Design of Internet Electrical Power Usage Metering System Based on ESP32s Mcu and Mysql Database with User Interface Application

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Abstract: This research concerned with the problem of high payment of electric power consumption for households increasing to 12.6%. Normal price in August 2021 reached IDR 286,000 for consuming 1 TV, 2 fan, and 10 lamps. In September 2021, it increased to IDR 322,000 within the same electric power consumption as in August 2020. Therefore, the researcher designed the monitoring system using kWh meter by implementing the principles of Internet of Things (IoT) in the feature of MySQL database web server. The method use in this research is engineering research, which tested several samples through observation method upon the system of electric power consumption by employing kWh meter. The research results were divided in 2 categories during 7 days of trial to 2 users. Furthermore, the monitoring processes were classified in two categories i.e. rush hour or night and non- rush hour or morning. The average inaccuracy of the current sensor after testing and calibration is 0.31% for the ACS712ELCTR-5A-T current sensor and 0.0017% for the ZMPT101B voltage sensor. Conclusion of this research that the data delivery to the web server database was successful without any number differences send by microcontroller and UI VB.NET, meaning that it could accumulate the kWh value.

1 INTRODUCTION

The use of electrical energy has become one of the main needs for human life as one of the efforts of the economic concept of capital to calculate the use of electrical energy. Today a lot of equipment that has been created uses and also depends on electrical energy sources. To measure the use of electrical energy using a device called the Kilo Watt hour-meter (kWh-meter).

The use of electrical energy has become one of the main needs for human life as one of the efforts of the economic concept of capital to calculate the use of electrical energy (Pujiharsono et al., 2015) Today a lot of equipment namely, by using the kWh-meter reading and converting it into a digital image that can be read and sent. on (Lestari et al., 2021) Today a lot of equipment that has been created uses and also depends on electrical energy sources. To measure the use of electrical energy using a device called the Kilo Watt hour-meter (kWh-meter).

Therefore, this study aims to design a building, a system for using electric power for homes, based on internet protocol using web hosting as a means of storing data from sensor readings, onto a server with a MySQL database. a kWh meter equipped with current and voltage sensors as input data which will be displayed in the monitoring process in reading the value of electric power consumption. How this kWh meter works can determine the consumption input of the household's electricity usage, with the hope of knowing an efficient way of using this electricity with a warning. Current and voltage sensor readings will be converted into power units (Watts), and the results will be uploaded to [3] web hosting protocol into the MySQL database web server. Apart from converting energy values, on Visual programming.

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Where later it will also be converted into the price per kWh into the nominal form of IDR (Rp.). The average value of electricity usage per day will be recorded and stored in the MySQL database for estimation(Herlambang et al., 2022) use of electrical energy. After achieving data collection for 30 days (1 month), the next step is to recapitulate electricity usage, all averaged into prices for usage each month, so that with the aim of users can save and estimate the use of electrical energy at home.

2 LITERATE REVIEW

2.1 Energy Usage Measurement

Study (Shu et al., 2007)A kilo Watt Hour (kWh) meter is a tool for measuring active energy that uses a counter and uses the principle of magnetic induction according to (Khawas & Shah, 2018) that alternating current is used, and if there is self-induction in the circuit, the energy given to the circuit cannot be measured by observing the deflections on a voltmeter and an ammeter and measuring the intervals of time with a watch and multiplying of these values together, the following equation can be used(*Ricks, G.W.D. (March 1896). "Electricity Supply Meters". Journal of the Institution of Electrical Engineers 25 (120): 57–77. - Google Search*, n.d.)).

$$V \int_{t1}^{t2} C \, dt \tag{1}$$

where, V being considered as being constant, the meter needs then only *C* measure with units coulomb-meter. And *t* is time measured interval.

2.2 Convert kWh to Nominal

Electrical energy generates power, and from the power generated it can power equipment to facilitate human work which has the active power formula [W] defined as follows (Shenbagalakshmi & Jaya, 2020):

$$P = V.I.Cos\emptyset \tag{2}$$

The formula for energy use (kWh) in electricity tariffs in a day is obtained from the following calculation:

$$energy = \frac{P}{1000} \tag{3}$$

Where, P is the total power consumption used in (Watts), while the constant 1000 is a constant used to convert(Shenbagalakshmi & Jaya, 2020) from Watt/hour units to kiloWatt/hour units. Calculation of the fee paid to estimate the amount of energy used (kWh) used in IDR (Rupiah) nominal units, where the calculation will be cumulative with the use of electrical energy for 1 month or 30 days. Using the basic electricity tariff of IDR. 1444.70 per kWh, for the tariff for class R-1/TR residential houses, then to calculate the range of energy use against the basic electricity tariff that applies is in equation 4 as follows.

$$Electricity\ bill = measured\ kWh\ x\ IDR.1444{,}70 \tag{4}$$

2.3 Data Storage

In the cumulative data used, of course, data storage is needed, where the database is obtained from measurements from modules that have been designed by researchers, installed in residential homes, and sent using wireless transmission with internet protocols, arranged into several categories or groups of data types in one tabular form. or entities. Using a MySQL database is a database server that is freeware.

