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# Designing a Real-Time DataLogger Using the Internet of Things for a Basic Imple Home Kwh Meter Capable of 1300 VA

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A R T I C L E I N F O

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A B S T R A C T

Researchers want to make a kWh meter monitoring tool with estimated usage costs so that the tools made can help people to minimize costs in electricity usage. The purpose of this research is the creation of an IoT-based kWh meter monitoring tool that has the ability to read current, voltage, frequency, power factor and power usage that flows and shows the use of costs that have been used in real time with the display results on the LCD and also on the user's smartphone. In the reading results of usage costs (Rp) on the tool and PLN there is also a difference of Rp. 12,000, where the reading results on the tool are also lower than the results of the payment slip provided by PLN. The cost reading error rate on the tool is 4.4% with a reading accuracy rate of 95.6%.

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**INTRODUCTION**

In 2018, coal production in Indonesia reached 557 million tons with domestic consumption of 115 million tons (MEMR, 2019). One of the sectors that consume the most coal is PLTU. The projected average growth of electric power consumption in Indonesia in 2003-2020 was 6.5% per year with production in 2020 amounting to 272.34 TWh. One of the factors causing an increase in electricity consumption in Indonesia is caused by the wasteful lifestyle of people in using electrical power (Sirait and Wicaksono 2017). KWH meter is a measuring instrument needed to measure the use of electrical energy. So far, to find out the current balance is monitored manually by monitoring the kWh (Kilo Watt Hour) meter and taking measurements manually so that sometimes the problem is too late to be known (Mustafa et al. 2020).

Manuscripts within the electrical engineering encompassing a variety of fields are accepted for publication in TRJT Journal (Telecommunication Network Engineering Technology). These fields include:

1. Telecommunication

Wave propagation, antennas, and information theory and coding, mobile and wireless communication, distributed platform, radar, microwave, and radio communication system and network, telematics application service, security network, etc. are some of the topics covered by signal processing and modulation for communications.

2. Electronics and Electrical Engineering

SCADA and power system analysis, electrical measurement, electrical substances and microelectronic apparatus, biomedical transducers and instrumentation, biomechanics and rehabilitation engineering, transistors, MOSFET, CMOS, power electronics, power quality, power economics, renewable energy, electromagnetic compatibility, high voltage insulation technology, high voltage apparatuses, lightning detection and protection, electrical engineering materials, electrical power generation, transmission, and distribution VERDICT, and more.

3. Computing and Informatics

Computer architecture, networking, pervasive computing, computer security, virtual and augmented reality, and human-computer interaction, network traffic modeling, performance modeling, programming, data engineering, knowledge-based management systems, knowledge discovery in data, computer security, human-machine interface, stochastic systems, information theory, intelligent systems, IT governance, networking technology, optical communication technology, Next Generation Media, robotic instrumentation, and information search engine, multimedia security, computer vision, and information retrieval.

4. Instrumentation & Control

Control methods including image-based, hybrid, and switching, fuzzy logic and artificial neural networks, complex adaptive systems, identification and modeling, robotics, adaptive control, robust control, stochastic and non-linear artificial intelligence and expert systems, intelligent control and systems, scheduling, optimization, and control, etc.

## LITERATURE REVIEW

### Electric Current

Electric charge in motion is referred to as electricity. The magnitude of The quantity of electric flow is defined as of charge flowing through a location for every instant. Electricity The expression of flow is the amount I and its unit is amperes, summed up by A. Then, the importance of electricity this is one way to plot flow (Rosman et al. 2019):

$$I = \frac{Q}{t} \tag{1}$$

Where is: I = amps of electric current (A)
Q = Charge of electricity in coulombs (C)
T = Seconds of time (s)

### Electrical Voltage

The measurement of the energy that could be difference between a pair of targets is called voltage, and it is expressed in volts (V). The unit of measurement for voltage is also units of joules per coulomb. Let's say a battery has a voltage of 12.6 volts, which translates to 12.6 joules of energy per coulomb charge. More energy than 12.6 joules are transformed into heat and light energy for each 1 coulomb charge that passes through the light, assuming that the light is connected to the battery. Furthermore, as per Rosman et al. (2019), the voltage conditions are as follows:

$$\mathrm{V} = \frac{\mathrm{E}}{\mathrm{Q}} \tag{2}$$

Where is: V = Voltage in units of volt (V)
E = Energy in units of joule (J)
Q = Charge in units of coulomb (C)

