Developing Energy Monitoring Application For Monitoring Power Consumption In Production Machines

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***Abstract*— The manufacturing sector in Indonesia is included in the category of countries with large-scale industries. Every day, of course, activities in the industrial sector need a production process and require electric power as a support for ongoing productivity. The power consumption used in the production process needs monitoring and control as needed. Monitoring the power consumption of machines in the PT. Modern Gravure Indonesia has not been well monitored. To make efforts in calculating the amount of electrical power used, a system that can monitor the amount of power consumption on production machines in real-time is needed for carrying out better electricity management. Then an Internet of Things-based system is made which is integrated into the Android-based Energy Monitoring application for monitoring power consumption and cost calculations, this monitoring system for monitoring power consumption uses the STC013 Current sensor as a flow detector and uses the Arduino Pro Mini as a microcontroller in developing a power consumption monitoring system. This research uses System Development Life Cycle that consists of planning, analysis, design, implementation, testing and integration, and maintenance. stakeholders. This Energy Monitoring application is expected to help get real-time power consumption data.**

Keywords-EMon; power consumption monitoring; SCT013 Sensor; production machine; internet of things

I. INTRODUCTION

Electric power consumption is a significant cost component for industrial manufacturing [1]. Large amounts of energy can be saved and energy costs can be minimized using energy audits or monitoring power consumption to optimize production machine performance and improve energy efficiency [2].

Electricity operating costs rank second after raw materials at PT. Modern Gravure Indonesia. Machines used at PT. Modern Gravure Indonesia has different amounts of production capacity and power consumption. To be able to efficiently consume the used, the company requires detailed and real-time monitoring of power consumption data. Apart from being in the industrial sector, energy consumption is also important for everyday life. A few studies have also discussed monitoring power consumption [3][9]. Several journals that discuss the Internet of things are used as study material as a reference [10][13].

It is necessary to control energy consumption in the field of the manufacturing industry to estimate the operational costs that will be incurred so that it can affect the company's cost of production. There is a relationship between energy and income, if there is a lack of energy, income will decrease, and vice versa, if energy use is too high, income can also be reduced [14]. The trend of developing mobile applications has also been implemented in various fields, one of which is the industry, health, education and many more [15][18]. This proves that the use of mobile application technology can help support work easier [4][15][17][18].

Unmonitored power consumption will have an impact on the costs incurred, therefore real-time monitoring of power consumption is needed, especially at PT. Modern Gravure Indonesia, which has never previously conducted real-time data on power consumption. So, this research helps in making a system that can provide real-time power consumption data and provide an estimate of the costs incurred which also have an impact on the cost of goods manufactured on each production machine.

II. METHOD

Energy Monitoring (EMon) application is developed using a system development method, namely the System

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Development Life Cycle (SDLC) [19] with several stages, namely planning, analysis, design, implementation, testing and integration, and maintenance. Meanwhile, at the analysis stage, the data collection method uses the Ishikawa method [20] through discussions with stakeholders with the stages, namely system requirements analysis, functional and non-functional requirements analysis.

A. System Requirements Analysis

For system requirements to be properly fulfilled, it takes an ordered flow starting from planning, system requirements analysis, design, system development, testing, and finally evaluation. At this stage, discussions are held with stakeholders to find out problems and needs. The following describes functional requirements related to monitoring power consumption at PT. Modern Gravure Indonesia:

1) Functional Requirements

The EMon application uses the Internet of Things integrated into the EMon mobile application which is able to provide accurate information in the form of power consumption data used during the production process per manufacturing order. The existing power consumption data is reprocessed to get the total costs that will be incurred from the power consumption. Able to make users understand and understand how to use the EMon application itself.

2) Non-Functional Requirements

This EMon application has several non-functional requirements including minimum specifications that must be owned by system software and hardware, the software needs itself includes the Windows 10 operating system and Arduino IDE. While the hardware needs include personal computing devices with Intel i5 Octa Core @ 1.6 GHz specifications, a suggestion of RAM to use 8GB and a minimum available hard disk capacity of 50GB besides that, several components are needed to build an Internet of Things system, namely 1 ESP8266, Arduino pro Mini, SCT013 amperage sensor, ZMPT10B voltage sensor.

