also a logout and save button. Users use the LogOut button if they want to exit the application and the Save button to save changes.

Then when the admin presses the List button, a new page will appear that shows the List view, this view can be seen in Figure 4 section d. Where in this section displays information about the list of names of water reservoirs. The names of registered water reservoirs will be displayed in this section. Users see a list of names of water reservoirs based on the closest location of the user, sorted from top to bottom. The further down the further the user is and the more expensive the price per liter. Then if the user
chooses one of the water reservoir names, the information will appear as shown in Figure 4 section e. Where will display four information, namely water level, water value, the price per liter, and the number of columns the user wants to order. The mobile application displays information on the water level, water value, and cost per liter based on data obtained from the database. Then the user enters the amount to be ordered. After that, if the user set seventh and pressed the order button, a new page will appear that shows the order confirmation display as shown in Figure 4 section f. Where the order confirmation page will display information on the amount ordered and the total price to be paid by the user. Then if the user is set seventh and presses the Yes button, a new page will appear that displays maps, as shown in Figure 4 section g. In picture 4 part g, the user can see the distance from the delivery location and the time required by the admin to deliver the order. Users can also monitor trips made by the admin directly.

The authors contributed to the form of two designs: design of a water reservoir and mobile application design. Where in the water reservoir design, there is an ultrasonic sensor to find out water level information. Then to display the water level information, the author uses a mobile application design. Besides that, the author also contributed to monitoring the water reservoir based on IoT using a mobile application.

5. Conclusion
The problem of lack of clean water is still common in Indonesia. Overcoming the problem of lack of clean water, the authors propose to use a combination of IoT and mobile applications. Ultrasonic sensors take information about the state of clean water in the water reservoir and then forwarded it to the microcontroller. The microcontroller sends information about the state of clean water to the database so that mobile applications can access and display the data. Through mobile application (C_Water), the admin and user can quickly find the availability of clean water. The app developed aims not only to detect water shortage quickly but also to accommodate online water purchasing. The authors also produced a mobile application design based on IoT, which can help the government to overcome the problem of lack of clean water that often occurs in Indonesia. The authors hope that future research can combine with automatic water pumps. The admin can turn on and turn off the water pump through a smartphone. The author also hopes that future research can implement this idea to help the community obtain clean water.

Acknowledgment
Authors expressed their appreciation for financial support from the Master of Informatics Engineering Study Program, Postgraduate, Universitas Atma Jaya Yogyakarta. Thank you to all those who have supported this research.

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