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Design of A Monitoring System for the Implementation of Energy Management in the Electrical Engineering Study Program Workshop of the Medan State Polytechnic

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A B S T R A C T
The researcher wants to make a KWH meter monitoring tool with estimated usage costs so that the tools he makes can help the community to minimize costs in the electricity consumption area, especially in the workshop room located on the 1st floor of building C at Medan State Polytechnic. The long-term goal of this research is to develop an Internet of Things (IoT)--based KWH meter monitoring tool that can read current, voltage, frequency, power factor, and power consumption. This utilization shows the use of costs that have been incurred in real-time by displaying the results on the LCD and can also be from the user's mobile phone. In this study, the strategy used in the energy management framework was determined using SWOT analysis. From the results of the measurement and monitoring of electrical energy consumption obtained the results that, energy management is carried out by applying Standard Operating Procedures for the use of electrical energy in the electrical engineering workshop room in order to save more minimal energy consumption with a large error (Error) PZEM in measuring Voltage is 0.0198% in measuring Current is 0.612%. in measuring Cosphi is 0.01%. in measuring Frequency is 0.003%. in measuring Power is 0.183%. And the average measurement error rate is below 0.5%, namely 0.23%.

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INTRODUCTION

Every year, the consumption of electric power in Indonesia has increased in line with population and national economic growth (Mustafa and Muhammad 2020). There is often a tendency for electrical energy to be wasted when using electricity because it is sometimes unknown how much energy has been used. As a result, measuring the use of electrical energy is required to determine the quantity that is being used. (Zulfadli & Arnita, 2021). To make it easier to read the measurement results, the data is displayed in graphical form on a web page that can be accessed through all gateway devices connected to the internet network (Despa et al., 2018).

For this reason, in overcoming this, a monitoring system for electricity usage at boarding houses is needed, namely by utilizing a microcontroller work system, one of which is like Arduino. In the previous prototype design, this system was made by Agung Prasetyo Wibowo with the title Prototype Design of Electricity Usage Recording Tool / KWH Meter for Boarding Rooms Using Arduino. Where this research aims to measure how much power usage in each boarding room by utilizing the ACS712 sensor and Arduino. The data on the amount of power used will then be displayed in the monitor application (Muhamad et al., 2021). This system allows for the remote monitoring of the workshop room's electrical energy consumption through the use of a smartphone and result data stored in a database that is also displayed to an Internet of Things (IoT) device system.

LITERATURE REVIEW

Characteristics of Power Sources

PLN power source is a source of electrical energy with alternating current (AC) generated from an AC generator. AC power sources produce voltages and polarities that always change from positive to negative polarity or vice versa periodically as a function of time, with a sine waveform (Lakapu et al., 2021).

Environmental Factors' Effect on the Output of Solar Modules

Electrical energy is a unit used to measure electrical energy. The formula can be used to calculate the amount of energy used by electrical equipment, can be seen in the following formula:

$E = P \times W$ ..... (2.1)

E = Energy (Watt Hours)

W = Time (Hours)

Information on the basic electricity tariff is required to calculate the electricity consumption tariff. The basic electricity tariff for a typical household is shown in the following table.

Class/Power	**Description**	**Price list (Rp/kWh)**
R-1/450 VA	Subsidy	415
R-1/900 VA	Subsidy	586
R-1/900 VA-RTM (Affluent households)	Non-Subsidy	1352
R-1/1300 VA	Non-Subsidy	1444.70
R-1/2200 VA	Non-Subsidy	1444.70

1. Arduino Uno

The creation of the Arduino Microcontroller began in early 2005 in Ivrea Italy. The goal was aimed at students who would create interaction design devices. Massimo Banzi and David Cuartielles named Arduin of Ivrea which now more than 120,000 units have been sold worldwide. Arduino is a controller from an open-source single board micro that was created to make using electronics in a variety of applications easier. It is derived from a wiring platform. (Winardi, 2016).

