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Performance Analysis of Energy Smart Control During Idle Time at Iot-Based Vocational School (Smk) Laboratory

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ABSTRACT
A technology that is relatively new to Indonesia. Technology with the implementation of this smart system will be able to support to improve and be able to create reliability and efficiency in power generation and distribution systems. This tool can operate automatically to stop the flow of electrical energy during breaks and the information is conveyed to the building manager by mobile. The results of the SiSCE measurement if the electricity is not turned off during the break time shows that the consumption of electrical energy at rest is almost half higher than the operational hours of office activities. This technology can also help speed up the electrification process in Indonesia. With the aim of saving consumption of electrical energy, to control the use of electrical energy, a smart energy control system is developed by applying Wireless Sensor Network (WSN) and Internet of Thing (IoT) technology which can realize an energy-efficient Smart Office for To support Smart City (SC) in the current Industrial Age, the Energy Smart Control System (SiSCE) Test was carried out at the Laboratorium Sekolah SMK *Office.*

Keywords : Idle Time, Smart Control Energi, SiSCE, IoT, Mobile, WSN

1. INTRODUCTION

Background of the Problem

Idle Time is an unproductive interval that occurs during breaks or when going home at both public and private institutions. Items that are no longer in use, are frequently left on during idle time, resulting in higher electrical energy usage. To control the moment PLN taking over power supply to the load and vice versa, an automatic power supply system transfer is necessary to assist in the transfer of PLTS power supply to PLN power supply. This sort of automatic control is known as an Automatic Transfer Switch (ATS).

The study at Vocational School (SMK) Laboratory shows that 25-30% of electrical energy is wasted during idle time in government offices, 20% in private companies, 25% in industry, 10% in households, and 25% in stores and markets. In comparison to those locations, the Vocational School Laboratory wastes the greatest electrical energy during idle time.

A lot of human labors and longer time are demanded to reduce the electrical energy waste by turning off electronic equipment and lightings in rooms on each floor as well as those that are not in use, Rahmaniar (2017).

Many researchers have carried out studies on electrical energy consumption. For example, Nusa et al. (2015) use an ACS712 current sensor and an ATmega 328 microcontroller to construct tools to monitor electrical energy consumption. Alamsyah et al. (2015) worked on developing a web-based remote-control system for electronic devices. Meanwhile, Zhou et al. (2016) presented the Home Energy Management System (HEMS) for managing electrical energy consumption and combining renewable energy sources. Calvillo et al (2016), on the other hand, offered an electrical energy consumption plan as well as renewable

No.	Activity	Month					
		1	2	3	4	5	6
1	Literary Study	■					
2	Designing		■				
3	Building			■	■		
4	Evaluation					■	
5	Preparation		■	■	■	■	■

energy to realize a smart city. Nonetheless, none of these studies have addressed the issue of electrical energy waste during idle time (outside of working hour).

2. DISCUSSION

1. Energy Smart Control System

It is a set of hardware and software components that work together and are integrated to accomplish a single goal. A smart system (Smart) is one that can be dynamically controlled. As a result, an Energy Smart Control System can be defined as an energy control system that operates dynamically Rahmaniar et al. (2022)

2. Internet Of Things

The internet industry, often known as the Internet of Things, is the emerging paradigm in worldwide networking technologies (IoT)

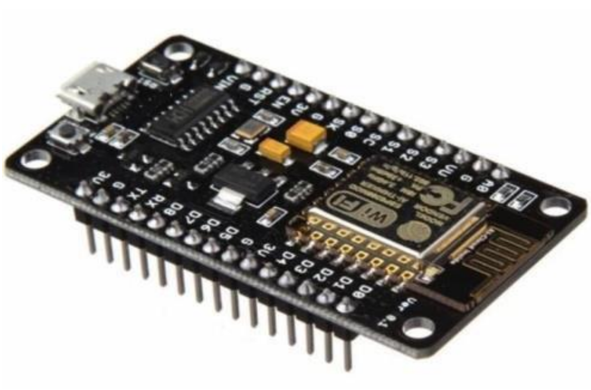

Figure1. ESP8366 IOT Microcontroller

Basic elements for building IoTs:

