Design of Smart Fuel Station and Management System Based on Arduino and Internet of Things

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Abstract—Patrol that is distributed to the public must meet the requirement for the quality, quantity and continuity. Pertamina as one of the companies that is responsible for the distribution of patrol to the public through gas stations and must have competent management and services. However, problems arise in the community and even companies in controlling fuel consumption and queues for sales services at gas stations. One solution is to use a station that is connected to smartphone wirelessly and a cashless.

Through the "Smart Fuel Station and Management System Based on Arduino and Internet Of Things", that will be able to help the community and companies in controlling their fuel consumption and making savings. This monitoring tool uses the Arduino ESP8266 which is combined with Internet of Things (IoT) Technology which is displayed on the LCD and the Internet Web. Customers can purchase the patrol at gas stations independently, by connecting the smartphone application with the gas station wireless and purchase and make payments through the application. By having top up the balance on the application to be able to make purchases as needed and the balance will continue to decrease according to usage. The fuel filling station will issue it according to the nominal or the number of liters we choose in the application. Customers can view detailed fuel purchase for place, date, time, amount and total balance.

Keywords—Consumption Monitoring, Arduino, Internet of Things, E-money, ESP8266.

I. INTRODUCTION

Fuel is one of the vital needs for living things on earth. Fuel is used by humans for various purposes, including fuel for motorized transportation, industry and energy sources. The population growth which is increasingly rapid has made the need for vehicle fuel continues to increase [1]. Gas Station is a public infrastructure provided by PT. Pertamina for distributing fuel needs which should meet the requirement [2].

Based on previous studies using the RFID system [3], there are still some weaknesses which is still using officers for filling and payment transactions, so that there are still queues purchasing, especially during rush hours. In addition, it is common to find several stations that have unavailable officers, so they cannot be used optimally. Another drawback is that there are frequent frauds committed by drivers to get benefits in managing vehicle fuel needs due to the absence of a good management system in terms of automatic, online and integrated, and accurate historical.

Observing in this research, it is necessary to have a transaction system that allows consumers to be able to refuel independently (self-service) and cashless transactions and historical data can be stored into the data base for management system. Fuel consumption monitoring by the community or a company as in other research on monitoring water consumption [4], by using a flow meter sensor Yf-s201 [5] as a sensor for the total volume of distributed fluid [6]. In order to be realized, it is necessary to create a tool that is able to carry out transactions independently and the data which can be applied to the purchase of fuel at gas stations.

In this study, an automatic fuel station will be designed and a fuel purchase management system as a part of online purchase data using...
Arduino [7] and the concept of the Internet of Things (IoT) [8] so that, when making transactions, customers simply enter the gas station, run the application via a Smartphone to control the filling machine. Customers must have sufficient balance in the application to be able to make purchases. By topping up electronic money [9],[10], customers can add to their balance. This balance will decrease according to usage. There is a database to store every transaction in detail that can be seen online through application or internet.

II. METHODS

2.1 Data Collection Methods

Collection data is retrieving data from hardware and software to determine whether the system meet the expectation. The methods used in collecting the data include:
1. Observation, which observing while testing the equipment has been made and measurements for further data analysis. This test includes:
   - Testing (Flow meter, LCD, Keypad, IoT, Relay and Solenoid valve).
   - Transactions simulation that is stored in the database as a management system.
   - Testing the control system on the application and filling balances.
2. Collect documentation of the results which are used as references to provide supporting knowledge.

2.2 Data Analysis Methods

The data analysis method used in this study used descriptive analysis, which is to describe the data according to the test results as follows:
1. A management system for monitoring fuel consumption displayed in a database that can be accessed via an application on a Smartphone and an internet web browser
2. Fuel transactions using the Yf-S201 flow sensor which can be seen through displays, applications on Smartphone or the internet web controlled by Arduino.
3. Control system for pump station machines with Smartphone and top up balance.

III. RESULTS AND DISCUSSION

3.1 System Testing Results
address for access to the smartphone or laptop application.

![IP Address](image)

Figure 3.3 Getting IP Address

d. Testing Relays, Selenoid

This relay works as an ON / OFF switch for the solenoid valve coil. Relay condition will be active when it starts filling until the desired transaction value is reached. The solenoid valve that we use is the NC type, which is without a voltage, the valve will be closed.