Figure 1. Arduino Uno Board

2. Internet Of Things

The concept of the Internet of Things, or IoT, allows any real-world object to interact with any other object as part of an integrated system by utilizing the internet network as a link. For instance, CCTV installed on the road is linked to the internet and centralized in a control center that could be located several hundred kilometers away or a smart home that can be accessed via an internet connection and a smartphone. In essence, Internet of Things devices are made up of sensors for data collection, servers for data analysis and collection, and internet connections for communication. (Efendi, 2018).

3. Management Information System

The term management information system consists of three keywords: system, information, and management. In order to get a good understanding of this term, there needs to be an understanding of each keyword (Paoki, 2012). An integrated human/machine system that provides information to support operations, management, and decision-making functions within an organization is called a management information system. This system makes use of databases, management and decision models, computer hardware and software, and procedural guidelines. All of the data that the information processing system is capable of accessing is stored in the database. SS(Pt et al., 2018).

METHODOLOGY

Stages Of Research

The stages of this research flow are as follows

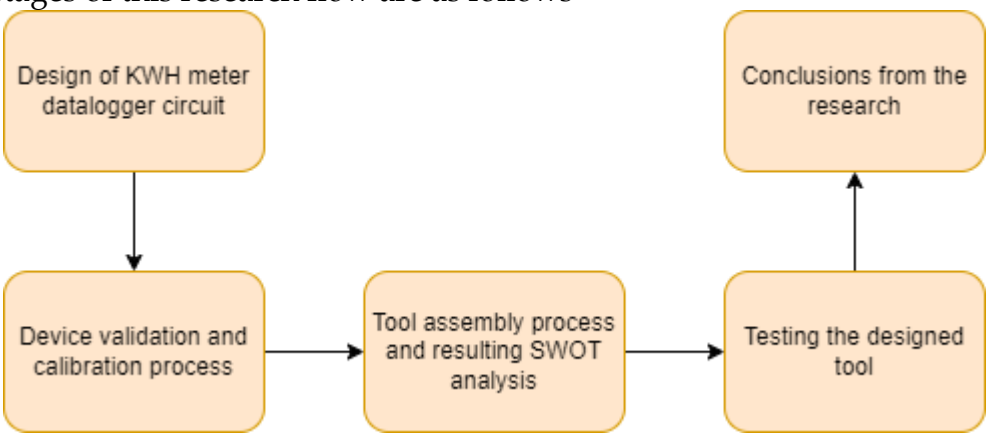


Figure 2. Flowchart of research design

The diagram above illustrates the overall steps in the research process or a general plan of what the researcher will do. The tool assembly stage follows calibration and verification of the sensor's ability to function properly. After assembly of the tool, the researcher takes test measurements under load, records the results and checks whether the tool can function as it should or requires further improvement.

Monitoring System Circuit Diagram Design

Figure 3.6 illustrates how the design of an Internet of Things-based electric power monitoring tool can be put together using several parts. The Arduino Nano microcontroller is used to process data obtained from current and voltage sensors. Can be seen in the following picture.

