Developing electrical energy saving in State University of Malang

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Abstract. This paper describes miles of developing electrical energy saving in State University of Malang. There are many methods that could be integrated to the electrical energy saving. It started from developing prototype for controlling a small number of devices until implementing for huge devices. In order to improve the method of energy saving, operational expense of electrical devices was added. Furthermore, introducing to optimization process was studied in this paper by developing a prototype. These implementations were studied for implementing as a pilot project at Building of G4 at State University of Malang. It showed that the system could be used appropriately.

1. Introduction
Campus can be considered as a small city consisting of buildings accessed by more than 5000 people [1]. It means that campus should obtain some standards, such a, it shoulds have standards for energy usage efficiency [2]. One of the problems faced in campus is that awareness of students in case of electrical energy usage is still low [3][4], so the cost which should be paid is high. Furthermore, buildings of the campus have been built without considering natural energy [5], so lightings are needed for daily activities, even in the afternoon. Considering these problems, campus needs control and monitoring system for developing energy efficiency [6].

The campus of Universitas Negeri Malang (State University of Malang) has many challenges and potentials for developing and implementing energy efficiency. It has many buildings where a huge number of electrical devices are installed, such as: lamps, projectors, air conditioners, and computers. Those devices are charged by two kinds of electrical power sources, that is, country’s electrical power (CEP), diesel power generation (DPG). The problem is that the capacity of CEO and DPG are different, so loads which are supplied by DPG should be considered furthermore. On the other hand, each building has been integrated with local area network (LAN) and WiFi, so it can be used as a potential media for solving the problems.

Considering those situations, there is a mile of developing electrical energy saving in State University of Malang, which is able to monitor and control a huge number of devices in campus by using LAN and WiFi. The system is described in this paper, which is organized as follows. Section 2 describes the methods, Section 3 describes the results, and Section 4 is devoted to conclusions.

2. Research Methods
The miles of developing energy saving is described as follows.
2.1. Handling a huge number of electrical devices

Generally, a microcontroller can be used to control electrical devices, however it is limited to the number of ports. In order to control a huge number of electrical devices, connection between microcontrollers can be considered to solve this problem. However, wiring connection between devices and microcontroller can bring out another problems, such as high-cost and inflexibility development [7]. So developing a monitoring and control system by using wireless connections can be a challenge for solving the problems. The proposed system consists of a number of Area-Controllers and a Central-Controller. An Area-Controller is developed to control some devices, which are connected as a group and are controlled by a microcontroller, as shown in Figure 1. Each of Area- Controllers represents a classroom and is controlled by a microcontroller. These Area-Controllers are connected to the Central-Controller via WiFi, so users can access and monitor the devices.

![Figure 1. Monitor and Control System using wireless connection](image)

Here, controlling the devices in each Area-Controller can be explained as shown in Figure 2. Conditions the devices, which are switched ON/OFF, are informed by current sensor to microcontroller. Then, the microcontroller delivers them to the Central-Controller via WiFi. In order to monitor and control a huge number of devices, ID number is generated as sequence unique number. So the action controls sent by Central-Controller can be received appropriate device in the specific Area-Controller. Furthermore, action controls are taken based on controlling times, which are determined by users. The Central-Controller can also send control actions as OFF switches, while selected devices are prohibited to be used.

Despite work as monitoring system only, the system works also as controlling system with two modes, that is, manual and optimum modes. Manual mode is chosen when action of administrator is needed. The rest system worked automatically by implementing optimum mode so the electrical power energy sources can be used efficiently. This system is to be implemented in Building G4 of State University of Malang, it consists of two levels. The situations of electrical power sources of the building can be explained as follows. The source of CEP is up to 50A; However the DPG is up to 20A. The diesel will be switched ON automatically when CEP is blackout. Because the capacity of DPG is smaller than CEP, so the devices which could be switch ON are limited and should be selected optimally.

2.2. Adding operational expense prediction

Information of electrical power usage and its expense could be considered to improve the students’ awareness. Since the system can be accessed by users remotely using web-based application. The Central-Controller gets information from Area-Controllers, so it can calculate the length of devices’ usage and daily, weekly, and monthly operational expenses. Data flow diagram of this system can be seen in Figure 2. User can set the time for activating devices; Then, the system sends action control to the devices. The system can also send the electricity usage report and operational cost prediction according to the information returned by electrical sensors. The detail information between user, system, and electrical devices are described in use case diagram, as shown in Figure 3.
2.3. **Improving system by adding optimization process**

As described before that the problem should be considered is that the capacity of CPE and DPG are different, that is, capacity of CPE is 50kVA, while that of DPG is 20kVA. This situation is shown in Figure 4. Considering this situation, supplying electrical power source to the devices in the G4 building should be maintained properly.

In this paper, the Dynamic Programming algorithm is proposed to maintain the electrical power supply. At the first stage, when electrical power of CFE is blackout; current sensor will inform to the system to calculate the load which should be supplied. The second stage, the system is calculate the classroom which could be switched ON, so the loads of RST phase could be balance. The next stage, is determined which devices could be switched ON according the priority. This system can be explained as shown in Figure 5.
3. Result and Discussion
Considering the proposed system described above, the operational system can be explained as follows. Here, the system is tested according to the black box method. The specification of the proposed system is shown in Table 1.

Table 1. Specification of the proposed system

| No | Specification     | Details                                      |
|----|-------------------|----------------------------------------------|
| 1  | Electrical sources| - CEP, DPG                                   |
|    |                   | - Load switching management system           |
| 2  | Load              | - Lamps; electrical devices for learning-teaching |
|    |                   | (LCD, computer, AC, etc.)                   |
| 3  | Data Communication| WiFi                                         |
| 4  | Media             | Running LED, Monitor                         |
| 5  | Working system    | Based on internet of Things (IOT); Area Control System; Central Control |

The proposed system is tried to be implemented as a prototype system. Since the capacity of CEP and DPG is high; then, scaling method is to be implemented smaller as 500VA and 200 VA, while the loads, such as lamp/laptop, projector, and AC are represented with lamps 5watt, 8 watt, and 15 watt.

Figure 6 shows an example of running system. The developed system is added with operational expense. When the condition is blackout and one Area-Controller is selected with one device is switched ON, the record data of expense is recorded. The duration of system to get the data is about 27-28 second, so, calculation of the expense can be recorded as total cost.
4. Conclusion
Based on the results, prototype of electrical energy saving in State University of Malang can work appropriately. The prototype will be tried furthermore to find the efficiency of saving energy of the proposed system, so it can make sure that the proposed system can be implemented to the building.

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