![Relay dan Solenoid valve Testing](image)

**Testing communication via Internet Web**

Testing the communication interface of the equipment with the internet web via a Smartphone or laptop. Web address used accordingly with the IP received by the Arduino ESP 8266 which has been shown as shown in Figure 4.3. If there is no internet service / data, the device cannot work.

The main menu on application as figure 3.4 which needs user registered login.

![Login Page](image)

Figure 3.4 Login Page

The design of the IoT tool uses 2 user types,

1. Login as admin username: "admin" password: operator

2. Login as client / user

Client 1: Username "a" Password "a"

Client 2: Username "b" Password "b"

The difference in the menu that is displayed between admin & client, namely

a. Admin: Displays the remaining balance data (Rp) for all clients, Fill in the balance to the client and transfer or display all transaction history.

b. Client: Transaction history, remaining balance and fuel filling

![Admin Page](image)

Figure 3.5 Admin Page

Admin, there is a menu of choices for Customers 1 or 2 who will top up the balance, the menu will appear in the admin menu as shown in Figure 3.5 above.

On the customer menu as shown in Figure 3.6 below, the web page displays the transaction history. To start fuel filling at a certain pump station, fill in the fields below the transaction for the pump selection and the desired transaction value in Rupiah...
Device Testing

This test is to find out every input / output of a system is working.

Table 3.2 Testing of equipment

<table>
<thead>
<tr>
<th>No</th>
<th>Testing</th>
<th>Target</th>
<th>Observation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flow Meter</td>
<td>Device able to detect velocity of flowing fuel</td>
<td>Device able to detect velocity of flowing fuel</td>
<td>[√] Accepted</td>
</tr>
<tr>
<td>2</td>
<td>LCD</td>
<td>Device able to show value on LCD</td>
<td>Device able to show value on LCD</td>
<td>[√] Accepted</td>
</tr>
<tr>
<td>3</td>
<td>Login Page</td>
<td>Login Page for Admin, Customer 1 &amp; Customer 2</td>
<td>Login Page for Admin, Customer 1 &amp; Customer 2</td>
<td>[√] Accepted</td>
</tr>
<tr>
<td>4</td>
<td>IoT</td>
<td>Top up through Smartphone or Notebook</td>
<td>Top up through Smartphone or Notebook</td>
<td>[√] Accepted</td>
</tr>
<tr>
<td>5</td>
<td>Fuel transaction through Smartphone or Notebook</td>
<td>Fuel transaction through Smartphone or Notebook</td>
<td>[√] Accepted</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Web page</td>
<td>Web page indicate transaction and total balance real time</td>
<td>Web page indicate transaction and total balance real time</td>
<td>[√] Accepted</td>
</tr>
</tbody>
</table>

Fuel Transaction Testing

In system testing for fuel transactions, the results are in table 3.3. In this test, it is carried out on one of the client users and the pump station. In this case the transaction is carried out by entering the nominal value of Rupiah on the application.

Table 3.3 Fuel transaction testing and display compared to actual volume

<table>
<thead>
<tr>
<th>Transaction</th>
<th>Conversion (L/H)</th>
<th>Velocity (second)</th>
<th>Actual (MiliLiter)</th>
<th>Error (MiliLiter)</th>
<th>Error (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rp 3,225</td>
<td>500</td>
<td>11.50</td>
<td>450</td>
<td>50</td>
<td>10.0%</td>
</tr>
<tr>
<td>Rp 6,450</td>
<td>1000</td>
<td>20.05</td>
<td>960</td>
<td>40</td>
<td>4.0%</td>
</tr>
<tr>
<td>Rp 9,675</td>
<td>1500</td>
<td>31.45</td>
<td>1550</td>
<td>50</td>
<td>-3.3%</td>
</tr>
<tr>
<td>Rp 12,900</td>
<td>2000</td>
<td>43.50</td>
<td>1800</td>
<td>200</td>
<td>10.0%</td>
</tr>
<tr>
<td>Rp 16,125</td>
<td>2500</td>
<td>55.10</td>
<td>2350</td>
<td>50</td>
<td>6.0%</td>
</tr>
</tbody>
</table>

Error Average 5.3%

Transaction History Testing

In accordance with the design of this equipment, all transaction data, both top up balances and fuel transaction, are automatically stored in a data base that can be viewed through the application on a Smartphone or laptop.