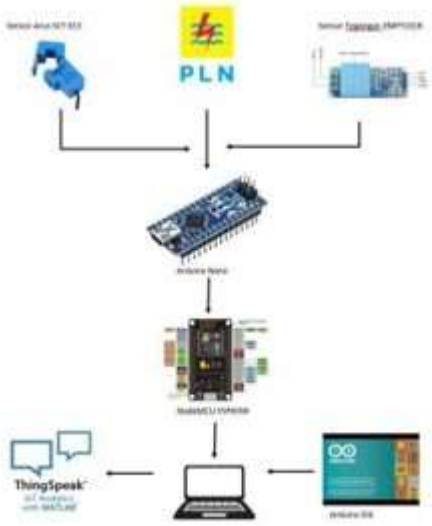


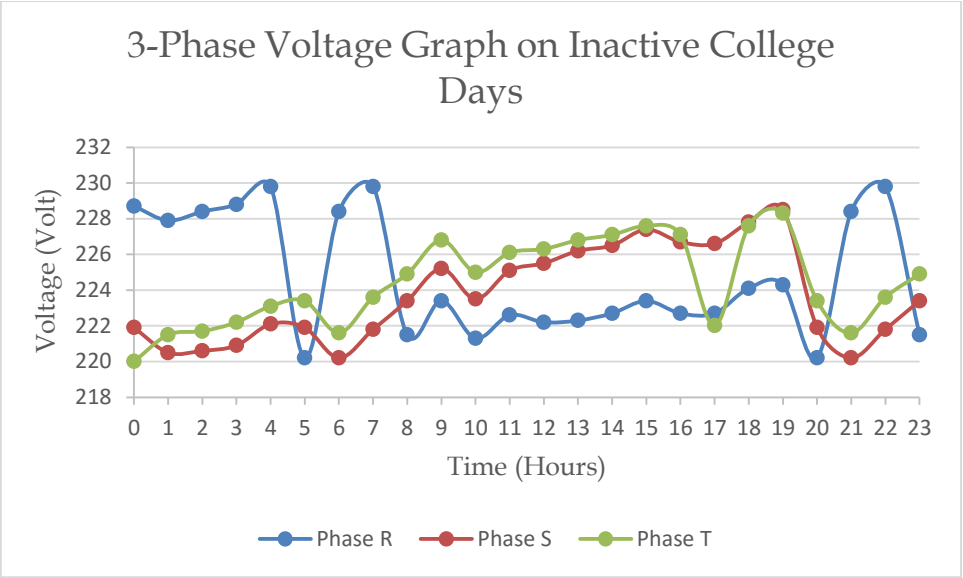
Figure 3. Solar Test Simulator Solar Panel

RESEARCH AND RESULT

Measurement of Inactive College Days

Measurement Day	Measurement Time (Hour)	Phase R (Volt)	Phase S (Volt)	Phase T (Volt)
Monday	00	228,7	221,9	220
Monday	01	227,9	220,5	221,5
Monday	02	228,4	220,6	221,7
Monday	03	228,8	220,9	222,2
Monday	04	229,8	222,1	223,1
Monday	05	220,2	221,9	223,4
Monday	06	228,4	220,2	221,6
Monday	07	229,8	221,8	223,6
Monday	08	221,5	223,4	224,9
Monday	09	223,4	225,2	226,8
Monday	10	221,3	223,5	225
Monday	11	222,6	225,1	226,1
Monday	12	222,2	225,5	226,3
Monday	13	222,3	226,2	226,8
Monday	14	222,7	226,5	227,1
Monday	15	223,4	227,4	227,6
Monday	16	222,7	226,7	227,1
Monday	17	222,7	226,6	222,01
Monday	18	224,1	227,8	227,6
Monday	19	224,3	228,5	228,3
Monday	20	220,2	221,9	223,4
Monday	21	228,4	220,2	221,6
Monday	22	229,8	221,8	223,6
Monday	23	221,5	223,4	224,9