1. Artificial Intelligence (AI)
   IoT has made practically all existing machines "smart". It indicates that, with the development of AI-based technologies, IoT can improve all parts of our lives. The development of existing technology is carried out by collecting data, artificial intelligence algorithm, and available networks.
2. IoT connectivity
   It is to build or establish new networks, as well as IoT-only networks. This network is no longer reliant on a single service provider.
3. Sensors
   It is to distinguish the Internet of Things from other modern equipment. This sensor has the ability to specify the instrument that changes IoT from a normal network with passive devices into an active system that can be integrated into the actual environment in everyday life.
4. Active Engagement
   IoT presents a new paradigm for active content, product, or service engagement called Active Engagement.
5. Small Size Device
   Small, custom-made devices are used in the Internet of Things to give high precision, scalability, and adaptability.

3. Sensor

A component that detects physical or chemical changes in an object or environment and converts the amount into an electrical quantity.

Types of sensors are as follows:

1. Wireless Sensor Network
2. Arduino
3. WEMOS D1
4. Gateway
5. Relay
6. Energy

3. RESEARCH METHOD

3.1 Schedule

The schedule prepared for designing and building Energy Smar Control System for the idlet time is as follow:

3.2 Tools and Materials

Several tools and resources were required to support the system in this investigation, including:

I. Hardware:

- Arduino Nano 1 piece
- Wemos D1 1 piece
- Max 485Energy Meter Converter 1 piece
- Power Supply 12V 1 piece
- Relay 1 piece
- RTC Module 1 piece
- LCD 16 x 2 1 piece
-

II. Software

- Software C++ 1 piece
- Arduino IDE 1 piece
- Laravel Framework 1 piece
-

3.3 The stages of this study are as follow:

1. Literary Study
   Finding theories about smart control, Energy consumption, Idle Time, IoT, sensors or WSN and others from books, articles and other reference sources.

2. Observasi/Survey
   Doing observations on the School Laboratory building during idle for student activities for initial data collection time at SMK Laboratory which determined as the place for observation.

3. Calculating electricity usage savings using SiSCE.

4. Analyzing data on the use of electrical energy before and after the use of SiSCE.

3.3 Flowchart

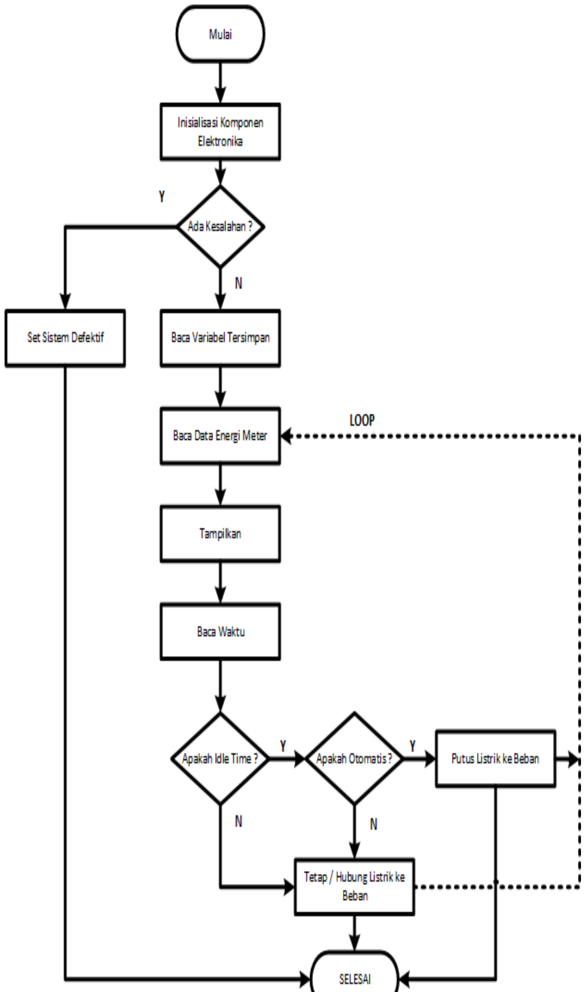

Figure 2. Flowchart SiSCE

The process described by the flowchart can be explained as follows:

1. Start, an instruction to start it
2. Electronic Component Initialization
3. Error checking
4. Defective System Set
5. Reading Stored Variables
6. *Reading Energy Meter Data*
7. Showing the Energy Meter value
8. Reading the time.
9. Parameter Evaluation.
10. Loop