### Active Power

Real power or power that may truly be utilized by current loads is referred to as active power, as for the unit of this active power is Watt. According to (Belly et al. 2010) One can compute active power, using the formula equation:

$$P = V.\, I\, .\, Cos\, phi \tag{3}$$

Where is: P = Active Power (Watt)/W
V = Voltage (Volt)/V
I = Current flowing (Ampere)/A
Cosphi = Power Factor

**Reactive Power**

Power that is taken or absorbed but cannot be used by the load is known as reactive power since it goes back to its source. Reactive power is measured in VAR units. Reactive power, according to Belly et al. (2010), can be computed using the following equation:

$$Q = V \cdot I \cdot \sin phi \qquad (4)$$

Dimana: Q = Reactive Power (VAR)
V = Tegangan (Volt)/V
I = Current flowing (Ampere)/A
I = Current flowing (Ampere)/A

**Arduino UNO**

Arduino is an electrical board that has an ATMega328 microprocessor on it, according to (Destriani, 2019). From basic to sophisticated electronic circuits, this Arduino UNO can be utilized.

Figure 1. Arduino UNO board

**Current Sensor ACS 712**

The ACS 712 is a current sensor designed to measure the current flowing through an electrical circuit. Where flowing AC and DC currents can be detected by ACS 712. This sensor's typical applications include protecting a circuit's load, detecting electrical loads, and controlling motor performance.

Figure 2. Current Sensor ACS712

**Voltage Sensor ZMPT101B**

Because it can detect the difference in electrical potential between two places in a circuit, the ZMPT101B voltage sensor is highly ideal for use in voltage measurement tools. It can measure both AC and DC voltages up to 250 volts (Ratnasari and Senen 2017).

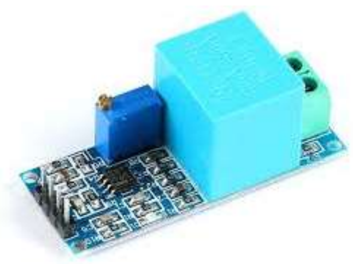

Figure 3. Voltage Sensor

**LCD**

LCD is a display media device that utilizes liquid crystal components as the main display media. LCD can display images or text through the light points contained in the liquid crystal (Ratnasari and Senen 2017).

Figure 4. LCD 2 x 16

**NodemCU**

NodemCU is an IoT device based on e-Lua with firmware. This NodemCU has a micro usb port which functions as the execution of existing programming. On this NodemCU there is also a pushbutton, flash button and there is also a reset button. Package language from ESP8266 is as a C programming language used by this NodemCU (Ratnasari and Senen 2017).

Figure 5. NodemCU

## METHODOLOGY

**System Work Process**

Understanding how the system in this study operates in an outline can be made easier by this functioning system procedure.

