ELECTRICITY CONSUMPTION MONITORING SYSTEM IN SUNNY SIDE BOARDING ROOMS AND MONTHLY COST ESTIMATION

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Abstract

This research aims to design an effective electricity monitoring system in the "Sunny Side" boarding house. The objective is to address the issues of unfair electricity cost distribution, energy wastage, and the difficulties faced by the boarding house management in managing electricity consumption. With this monitoring system, it is expected to achieve fair cost distribution, reduce energy wastage, and increase the awareness of residents regarding wise electricity usage. The research methodology employed in this study is a case study approach, which includes observations and interviews with the boarding house owners and tenants. The system utilizes NodeMCU as the microcontroller and PZEM sensor to measure voltage, current, power, and energy consumption. The data is stored using FIREBASE, while real-time information on electricity consumption and cost estimation is presented through a mobile application based on REACT NATIVE.

Keywords: Electricity monitoring device, NodeMCU, PZEM sensor, React Native-based mobile application.

Introduction

The increasing awareness of the importance of efficient and sustainable energy use has driven the development of effective electricity monitoring systems in various environments, including dormitories. This research aims to design an effective electricity monitoring system in the "Sunny Side" dormitory. However, there are several challenges that need to be addressed in its implementation. One common challenge is the unfair distribution of electricity costs among residents. The division of electricity costs in dormitories often lacks fairness, as residents with higher electricity consumption pay the same amount as those with lower consumption. Additionally, energy wastage is also a problem that needs to be tackled. Some residents may be unaware of excessive electricity usage, such as leaving the television or electronic devices on when not in use, leading to unnecessary energy wastage. Furthermore, dormitory management faces difficulties in managing electricity consumption in individual rooms. They struggle to monitor and control the electricity usage of each resident individually.

To overcome these challenges, this research will design an effective electricity monitoring system in the "Sunny Side" dormitory. With this system, the electricity consumption of each resident can be measured individually, allowing for a more equitable distribution of electricity costs based on individual consumption. Additionally, the system will provide real-time information to residents regarding their electricity consumption through a mobile application. This will increase residents' awareness of wise electricity usage and reduce unnecessary energy wastage. Dormitory management will also benefit from this system as they can monitor the electricity consumption of each resident and take necessary steps to optimize energy usage in the dormitory as a whole.

Literature Review

Previous research has extensively proposed the use of NodeMCU and PZEM sensors in electricity monitoring systems for various applications, such as smart homes and industries. In a study by Khan et al. (2019) titled "Smart Energy Metering and Monitoring System for Efficient Energy Management in Smart Homes," NodeMCU and PZEM sensors were used to measure and monitor electricity consumption in a smart home. The results showed that this monitoring system could assist users in managing and optimizing energy usage in their homes.

Another study by Saranya et al. (2018) proposed the use of NodeMCU and PZEM sensors in an electricity monitoring system for energy savings in industries. The developed monitoring system could measure energy consumption and monitor electrical loads in real-time, enabling users to identify and reduce energy wastage.

In the context of this research, the authors aim to adapt the NodeMCU and PZEM technology to design an electricity monitoring system in the "Sunny Side" dormitory. The NodeMCU, as a microcontroller, will be used as the control center to collect data from the PZEM sensors. The PZEM sensors will be installed in the electrical circuit to accurately and real-time measure voltage, current, power, and energy consumption. The electricity consumption data of each resident will be stored in a database and accessed to calculate individual electricity costs.

Furthermore, real-time information about electricity consumption will be presented through a React Native-based mobile application. Dormitory residents can easily monitor and manage their electricity usage through this application.

Based on previous research, the use of NodeMCU and PZEM sensors has proven to be effective in measuring and monitoring individual electricity consumption. In this study, this technology will be adapted to address the unfair distribution of electricity costs among "Sunny Side" dormitory residents and reduce energy wastage.

Method/ Design Analysis

To facilitate the design of this system, comprehensive data is needed to support the accuracy of the information provided. The methodology that will be used is field research with an approach involving observation and interviews.

Field research will be conducted by directly observing the object under study, which is the electricity monitoring system in the "Sunny Side" dormitory. During this observation, the author will observe the existing system, such as the use of NodeMCU, PZEM sensors, and the React Native-based mobile application. This will help the author to understand firsthand how the system functions and interacts with the dormitory residents.

