Android-Based Monitoring and Meter Recording Applications

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Abstract. It is difficult for the people of Dlimas Tegalrejo village to find out information on drinking water bills and payment due dates. They have to wait for the presence of Pamsimas officers to find out this information. Water customers also cannot access billing and payment data in real time. This study aims to produce an application system for monitoring and recording metering in the village of Dlimas, Tegalrejo using a QR code with a mobile-based application. This system will be designed using the prototyping method, database design using ERD, and application design using UML. This application is built using Firebase services to produce Android-based applications. This research produces an Android-based application with three access rights, namely officer, admin and customer. Officers can send customer data meter numbers with the QR code scan feature. The admin is in charge of inputting customer meter data. Customers can view data on drinking water bills in real time. This study produced several algorithms in mobile programming, namely water payment calculations, late payment calculations, fine calculations, tariff and price data, and total payment calculations. The designed system can complete the work in 23.34 seconds or four times faster than the previous process.

1 Introduction

Community-based provision of drinking water and sanitation (Pamsimas) is a government program to fulfill and increase the population's access to proper clean water and sanitation facilities, especially for suburban and rural communities. This program has been started since 2008 and has succeeded in increasing the number of accesses to drinking water and sanitation services for the poor, rural and suburban residents, as well as increasing the values and behavior of clean and healthy living in around 12,000 villages spread across 233 districts and cities, including the village of Dlimas, Tegalrejo sub-district [1,2].

Pamsimas Dlimas currently does not have an information system that can handle customer data processing. Officers process customer data computerized using the Microsoft Excel application program. Customers must wait for the officer to come when

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billing for water payments to find out billing information and payment due dates. It is not optimal for data processing. Officers who carry out the process of recording customer meter stands are still not efficient. The meter stand recording officer must go to each customer’s house and take a photo of the customer's meter. The officer sent the photo using the Whatsapp application to the managerial officer. Managerial officers process the value of the stand meter using Microsoft Excel [3].

Officers who provide services to customers are inefficient due to the lack of utilization of information technology. Utilization of information systems within the organization is one of the keys to improving organizational performance. The decision to invest in information technology is an important matter, and is expected to improve overall organizational performance [4].

PDAM Tirta Benteng Kota Tangerang has applied the use of information systems in research. This research designed and built a web-based application system to register new customers, search customer data, check billing info, pay, and generate reports. The system built is proven to increase efficiency in the service process, because customers do not have to go to the PDAM head office to access this information [5]. The weakness of this research is that the system has not been able to process the customer's water usage meter recording process, so to obtain the amount of water usage each month the customer must look for information outside the system.

In other cases, there are other studies that apply customer service information systems in PDAM Grobogan Regency. This research designed and built a web-based public service information system, for registering new connections, submitting complaints, checking billing info, recording customer meters, and generating reports [6]. The weakness of this research is that the meter recorder must input based on the customer ID number in the meter stand inputting process. This becomes inefficient if there is a lot of customer data that is inputted into the system.

Santoso, et al (2020) conducted research by building an Android-based PDAM Denpasar Customer Information System (Singgan). This research builds a system with several features, namely managing new customer registration, customer surveys, account checking, meter stand reports and customer complaints [7]. The weakness of this research is that it has not discussed the process of recording customer water meter stands, and the calculation of payment fines if customers are late paying water bills.

Based on the background of these problems, it is necessary to have an application system for monitoring and recording customer meters at Pamsimas in Dlimas village based on a mobile application [8]. There is something that has not been explored by previous researchers, namely the use of a QR code to assist the process of recording a stand meter. This is necessary so that officers do not need to type in the meter number and customer name [9].

This research produces an Android-based application with three access rights, namely officer, admin and customer. Officers can send customer data meter numbers with the QR code scan feature. Admin is the person in charge of inputting customer meter data. Customers can view data on drinking water bills in real time. The application system that will be built functions for data management, meter recording to billing processing so that the data collection and processing process becomes more efficient. Pamsimas customers
can monitor water bills every month in real time. With this application, it can reduce the risk of errors, improve the quality of work in providing services to the community.

2 Method

The system development method used in this study is the prototyping method. The prototyping method is a system development technique that uses a prototype or initial model as an example to describe the system. This technique is often used when the system owner does not know the system to be developed. In the development of information systems, prototyping is often manifested in the form of a user interface and reporting examples [10].