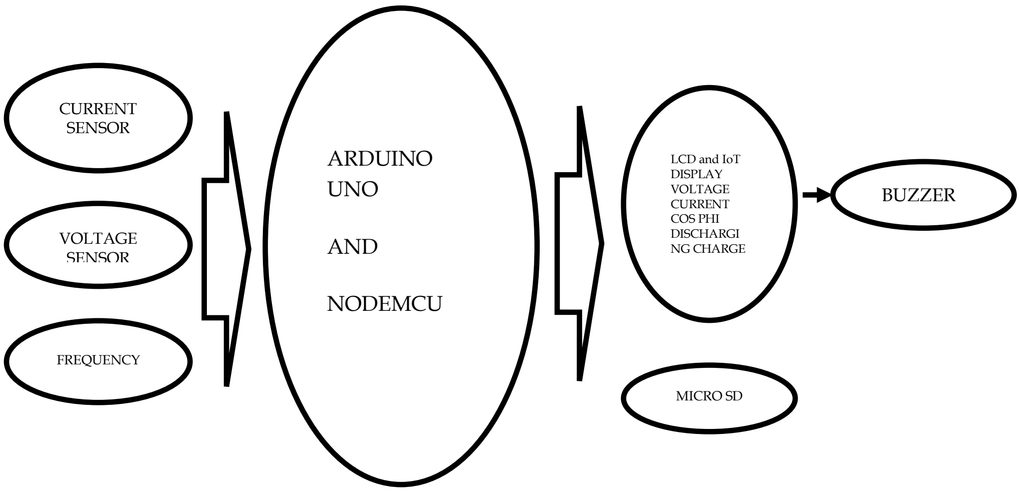


Figure 6. System Process Work

**System Circuits**

The general circuit diagram of the system shows multiple sensors, including those for frequency, voltage, and current, followed simply using a microSD card, an LCD, and an Arduino UNO as outputs. The general circuit is described below. It has the following pins connected to the Arduino:

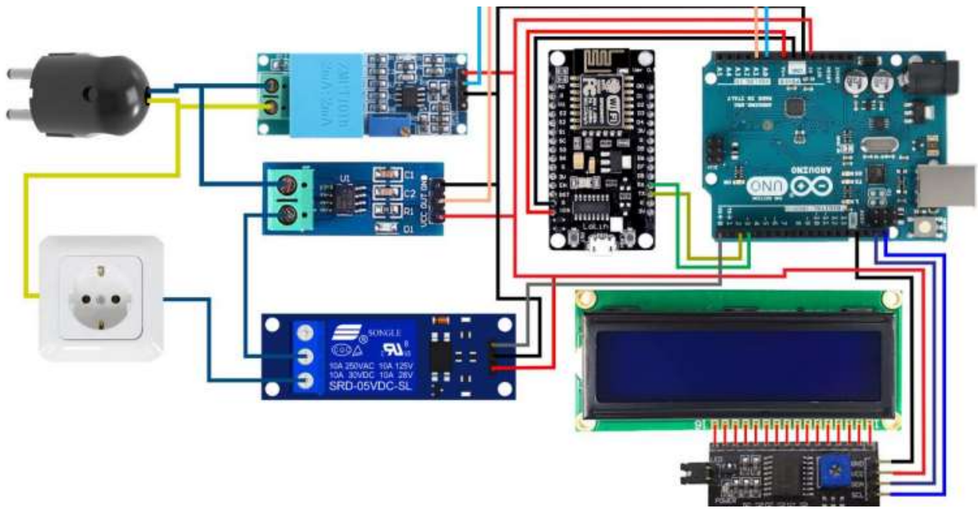

Figure 7. System Circuits

In figure 7, the above shows a picture of a one-line diagrams circuit of the tool to be made. Where the output of the tool to be made is LCD and Buzzer. Where the LCD as a data retrieval that will be read while the buzzer functions as a tool that will work when usage has reached a predetermined limit.

## RESEARCH RESULT

Table 1. Current Data on Tools and Multimeters

| Experiment | Current on Tool LCD (Ampere) | Current Multimeter Reading (Ampere) | Tool Error Rate (%) | Tool Accuracy Level (%) |
|---|---|---|---|---|
| 1 | 0,04 | 0,05 | 20 | 80 |
| 2 | 0,05 | 0,06 | 16,67 | 83,33 |
| 3 | 0,04 | 0,04 | 0 | 100 |
| 4 | 0,04 | 0,05 | 20 | 80 |
| 5 | 0,04 | 0,04 | 0 | 100 |
| Average | 0,42 | 0,48 | 11,33 | 88,67 |