Table 3.4 Transaction History

<table>
<thead>
<tr>
<th>No</th>
<th>Location</th>
<th>Transaction Date</th>
<th>Transaction value</th>
<th>Type</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>54,604.80</td>
<td>2021-01-01 15:42:26</td>
<td>100,000</td>
<td>Top Up</td>
<td>1,150,000</td>
</tr>
<tr>
<td>2</td>
<td>54,604.80</td>
<td>2021-01-01 14:30:36</td>
<td>1,000</td>
<td>ISI DISP A</td>
<td>1,050,000</td>
</tr>
<tr>
<td>3</td>
<td>54,604.80</td>
<td>2021-01-01 14:32:24</td>
<td>1,000</td>
<td>ISI DISP A</td>
<td>1,060,000</td>
</tr>
<tr>
<td>4</td>
<td>54,604.80</td>
<td>2021-01-01 14:00:38</td>
<td>1,000</td>
<td>ISI DISP A</td>
<td>1,070,000</td>
</tr>
<tr>
<td>5</td>
<td>54,604.80</td>
<td>2021-01-01 14:05:46</td>
<td>1,000</td>
<td>ISI DISP A</td>
<td>1,080,000</td>
</tr>
</tbody>
</table>

Top Up Balance Testing

In this test, it is carried out on all client users via admin login. The balance top up test that has been carried out for each customer is as follows.

Table 3.3 Top up balance testing

<table>
<thead>
<tr>
<th>No</th>
<th>Top Up Balance</th>
<th>Balance value updated</th>
<th>Result</th>
</tr>
</thead>
</table>
3.8 Wiring Diagram Tools

The wiring diagram for the equipment as follow assembled component.

<table>
<thead>
<tr>
<th></th>
<th>User A</th>
<th>User B</th>
<th>User A</th>
<th>User B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rp 5,000</td>
<td>Rp 10,000</td>
<td>Rp 5,000</td>
<td>Rp 10,000</td>
</tr>
<tr>
<td>2</td>
<td>Rp 25,000</td>
<td>Rp 20,000</td>
<td>Rp 25,000</td>
<td>Rp 20,000</td>
</tr>
<tr>
<td>3</td>
<td>Rp 50,000</td>
<td>Rp 30,000</td>
<td>Rp 50,000</td>
<td>Rp 30,000</td>
</tr>
<tr>
<td>4</td>
<td>Rp 75,000</td>
<td>Rp 40,000</td>
<td>Rp 75,000</td>
<td>Rp 40,000</td>
</tr>
<tr>
<td>5</td>
<td>Rp 100,000</td>
<td>Rp 50,000</td>
<td>Rp 100,000</td>
<td>Rp 50,000</td>
</tr>
</tbody>
</table>

3.2 Discussion

Based on the testing that have been carried out, the system that has been designed is working properly, even though there are errors in some circuits or sensors that are relatively small.

A management system for monitoring fuel consumption displayed in a data base that can be accessed via an application on a smartphone and the web. The device works well. The system can display all transaction, both top up balances and refueling gasoline either via smartphone or laptop in detail for the location, date, time, top up and total balance.

Fuel transactions using the Yf-S201 flow sensor which can be seen on the LCD / display are controlled using the Arduino. In this case the system works well, the display can show the desired rupiah and the number of milli liters issued with an error of 5.3%.

Control system for fuel pump station with smartphones / laptops and balance top up. In this section the system works well, when the transaction process (via a smartphone or laptop) starts, the equipment works by opening the solenoid valve automatically at the selected pump station and the fluid comes out through hose and the flow will stop when the value has been reached. In the case of initializing balances, the system also works properly. The transaction data is stored in detail for the location, date, time, top up and total balance.

IV. CONCLUSIONS

Based on the results of the research and discussion that has been described in the previous chapters, it can be concluded as follows:

The designed tool is equipped with the following facilities:

1. Management data for the history of all transactions can be accessed via a Smartphone or laptop which is recorded in detail for the location of filling, date, time and top up value and total balance.

2. Control when charging fuel can be done automatically by using a Smartphone or laptop, only through the local wifi network.
with the desired value during the transaction with an error value of 5.3%, and the flow being issued is displayed on the Display / LCD.

3. Topping up the balance can be done only using the user / Admin either via Smartphone or laptop.

REFERENCES