The table above can be seen with the graph below

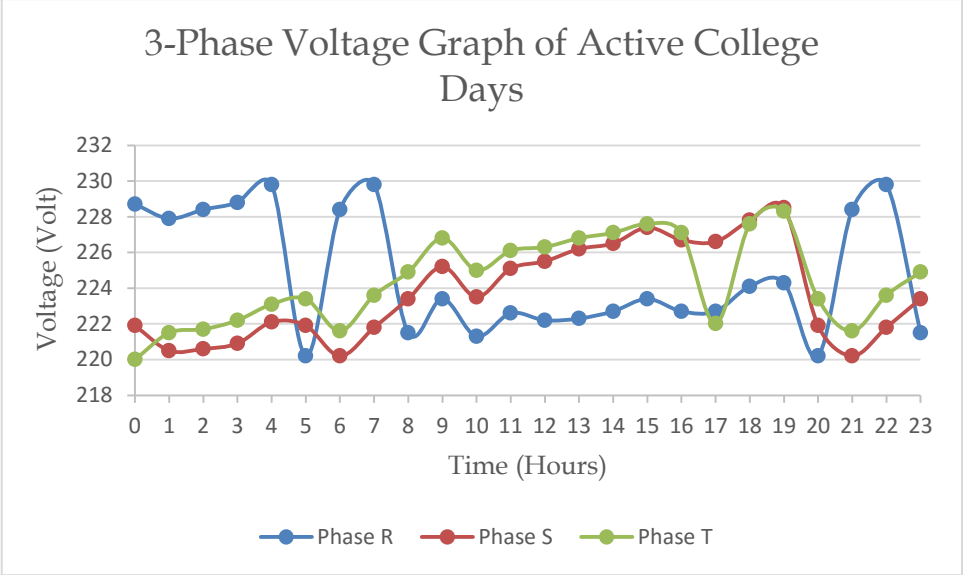


Measurement of Active College Days

Measurement Day	Measurement Time (Hour)	Phase R (Volt)	Phase S (Volt)	Phase T (Volt)
Monday	00	228,7	221,9	220
Monday	01	227,9	220,5	221,5
Monday	02	228,4	220,6	221,7
Monday	03	228,8	220,9	222,2
Monday	04	229,8	222,1	223,1
Monday	05	220,2	221,9	223,4
Monday	06	228,4	220,2	221,6
Monday	07	229,8	221,8	223,6
Monday	08	221,5	223,4	224,9
Monday	09	223,4	225,2	226,8
Monday	10	221,3	223,5	225
Monday	11	222,6	225,1	226,1
Monday	12	222,2	225,5	226,3
Monday	13	222,3	226,2	226,8
Monday	14	222,7	226,5	227,1
Monday	15	223,4	227,4	227,6
Monday	16	222,7	226,7	227,1
Monday	17	222,7	226,6	222,01
Monday	18	224,1	227,8	227,6
Monday	19	224,3	228,5	228,3
Monday	20	220,2	221,9	223,4
Monday	21	228,4	220,2	221,6
Monday	22	229,8	221,8	223,6

Measurement Day	Measurement Time (Hour)	Phase R (Volt)	Phase S (Volt)	Phase T (Volt)
Monday	23	221,5	223,4	224,9

The table above can be seen with the graph below



DISCUSSION

From the graph 3-Phase Voltage Graph on Inactive College Days it can be seen that phase R has a significant difference with phase R and phase T. phase R dropped drasitis at 05.00 and rose again at 06.00 and reached the peak voltage at 08.00. the above results show the difference in the 3-phase graph that is not aligned on the polmed electrical workshop panel.

From the 3-Phase Voltage Graph of Active College Days, it can be seen that on holidays the outpout voltage of the polmed workshop panels
experienced differences in both phase voltage differences and also differences in voltage spikes.

The lowest voltage occurs on Monday at 14.00 with a voltage of 277 V on phase R, this is still in accordance with PLN standards, but for the highest voltage occurs at phase T, which is 277 V.
still in accordance with PLN standards, but for the highest voltage occurs in phase T, which is 238 V, which almost exceeds the permissible voltage limit.
which almost exceeds the permissible voltage limit. Phase R S T has a voltage difference that is voltage difference is quite different because the loading of each phase is also different. This also happens because The load of the polmed workshop panel is a practical room from semester 1 to semester 6 which uses different loads.

CONCLUSION

Based on the results of the process of designing, making, and testing the design of the Energy Management Implementation Monitoring System in the Medan State Polytechnic Electrical Engineering Study Program Workshop, it can be concluded that the large error (Eror) PZEM in measuring Voltage is 0.0198% in measuring Current is 0.612%. in measuring Cosphi is 0.01%. in measuring Frequency is 0.003%. in measuring Power is 0.183%. And the average measurement error rate is below 0.5%, namely 0.23%.

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