There are several stages of research conducted to design and build an application system for monitoring and recording meters. The initial stage of research is data collection. There are two stages of data collection in this study, namely observation and interview. At the observation stage, the researcher directly observed the processes carried out by Pamsimas officers in Dlimas village, namely recording customer meters, data processing, making billing reports, customer payment bills, and customer meter conditions. At the interview stage, the researcher conducted a questions and answers session with Pamsimas officers and customers. Researchers conducted interviews with officers to find out the price of water, fines and other determined rates, as well as workflow starting from recording customer meters, managing data, making invoices and collecting customer payments. Interviews were conducted with customers to find out how the payment process is carried out, and how to monitor water usage bills.

At the system analysis stage, the current meter recording process is as follows. The officer takes a photo of the meter then sends it using the WhatsApp application to the admin. The admin inputs the information contained in the photo into Microsoft Excel to calculate how much the bill must be paid. Admin prints customer's water bill. The clerk sends the bill to each customer's home.

2.1 Building prototype

At this stage the author makes a prototype or initial model which is an example to describe the system in general. The resulting prototype is in the form of user interface interactions and examples of customer billing receipts. This research using the Adobe XD application program to create user interface prototype. In Fig. 1(a) the officer scans the QR on the customer’s meter. The application system will ask for input on the amount of usage of the stand meter, payment limit and photo of the stand meter as proof to be uploaded to firebase storage. Fig. 1(b) displays the main page when the application system user is logged in as an admin. Fig. 1(c) shows the tariff and price data determined by Pamsimas. Fig. 1(d) shows a simulated total payout calculator.
Fig. 1. Image of some of the prototype page: (a) Prototype of the stand meter recording page; (b) Admin main page prototype; (c) Prototype of the tariff and price page; (d) Tariff simulation page prototype

2.2 Refining prototype

At the refining prototype stage, the researcher adjusted the prototype based on input from various parties. In Fig. 2(a) the officer scans the QR code on the customer's meter. The system will display the meter owner's data and ask for a photo of the meter stand and then upload it to firebase storage. At the building prototype stage, the system has not been able to scan the QR code. Fig. 2(b) is the main admin menu display. At this stage there is an adjustment, namely the Stand Meter feature on the admin menu. The admin can input the meter stand number based on the photo of the meter stand that has been taken by the officer. Fig. 2(c) is the admin process for inputting stand meter data. This page displays all customer stand meter lists in the database. At the building prototype stage, the officer responsible for inputting the stand meter data. Fig. 2(d) will appear after the admin selects the stand meter to be inputted from the stand meter list in the previous image. On this page the application will display a photo of the stand meter number then ask the admin to input the meter stand number based on the photo from the officer. The admin must also input the limit for paying bills.

Fig. 2. Image of several refining prototype pages: (a) Refining of the QR code scanned page prototype; (b) Refining of the officer's main page prototype; (c) Refining of the prototype of the stand meter list page; (d) Refining of the prototype input page for the use of a stand meter
2.3 System planning

This research uses Entity Relationship Diagram (ERD) to model the database. ERD describes entities and relationships between entities in abstract [10]. This study uses six entities to describe database modeling, namely admin, clerk, customer, billing, stand_meter, and rates. Each entity has its own relationship as shown in the Fig. 3(a). In object-oriented modeling, all models are described using the Unified Modeling Language [11]. The Use Case diagram in this study uses three actors, namely Officers, Customers, and Admin. Each actor has a function as shown in Fig. 3(b). Admin has several features, namely stand meters for recording stand meters, adding customers, adding officers, tariff and fee menus to view and change applicable rates and prices, tariff simulation menu to simulate total bill payments. Officers has several features, namely a QR scan to scan the customer’s meter meter QR code, a billing menu to confirm customer bills, a tariff and fee menu to view applicable rates and prices, a tariff simulation menu to simulate total bill payments. Customers have several features, namely bill monitoring to display the customer’s latest billing data, history menu to display all previous customer billing records, tariffs and fees menu to view applicable rates and prices, tariff simulation menu to simulate total bill payments.