Additionally, interviews will be conducted to gather data related to relevant sources of information. Interviews will be conducted with dormitory management and residents. During these interviews, the author will communicate directly with the respondents to gather information about the needs of the dormitory residents regarding electricity consumption monitoring and management, as well as the issues related to electricity cost distribution. The data obtained from these interviews will serve as important primary data sources in designing an effective electricity monitoring system in the "Sunny Side" dormitory.

After collecting the data and understanding the existing issues, the next step is to design a flowchart that will serve as a guide in interpreting the data and designing the appropriate tools based on the identified needs.

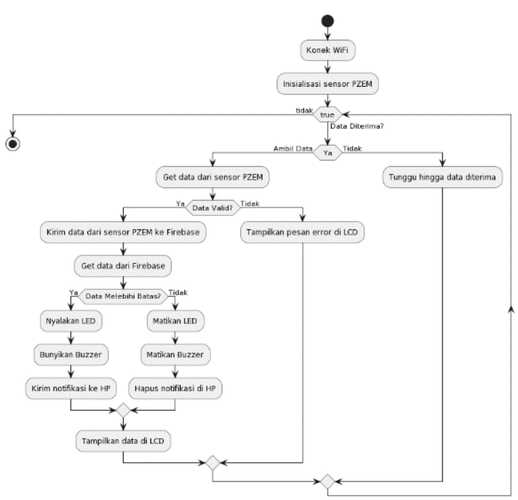


Figure 1: System flowchart

Results and Discussion

To facilitate the design of this tool and support its development, a diagram will be created to illustrate the input and output of the designed tool

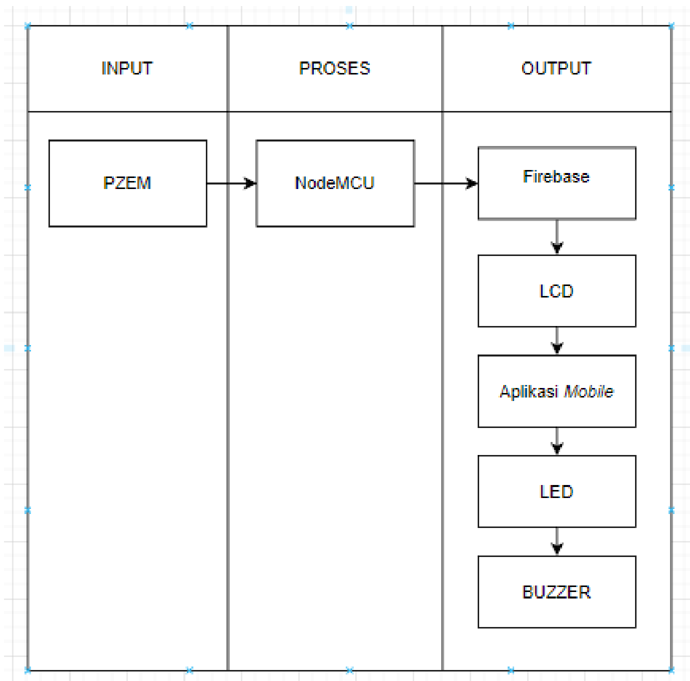


Figure 2 : Block Diagram

The block diagram above depicts the input, process, and output for the design of a device that utilizes a PZEM sensor, NodeMCU, and several output components such as a mobile application, buzzer, LCD, and LED:

1. Input Block

   The PZEM sensor is used as the input to measure electrical parameters such as voltage, current, power, and energy.
   The PZEM sensor provides data regarding the measured electrical parameters.

2. Process Block

   The NodeMCU functions as the microcontroller that processes the data from the PZEM sensor.
   The NodeMCU reads data from the PZEM sensor and performs additional processing or calculations if needed.
   The NodeMCU sends the processed data to several output components.

3. Output Block

   The mobile application serves as one of the outputs for monitoring and controlling the device. Users can view the electrical data measured by the PZEM sensor through the mobile application.
   The buzzer can be used as an audio indicator to provide specific alerts or notifications. For example, the buzzer can sound if the measured conditions by the PZEM sensor exceed a specified limit.
   The LCD can be used as an output to display information received from the PZEM sensor or other processing results. For instance, the LCD can display real-time voltage, current, power, or energy consumption.
   The LED can be used as a visual indicator to display specific status or conditions. For example, the LED can illuminate if the power measured by the PZEM sensor exceeds a certain threshold.