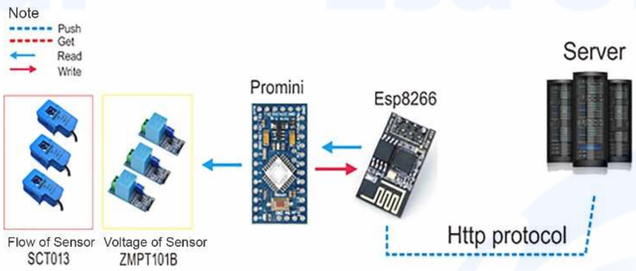

Figure 1. Schematic of the power monitoring system

B. The Scheme of System

The power monitoring system consists of several tools, namely the SCT013 AC amperage sensor whose task is to detect the amount of electric current flowing, the power consumption monitoring system scheme with the Internet of things in Figure 1. It shows several processes, namely reading the flow of electricity flowing by the amperage sensor SCT013, the process of reading the voltage by the ZMPT101B voltage sensor, the reading results from the two sensors will be read by the Arduino pro mini microcontroller after the data calculation process will then be processed by SP8266 to the database with HTTP protocol. The following is an explanation of each component in Figure 1:

1) Ammeter SCT013. This sensor functions as a large detector for the flowing electric current
2) ZMPT101B Voltage Sensor. This sensor is used as a detector for the size of the tank
3) Arduino pro mini. It is a microcontroller where its role is as a data processor that is captured by the sensor
4) ESP8266. The ESP8266 functions as a WiFi module so that it can communicate with the server without using cables as a connecting medium
5) Database / Server. The server in this system functions as a database to store data that the microcontroller processes and sends to the server via the ESP8266

C. How the Device Works

The way the power consumption monitoring tool works starts with the amperage sensor initialization to find out how much electric current is passing and the voltage sensor initialization to find out how much current is the current. If the data is read, it will be sent to the Arduino pro mini microcontroller as a data processor which will then be processed. send it to ESP8266 as a gateway to be sent to the database, the flowchart can be seen in Figure 2.

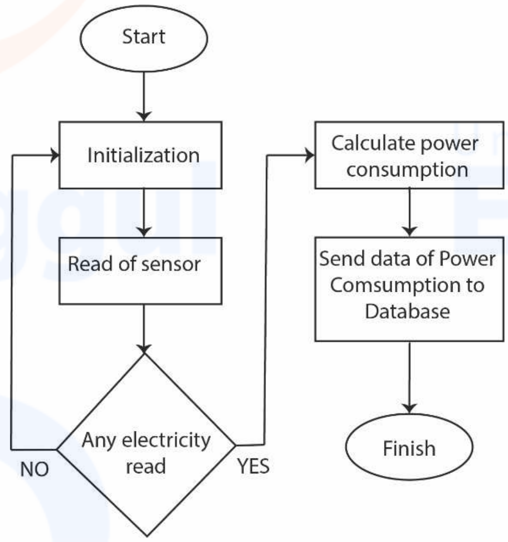

Figure 2. How power monitoring tools work

III. Results and Discussion

A. Analysis

The problems and their analysis sere described in Table 1, as below:

TABLE I. ANALYSING PROBLEMS

Factor	Number	Analysis Results
DATA	1	The power consumption data used so far did not exist and was real time
	2	There was not any report on the power consumption
TOOLS	1	The absence of tools or systems that help monitor power consumption
	2	Not properly monitored causes uncertainty of the cost of production issued

B. Design

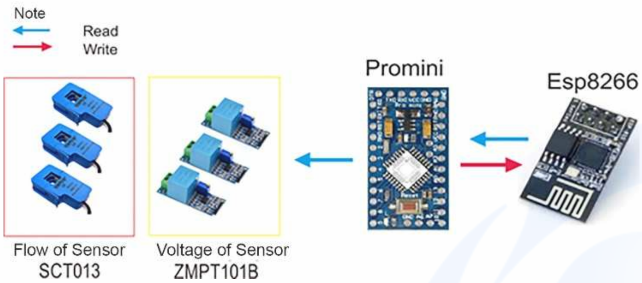

Figure 3. How the tools work

Figure 3 shows a schematic of a power consumption monitoring tool. The following are some of the hardware components used to build a power consumption monitoring system:

1) Sensor SCT013, in Figure 3 the current sensor used is AC SCT013, this sensor will read the current flow

2) Sensor XMPT101B, in Figure 3 the task of this sensor is to read the amount of voltage that passes

3) Promini, in Figure 3 its role as a microcontroller where the data that has been read by the two sensors will be processed.

4) ESP8266, in Figure 3 its role as a gateway between the server and Promini as a data processor to the database.