Fig. 3. Image of several System planning pages: (a) Entity relationship diagram (ERD); (b) Use case diagram system

3 Results and discussion

3.1 Application results

The results of this study are the design of a meter monitoring and recording application system using an Android-based QR code. There are three types of users with different access rights, namely admin, officers, and customers. Fig. 4(a) shows the view with officer access rights. The process of recording a stand meter starts with the meter recording
officer scanning the QR code found on the customer’s meter. The QR code contains the user id number, the application system will display the meter owner's customer information. Fig. 4(b) is a display of the QR Code scanning process. Fig. 4(c) shows the customer data of the meter owner scanned by the QR Code. The application system will ask the officer to take a photo of the meter stand number. Fig. 4(d) shows the photo process of the customer's stand meter number taken by the officer. When the user presses the "Save" button, the application system will create a new collection in the Firebase Firestore database, namely the StandMeter collection. After the StandMeter collection has been successfully created, the application system then uploads the photo of the stand meter to firebase storage. Fig. 4(e) shows the preview before the application system saves data to Firebase.

Fig. 4. Image of multiple pages with Officer access rights: (a) Officer dashboard page; (b) Officer main page; (c) Customer data page; (d) Photo stand meter process page; (e) Display of stand meter

The admin inputs the meter stand number according to the meter stand photo number listed on the application system. Admin input the payment limit or payment due date. The stand meter record page can be seen in Fig. 5(a). The system will carry out the process of taking this month’s stand meter id and last month’s stand meter id to calculate usage. The clerk carries out the invoice confirmation process by selecting a customer bill from a list of unconfirmed bills. The billing list is sorted by confirmation status. Bills that have not been confirmed will be in the top sequence, it's shown in Fig. 5(b). The system will calculate the cost of paying for water, late payments, fines, and total payments. After the customer pays according to the total payment that appears on the system. The clerk will confirm to complete the payment from the customer. The system displays details of the customer's last bill in real time, it is shown in Fig. 5(c). The system displays rates and fees which are determined by Pamsimas Dlimas. Fig. 5(d) displays this rates and fees. They are price per cubic meter of water, monthly fines, monthly maintenance costs, minimum bills for household groups, and minimum bills for business groups. Rates and fees page is accessible to all types of users but only admins can change it. Tariff simulation page in Fig. 5(e) displays the tariff simulation calculator. The system will ask for several inputs,
namely water usage (cubic millimeters), fines (days), and type of customer group (household or business). The system will calculate rates based on user input.

![Image of multiple pages with Admin and Customer privileges](image)

**Fig. 5.** Image of multiple pages with Admin and Customer privileges (a) Stand meter record page; (b) Billing list page; (c) Customer billing monitoring; (d) Tariffs and fees; (e) Tariff simulation page

### 3.2 Discussion

Stand meter usage is the value or amount per cubic meter of customer's water usage in one month. The amount of use of the stand meter is obtained from the result of this month's stand meter number minus the last month's stand meter number. System uses the script in **Fig. 6** to calculate the usage of a stand meter.

```c
1  int pemakaian = standBulanIni - standBulanLalu;
2
```

**Fig. 6.** Script for usage of a stand meter script

The cost of using water is a fee that must be paid based on the calculation of the use of a stand meter and the price of water per cubic meter determined by Pamsimas Dlimas. Pamsimas Dlimas uses three conditions to determine the cost of water usage. The first condition is the amount of use of the stand meter from 0 to 10 m$^3$. The total cost of using water is obtained from the result of using a stand meter multiplied by the price of water per cubic meter. The second condition is the use of 11 to 20 cubic meters of stand meters. The total cost of using water is obtained from the result of using a stand meter times the price of water per cubic meter plus the amount of water that exceeds m$^3$ times 1000. The third condition is the use of a stand meter of more than 20 m$^3$. The total cost of using water is obtained from the result of using a stand meter times the price of water per cubic meter plus 10,000 plus the amount of water that exceeds 20 m$^3$ times 2,000. **Fig. 7** is the Script for the cost of using water.
Late payment is the number of days of late payment calculated from the payment limit determined by Pamsimas Dlimas. The logic for getting late payments is as follows. The system converts the date format (dd-MM-yyyy) to long milliseconds counting from 01-01-1970 07:00:00. The system calculates the difference between the payment date and the payment limit. The system checks if the difference obtained is smaller than zero or greater. If the difference is less than zero then the late payment is equal to zero. If the difference is greater than zero, then the result of the difference is divided by the number of milliseconds in a day (86400000), so that late payments are obtained in days. **Fig. 8** is the late payment script.