By using the PZEM sensor as the input, the NodeMCU processes the data and sends it to several output components such as the mobile application, buzzer, LCD, and LED. The mobile application allows users to monitor and control the device in real-time, while the buzzer, LCD, and LED provide visual and audio indications based on the conditions measured by the PZEM sensor.

System Circuit Design:

In the design of this system circuit, attention is given to the arrangement of the circuit layout to ensure that all necessary components are properly identified and can be implemented smoothly. Consideration is given to the devices to be used and ensuring that all required components are available and properly connected in the circuit. This is important to ensure that this device functions properly and produces accurate data in monitoring the power consumption in the "Sunny Side" apartment.

Device Design

In the design of this device, a schematic diagram is first created to understand its electronic form and arrangement. In the assembly of this device, all necessary parts will be integrated into a unified device.

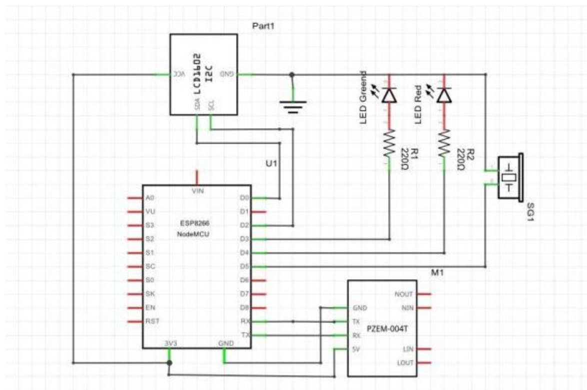


Figure 3 : circuit diagram

Simulation Design

In this design, the device is designed with a minimal and easy-to-implement concept. This simulation design does not use a breadboard because the number of ports available on the NodeMcu is sufficient to connect all the components used. Therefore, the use of a breadboard is not necessary. This device uses a PZEM sensor to measure electrical parameters such as voltage, current, power, and energy. NodeMcu is used as a microcontroller to process the data and send it to Firebase, so it can be displayed on a mobile application. The physical design of the device created in the simulation can be seen in the following image:

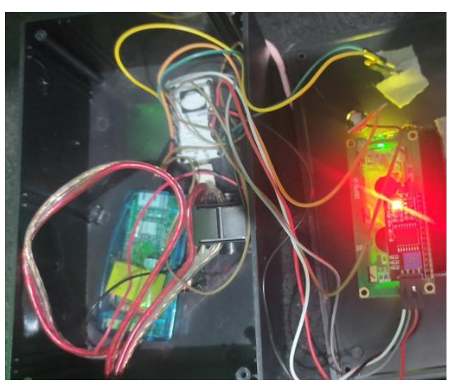


Figure 4 : Physical Circuit

Here are the simulation results of the electrical monitoring system and monthly cost estimation:

Figure 5 : Device is connected to Wi-Fi

In the image, the LCD displays a message confirming that the device is successfully connected to Wi-Fi. If it fails to connect, please ensure that the SSID name and password are correctly set according to the configurations made using the Arduino IDE.

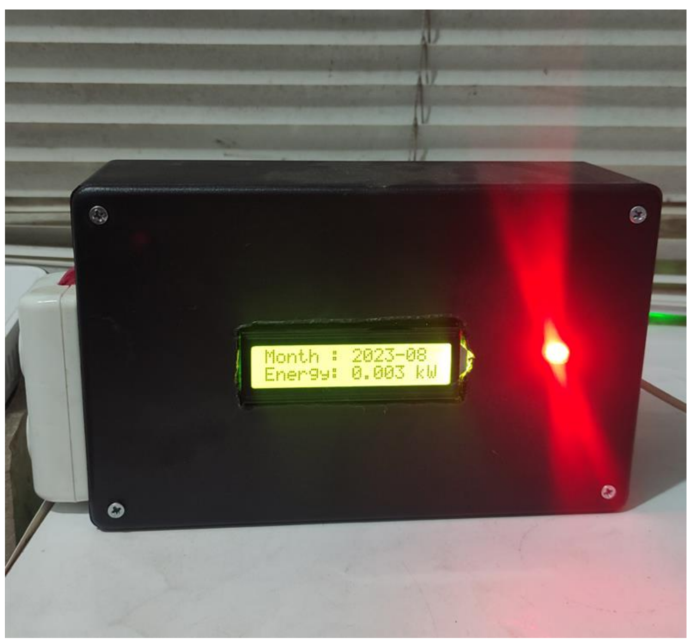


Figure 6 : Device displays data on the LCD

After a successful connection, the LCD will display information related to the current month and the amount of power consumed. The information for the current month can include data such as the current month and year. Meanwhile, the amount of power consumed can be displayed in kilowatt-hours (kWh). This allows users to easily view and monitor their power consumption for the current month through the real-time LCD display provided.