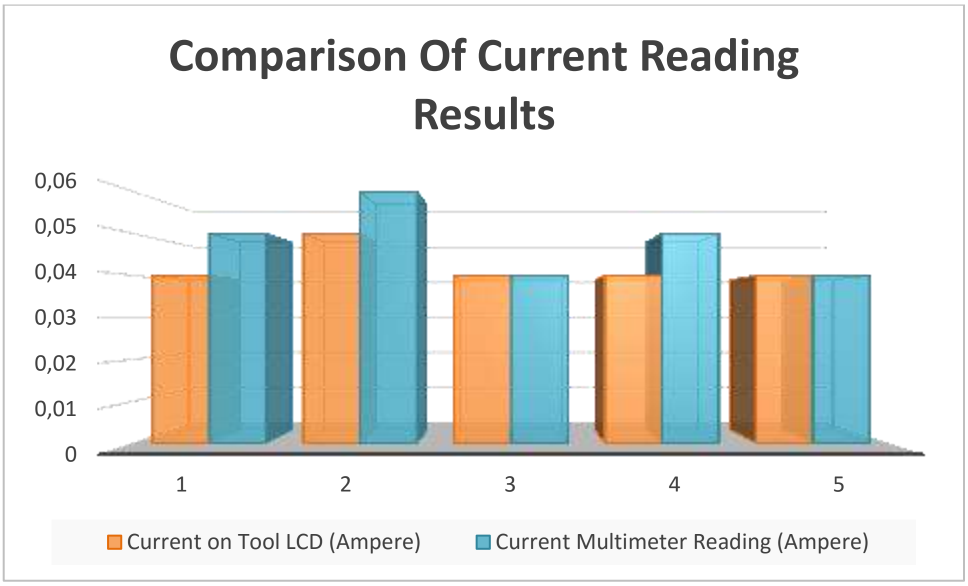


Figure 8. Comparison Chart of Current Reading Results

Table 2. Voltage Data on Tools and Multimeter

| Experiment | Current on Tool LCD (Ampere) | Current Multimeter Reading (Ampere) | Tool Error Rate (%) | Tool Accuracy Level (%) |
|---|---|---|---|---|
| 1 | 216 | 219 | 1,38 | 98,63 |
| 2 | 216 | 219 | 1,37 | 98,63 |
| 3 | 217 | 220 | 1,36 | 98,64 |
| 4 | 217 | 219 | 0,91 | 99,09 |
| 5 | 216 | 220 | 1,82 | 98,18 |
| Average | 0,42 | 0,48 | 1,37 | 98,63 |

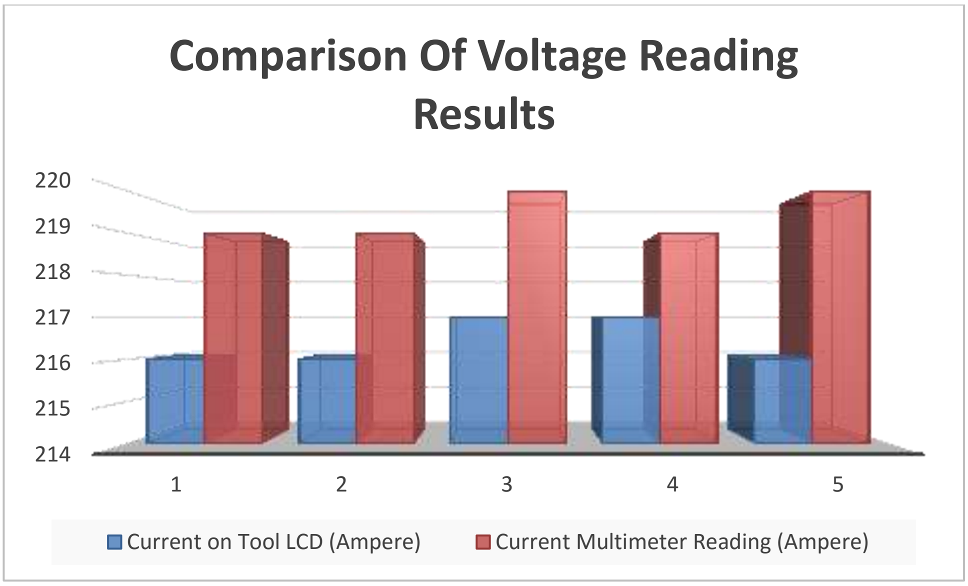


Figure 9. Comparison Chart of Voltage Reading Results

Table 3. Load Usage Charge Readings on Tools

| Week | Total Load Usage (kWh) | Total Cost (Rp) |
|---|---|---|
| Ke-1 | 45,16 | 67,183 |
| Ke-2 | 75,142 | 112,713 |
| Ke-3 | 123,347 | 185,021 |
| Ke-4 | 173,215 | 259,823 |