**Fig. 7.** Script for the cost of using water

```java
1  public double getBiayaPencairanAir(int iPemakaian, int iHarga) {
2      double pemakaian = ((double) iPemakaian) / 1000;
3      if (pemakaian > 0 && pemakaian < 10) {
4          return (iHarga * pemakaian);
5      } else if (pemakaian > 10 && pemakaian < 20) {
6          return (iHarga * pemakaian) + ((pemakaian - 10) * 1000);
7      } else {
8          return ((pemakaian * iHarga)) + (100000) + ((pemakaian - 20) * 2000);
9      }
10  }
```

**Fig. 8.** Script for late payment

Fines are additional costs if the late payment results are greater than zero. There are three conditions that affect the amount of the fine. The first condition is that the number of days overdue for payment is less than zero. The number of fines that must be paid is obtained from the results of late multiplied by zero. The second condition is the number of days of late payment of 1 to 30 days. The amount of the fine to be paid is obtained from the result of 1 multiplied by the price of the fine. The third condition is the number of days overdue for payments of more than 30 days. The amount of the fine to be paid is obtained from the late result for 30 plus 1 times the price of the fine. **Fig. 9** is the fine calculation script.

```java
1  public static long getKeterlambatanPencairan(String tanggalBayar, String tanggalTempo) {
2      SimpleDateFormat f = new SimpleDateFormat("dd-MM-yyyy");
3      try {
4          long tglBayar = f.parse(tanggalBayar).getTime();
5          long tglTempo = f.parse(tanggalTempo).getTime();
6          long telat = tglBayar - tglTempo;
7          if (telat < 0) {
8              return 0;
9          } else {
10             return telat / 86400000;
11          }
12      } catch (Exception e) {
13          return 0;
14      }
15  }
```
The total bill payment is the total fee that must be paid by the customer to Pamsimas Dlimas to pay off according to a predetermined bill every month. Total bill payments are affected by water usage fees, maintenance fees, fines, and minimum bills for each class of users.

The method used to perform the test is black box testing. Latif in Hendri et al (2020) argues that black box testing is a method used to test a system without having to pay attention to the details of the system [12]. Testing the use of a stand meter is carried out to see the results of the use of a stand meter based on the current month’s stand meter number and last month’s stand meter number. The Late Payment Test is calculated based on the predetermined payment date and payment limit. Testing fines is carried out to see the number of fines that must be paid based on late payments and the price of fines that have been determined. Testing of total bill payments is carried out to see the total amount of payments that must be paid based on water usage fees, maintenance costs, class, minimum bill class and fines.

This study conducted a speed test to determine the time needed to complete a work process. The work process tested in this speed test includes the process of recording the

Fig. 9. Script for fines

public long getDenda(long keterlambatan, int harga)
{
    if (keterlambatan <= 0)
    {
        return keterlambatan * 0;
    } else if (keterlambatan > 30)
    {
        return ((keterlambatan / 30) + 1) * harga;
    } else {
        return 1*harga;
    }
}
stand meter to produce customer billing details according to the system flow. This research conducts tests under the same conditions, namely using ten random samples of customer data, internet download speeds of 38.1 Mbps and internet upload speeds of 15.9 Mbps. This research uses prior testing, namely testing carried out without using the application system that has been built. Prior testing is also called testing carried out on a running system. This research also uses after-testing, namely testing carried out using the application system that has been built. The average time needed to complete a work process before using the system based on the test results is 96.36 seconds. The average time needed to complete a work process after using the system based on the test results is 23.34 seconds. The time difference between the time required before and after using the system is 73.02 seconds. Thus, the time efficiency achieved after using the built application is 75.78%.

4 Conclusion

Based on the research results, the meter monitoring and recording application system that was built can make it easier for customers to monitor usage data and billing details in real time. Utilization of the QR code in the process of inputting the stand meter can make it easier for officers to record customer stand meters. The application system built can complete the work process in an average of 23.34 seconds, while without using an application system the work process is completed in an average of 96.36 seconds. This shows that the use of application systems can complete work processes four times faster, so as to increase the effectiveness of service performance to customers by 75.78%. There are several suggestions to become material for further research. Subsequent research can add a realtime notification feature so that customers can find out billing information without checking manually in the application. Future research can also implement image processing to read the meter stand number, so officers do not need to input the meter stand number. Another suggestion for future research is to implement a payment gateway in the customer bill payment process, so that officers do not have to go to every customer’s house to do billing.

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References