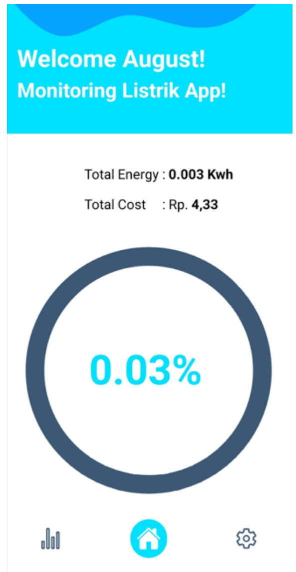


Figure 7 : Home Menu Mobile Application

In the above image, the current month is displayed along with the application name shown in the header. Additionally, the total energy, total cost, and percentage of kWh per month are also displayed.

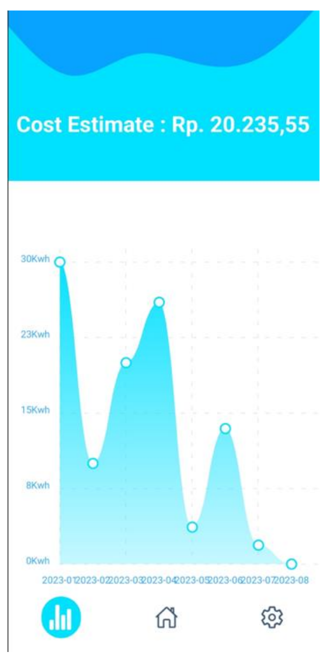
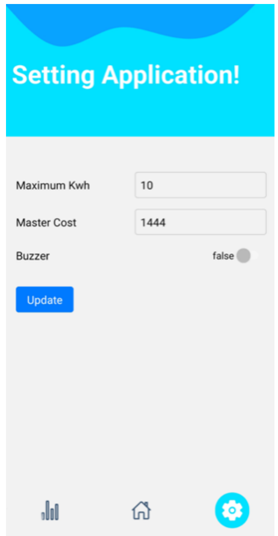


Figure 8 : Statistic Menu Mobile Application

In the above image, it shows the energy usage graph from month 1 to 8, with the highest usage occurring in month 1 at 30 kWh. Additionally, this menu also displays the estimated cost obtained from the average energy usage until the current month within one year.



Picture 9 : Setting Menu Mobile Application

In the above image, it can be seen that the device is currently in the settings menu. In this menu, you can set the maximum kWh limit, the price per kWh, and also configure the buzzer usage. When the "Update" button is clicked, it will prompt for a password as a security measure for data access

Conclusion

Based on the research and analysis conducted, the electrical monitoring system designed for the 'Sunny Side' boarding house using NodeMCU, PZEM sensor, and a React Native-based mobile application has the potential to address the injustice in electricity cost distribution, reduce energy waste, and improve residents' awareness of wiser electricity usage.

In this study, the electricity consumption of each resident is measured individually using NodeMCU and PZEM sensor. Real-time information about electricity consumption is presented through the mobile application and LCD, enabling residents to monitor and manage their electricity usage more effectively.

The use of NodeMCU and PZEM sensor in the electrical monitoring system has been proven effective in measuring and monitoring individual electricity consumption in previous studies. In this research, this technology is adapted to address the constraints of unfair electricity cost distribution and energy waste in the 'Sunny Side' boarding house.

The research methods used include observation and interviews with the boarding house owner and tenants. The results and discussions show that the designed electrical monitoring system can connect to Wi-Fi, display electricity consumption data on the LCD, and provide monthly cost estimates through the mobile application.

However, there are several factors that can hinder the optimal performance of this system, including limitations in Wi-Fi infrastructure, limitations in the durability of NodeMCU and PZEM sensor devices, limitations in sensor reliability, limitations in interoperability between hardware and software used, as well as limitations in availability and compliance of the residents.

Furthermore, other potential weaknesses of this system include implementation costs that require initial investment, technical complexity in installing and operating the devices, as well as concerns regarding privacy and data security of the collected information.

In designing and implementing this electrical monitoring system, it is important to consider the aforementioned factors to achieve optimal results.

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