3 METHOD

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3.1 Internet of Things System Design

Each system has a relationship between the input and output that will be given from the workings of the system. The block diagram is one form of how the system will work with the conditions to achieve the intended goals. The following is a block diagram of the system of the Internet of Things (IoT)-based Electric Power Usage Monitoring System.

3.2 Work System Design

This section will explain the software diagram blog and system flowcharts. The following is an explanation of the Software Block Diagram as well as

the overall system flowchart which can be seen in the following figure:

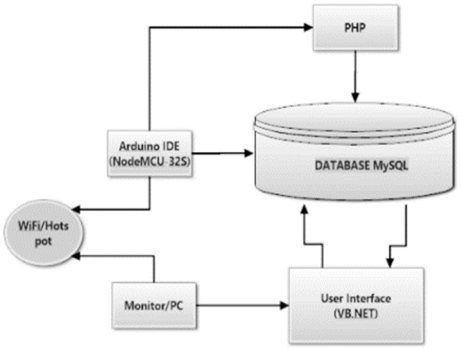

Figure 1: Hardware Block Diagram

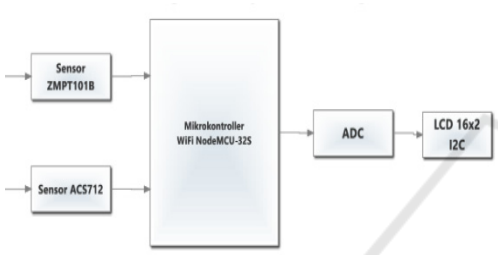

Figure 2: Overall Work System Flowchart

In Figure 2.a it can be explained that the connectivity between all the software, where in the PHP programming to connect to the database and contains the GET or POST sending methods that will be used by the Arduino IDE programming. After the Arduino programming is connected to PHP, it then sends a series of reading data to be stored in the MySQL database, provided that it is sent to the microcontroller connected to Wi-Fi. Furthermore, the monitoring process is carried out by connecting to Wi-Fi on the monitor/PC so that it can display data into the user interface that has been made. In the VB.NET user interface, it will display data per day or month according to the time and year that has been determined. And lso, this UI will convert kWh values into IDR values and upload IDR values as bills for a month.

The workings of this system are active microcontroller initialization, the sensor will automatically take and send data to the microcontroller to be processed through a calibrated formula and conversion from the ADC, then the data will be sent to the entry cloud web server which will be authenticated by the MySQL database server via the link instruction provided. programmed on the ESP32 microcontroller. During the process of sending data to the database in 10-minute intervals 1 data is complete then the data will be collected into the MySQL database server. If authentication is still incomplete or not running, it must be re-authenticated so that the data can be stored on the database server. Furthermore, these data will be recorded and processed to upload a billing list to the MySQL database server.

3.3 Result and Discussion

3.3.1 Test Results Data 1 (on User 1)

This user has retrieved electrical power measurement data in June from which is automatically inputted into the tables in the user database, namely dB_monitoring user1 which has been changed to the following graphic image.

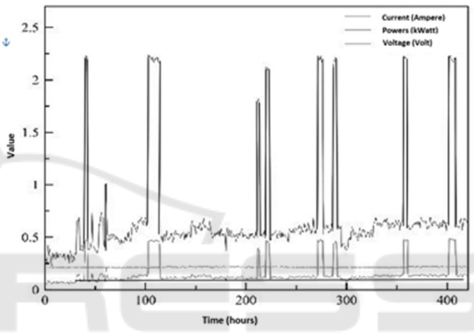

Figure 3: User 1 Data Graph.

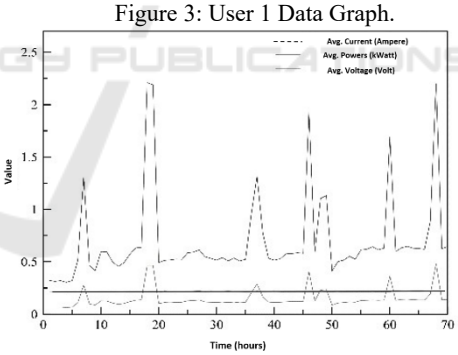

Figure 4: Monitoring Data Conversion to kWh User 1.