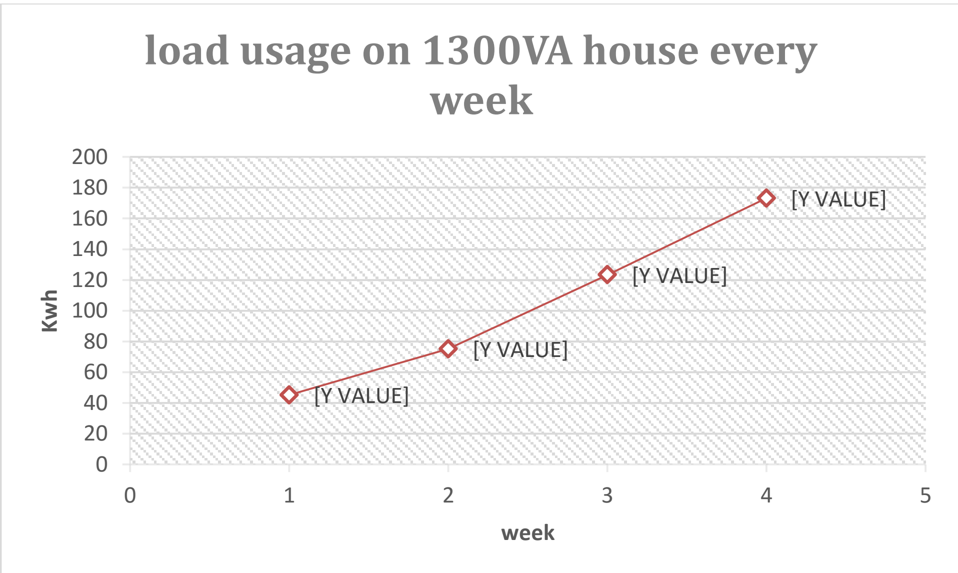


Figure 10. Load Usage Chart

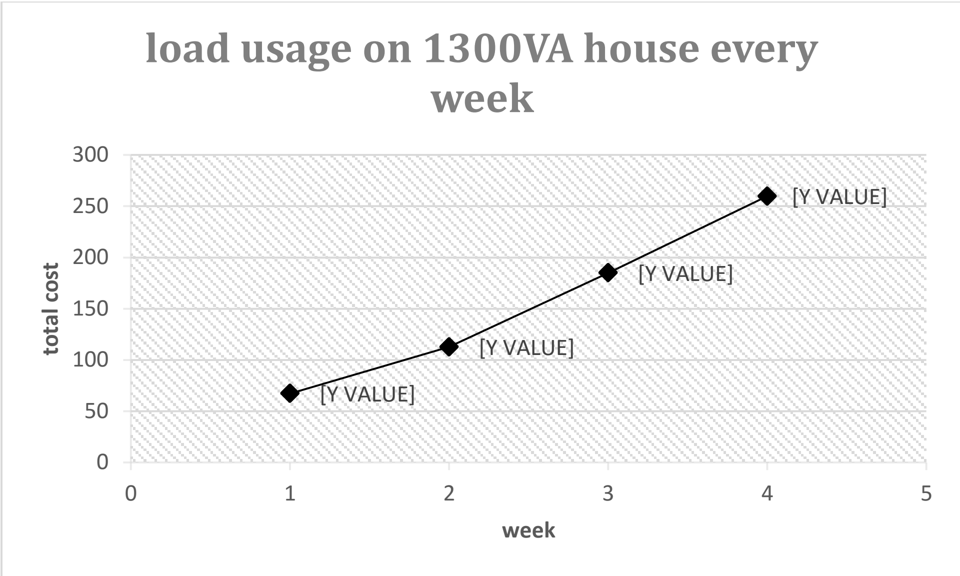


Figure 11. Load Usage Chart

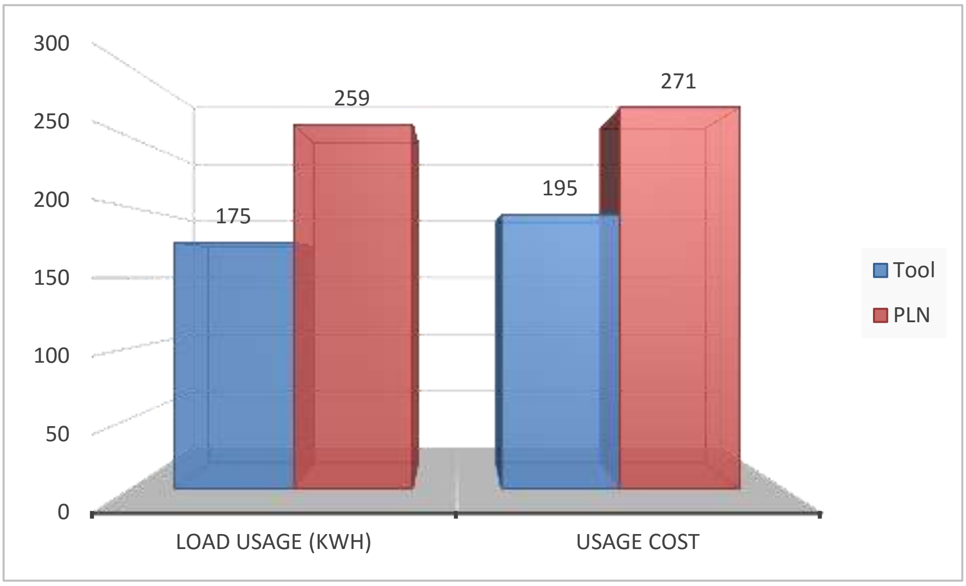


Figure 12. Comparison of kWh and Cost Readings on Tools and PLN

**DISCUSSION**

The table 1 above explains the difference in current reading results on the multimeter with the reading results of the tool. Where the average error rate of the tool is 11.33% with an average accuracy rate of 5 trials is 88.67%. In Figure 8, it can be seen that the current graph line (ampere) on the KWH meter data logger with a multimeter is not much different. There is a difference that is not too significant as shown by the graph line that is not too far adrift. From table 2, it can be seen the difference in Voltage reading results on the multimeter with the reading results of the tool. Where the average error rate of the tool is 1.37% with an average accuracy rate of 5 trials is 98.63%. In Figure 9, it can be seen that the voltage (volt) graph line on the KWH meter data logger with a multimeter is not much different. There is a difference that is not too significant as shown by the graph line that is not too far adrift. From table 3, it can be seen that the use of kWh load in a 1300 VA house according to the kWh meter datalogger tool that has been made at the research location for one month (4 weeks) is 173,215 kWh with the total cost of using the load charged for 1 month is Rp. 259,823. as for the graph of load usage. In the previous sub chapter, it is known that the reading results of kWh and the cost of using the load read by the tool for 1 month is 173 kWh / month and the fee charged is Rp. 259,823. In Figure 12, it can be seen that the kWh reading results on the tool and PLN have a difference of 22 kWh, where the reading results on the tool are lower than the reading results by PLN. The error rate of the reading results on the tool is 10.25% with the accuracy of the tool accuracy of 89.74%.