5. DATA AND ANALYSIS

To determine the functionality and performance of the tools, prototyping testing of the assembled tool is required. The hardware, which includes the calibration reading tool and the physical condition of the components (such as test relays and contractors),Agus Junaidi (2021), as well as web testing for the monitoring function, and the software, which includes sending and receiving data and data processing, are the two sections that should be tested. The actual data can be recorded after testing and installing the SiSCE device in the Laboratory building. The manual mode of the tool is used in this data collection so that the contactor does not cut off the power even though the condition is idle. It is intended to measure the electrical energy used during idle time in order to calculate the potential for electricity savings while using this tool.

Figure 3. Location of Test Load

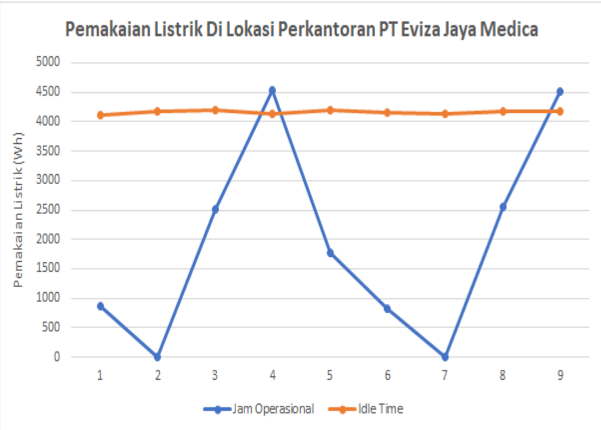

Figure 4. Graph of Electrical Energy Usage

This graph depicts how electricity consumption varies by day during operating hours. This is due to lab activities, and the amount of computer use by students varies from time to time. The data for idle time show that electricity use appears constant, because the load used during idle time is the same even on different days. The 4th and 9th days (both on Fridays) have the highest levels of electricity consumption during operating hours, with 4530 and 4510 Wh consumed, respectively. The use of idle time remains consistent from the first to the last day of the trial period, with a median of around 4163.3 Wh per day in which Saturday and Sunday are not counted due to holidays.

The total amount of electrical energy used in the SMK Laboratoy during idle time is 37,470 Wh. The financial loss can be calculated using the data obtained and the basic building electricity tariff of Rp1100/kWh (B-1 1301-5500 VA), yielding the following results:

Total idle time usage = 37470 Wh.
Duration = 11 days
Idle time/day = 37470
Idle time/day = 406.36 WH/day
Idle time / month = 102190 Wh/month
Idle time / month = 102190 Wh/month
Idle time / month = 102190 kWh/month

Loss per month =
102.190 kWh/month × Rp 1100/ kWh

Loss per month = Rp112,410 / month

With an idle time, load of 10 computers, the above calculation shows that a monthly loss of Rp. 112410 must be paid. Each computer consumes approximately 135 Watts of power. As a result, daily usage is (135 Watt / 1,000) x (10 hours + (30 minutes / 60)) = 0.135 kWh x 10.5 hours = 1.4175 kWh.

From data collected, the total electricity consumption during idle time is very high when compared to the use during operational time. According to the findings of this study, the use of electrical energy during idle time is nearly half that of operating hours. By using SiSCE, you can save up to 50% of your electrical energy or Rp. 112410 per month by automatically turning off the electricity when it is not in use.

5. CONCLUSION

A. Conclusion

The results of designing and actual tool implementation show that:

1. A SiSCE electrical control system that works well and meets the planning expectations has been implemented.
2. It is proven that SiSCE is able to reduce electricity consumption in the laboratory of Private Vocational School (SMK) by up to 50%.
3. The Arduino Nano and Wemos D1 are the most appropriate microcontrollers

designed for electrical and Internet of Things data reading applications.

B. Suggestion

Following a study of the design and manufacturing of this tool, the following points were discovered:

1. In this case, it is discovered that the Arduino Nano used is slow at data processing. As a result, other microcontrollers with faster clock speeds, such as the ESP8266, can be used.
2. For more complex electricity use on a large scale, the number of contactors and relays in this system should be increased.
3. To reduce noise on MODBUS and I2C data lines, communication cables can be covered with conductors that are grounded, and a noise filter can be added to the power supply system.

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