C. Implementation

The power consumption monitoring system with the Android-based EMon application will display data results in the form of a grid view in the application, where data is obtained from a server or database that is connected to sensors, microcontrollers and ESP8266.

D. Testing and Integration

1) *Results of Power Consumption Monitoring System*

In Figure 4, it can be seen the results of the ACT013 sensor readings on a 3-phase production machine, each of which is read separately, while the current that is read is the current on the R, S, T lines connected to the machine. Figure 5 shows the results of the ZMPT101B voltage sensor readings on a production machine connected to the R, S, T, and N lines.

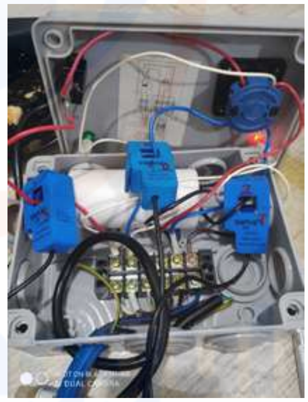
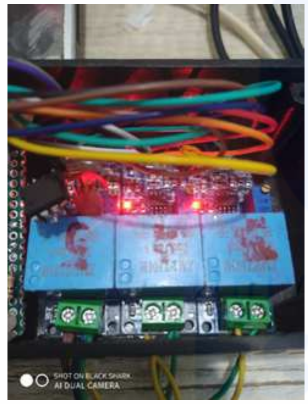

Figure 4. (left) Current measurement results from the tool, and Figure 5. (right) The result of the voltage measurement from the tool

2) *Testing of SCT013 Sencor*

This test was carried out in synchronous, namely, testing simultaneously between the sensor and the digital ammeter and then the accuracy between the digital multimeter and the SCT013 sensor is measured to determine the difference in detecting the current in the engine. Figure 6 shows the measurement, and Table II shows the results of testing the SCT013 sensor.

Figure 6. Testing of SCT013 sensor

TABLE II. TABLE TESTING OF SCT013 SENSOR

Current in Digital Ammeter	Current in SCT013 Sensor			Average Testing	Difference
	Testing 1	Testing 2	Testing 3		
2.2	2.15	2.2	2.2	2.18	0.02
2.25	2.2	2.25	2.2	2.21	0.04
2.2	2.15	2.15	2.09	2.13	0.07
2.2	2.09	2.15	2.15	2.13	0.07
2.3	2.15	2.27	2.25	2.22	0.08

The test results above show that the measurement results were quite good, the current sensor measurements obtained show an average difference of 0.05. This difference in measurement occurred, because the rounding process of the results and the calibration value carried out was still not good, so a better calibration was needed.

3) *Testing of ZMPT101B Sensor*

Testing of the ZMPT101B Voltage sensor is also carried out in synchronous, where the test is carried out by attaching a digital multimeter probe to one of the wire wires, this test is carried out to determine the difference between the results read by the ZMPT101B sensor and a digital multimeter. Figure 7 shows the measurement, and Table III shows the results of testing the ZMPT101B sensor.

Figure 5. Testing of ZMPT101B sensor

TABLE III. TESTING OF ZMPT101B SENSOR

Current in Digital Multimeter	Current in ZMPT101b Sensor			Average Testing	Difference
	Testing 1	Testing 2	Testing 3		
237	234	237	232	234	2.6
235	233	232	235	233	1.6
233	231	232	235	232	1
235	235	235	233	234	1
233	235	237	233	235	2

The test results above also show that the measurement results were quite good, the voltage sensor measurement obtained shows an average difference of 1.64. for the difference in voltage measurement occurred, because the sinusoidal wave reading process is not good from the ZMPT101B sensor.

4) *Display of Login Page at the EMon Apps*

Login is used to check or validate users who will use this mobile application so not everyone who has this application can use this application. If it is not a person who has access to this application and the account has been registered to have access rights to use the MGI stock-taking system mobile application, to be able to access this application requires validation of the username/email and password as can be seen in Figure 8.

Figure 8 (left). Display of Login Page at the EMon Apps, and Figure 9 (right) Display of Machine List

5) *Display of Machine List*

Displays a list of machines from the Android-based EMon application from the menu displayed in the grid view model and there is an icon for each machine to be able to distinguish between one machine type and another on the EMon mobile application, as can be seen in Figure 9.

IV. CONCLUSION

Based on the description above, it can be concluded. The EMon application based on mobile apps runs effectively and can be used optimally according to its purpose and function [15], so that the optimization of the new system has implemented the method used in the study.

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