In the reading results of usage fees (Rp) on the tool and PLN there is also a difference of Rp. 12,000, where the reading results on the tool are also lower than the results of the payment slip provided by PLN. The error rate of the cost reading on the tool is 4.4% with a reading accuracy rate of 95.6%.

In the reading results of usage costs (Rp) on the tool and PLN there is also a difference of Rp. 12,000, where the reading results on the tool are also lower than the results of the payment slip provided by PLN. The error rate of the cost reading on the tool is 4.4% with a reading accuracy rate of 95.6%.

**CONCLUSIONS**

The results of data collection development are carried out with several considerations that have been designed to produce a design that uses a nominal 220 V low voltage source that successfully functions as a monitoring tool for the use of electricity usage in household loads of 1300 VA. The Blynk android IoT platform functions properly and can monitor remotely in real time through Arduino Software. The ACS 712 Current sensor module and the ZMPT101B Voltage sensor can work well, indicated by accurate readings that can be seen from the kWh reading results on the tool and PLN there is a difference of 22 kWh, where the reading results on the tool are lower than the reading results by PLN. The error rate of the reading results on the tool is 10.25% with the accuracy of the tool accuracy of 89.74%. In the reading results of usage fees (Rp) on the tool and PLN there is also a difference of Rp. 12,000, where the reading results on the tool are also lower than the results of the payment slip provided by PLN. The error rate of the cost reading on the tool is 4.4% with a reading accuracy rate of 95.6%.

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