In Figure 3.a is a graph of the results of the monitoring process originating from sending the microcontroller to the MySQL database which is displayed on the VB.Net user interface. The sending process from the NodeMCU-32S Microcontroller is to send data at intervals of 10 minutes per 1 data taken starting from 06.00 AM – 16.00 PM for 7 days, namely June namely June 13 – June 19, 2021.

From this graph it can be seen that the highest power usage when using all equipment load of 2.21 A so that the kWh found also follows the increase.

The surge in current is due to the load of the iron being too large, if the load of the iron is removed from the normal use switch 5 loads The light and fan only reach 0.7 A. the use of iron loads is used significantly every 12 noon to 13 noon. In Figure 3.b is a graph of the average hourly conversion on a daily basis from the test results of Figure 3.b. This conversion is to determine the average of the voltage value, current value, and kWh power usage every hour using the formula kWh = (6 kW data added / 6 data).

3.3.2 Test Results Data 2 (on User 2)

This user has retrieved electric power measurement data in July from which is automatically inputted into the tables in the user database, namely dB_monitoring user2 which is changed to the following graphic image.

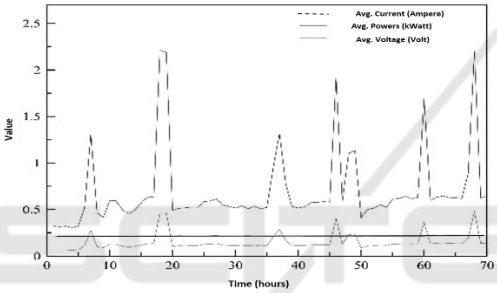

Figure 5: User 2 Data Graph

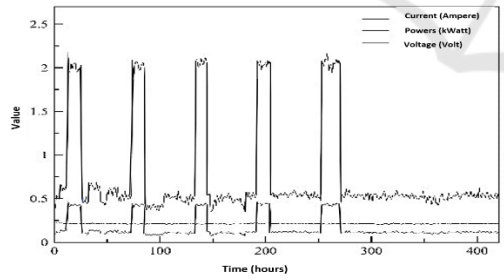

Figure 6: Monitoring Data Conversion to kWh User 1

In Figure 4.a is a graph of the results of the monitoring process originating from sending the microcontroller to the MySQL database which is displayed on the VB.Net user interface. The sending process from the NodeMCU-32S Microcontroller is to send data at intervals of 10 minutes per 1 data taken from 06.00AM – 16.00 PM for 7 days, namely June 21 – June 27, 2021. The highest power usage when using all equipment loads is 2.11 Amp so that the kWh found also follows an increase. The surge in current is due to the load of the iron being too large, if the load of the iron is removed from the normal use switch 4 loads The light and fan only reach 0.6 A. sing the formula kWh = (6 kW data added up / 6 data).

3.3.3 Test Results of Average Power Usage Comparison Between 2 Users

The comparison of electric power usage between the 2 users of this monitoring system is by taking a sampling of test data at certain hours, namely at 09.00 AM–13.00 PM.

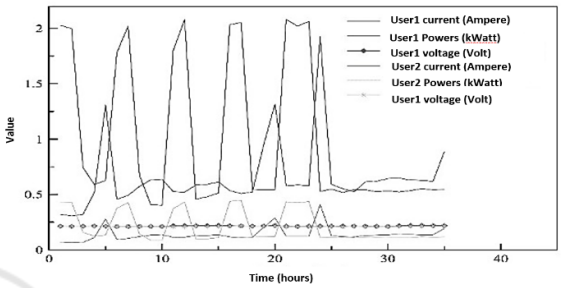

Figure 7: Graph of Average Comparison of 2 Users.

In Figure 5 is data taken from a table in the database, which is named *tb kwh per hours*, from the author's observations it can be concluded that during peak hours the two users can be compared, the first user has the highest peak current at 2, 21 Amp, while the second user is only 2.08 Amp and the use of electric power used is more dominant in the use of electrical equipment within 5 days of data collection, it can be seen that there are only 5 surges in the current load. After reaching 5 days, it can be concluded that the last 2 days the load of the equipment used by the two users of the monitoring system only used normal equipment, because there was no significant current spike between the two users in the last 2 days of data collection.

4 CONCLUSIONS

Based on the research data, it can be concluded that this system can work well. This web-based monitoring system for kWh meters uses the NodeMCU-32S microcontroller with 2 voltage sensors (ZMPT101B) and current sensors (ACS712ELCTR-5A-T) to process kWh values by accumulating them into the active power formula, namely from the data of the two sensors. From the results of research through testing this monitoring system with the UI that has been made to be able to

process the entire implementation of Internet Of Things (IoT)-based data transmission correctly in retrieving monitoring data on electric power usage (kWh) for 7 days in June 2021 for 2 service users Monitoring system with user 1 has a bill of IDR. 15,121,674 and user 2 has a bill of IDR. 16390,121.

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