Controller System Module as Technology Solution for Realizing Eco-Campus

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I. INTRODUCTION

Almost global country agreed that sustainable development was issue deserving to get more attention from various society segments and roles. This awareness was considered since the idea of resources availability supporting future human life was increasingly important. Whereas, aforementioned resources were able to be threatened by human's behavior in daily activities. Thus, every human had to contribute and be responsible for maintaining sustainability regardless of their life's back ground. In the case of university as education institution, it was inevitable that university had big role to educate people in sustainable development awareness. Presently, many global universities have already started implementing sustainable development through eco-campus realization. Designing eco-campus efforts could be started from class, environment, waste treatment, sanitation and other installation. However, eco-campus realization was able to be conducted in smaller scope first such as designing comfortable and good green technology for class where the learning process took place. According to the aforementioned background, the general purpose of this paper was to understand, search for technology solution and realize eco-campus. Meantime, the specific purpose of this paper was to identify and implement technology solution such as controller for supportive learning tools (lamps and air conditioning). Thus, electrical energy efficiency would be achieved by using optimum lamps.

II. METHODOLOGY

Research conducted was classified into action research (AR) and it used systems development (SD) method. Action research was a solid methodology process oriented to participatory and action. Action research acted as a series of events and approached for problems solving. As a problem solving approach, action research was scientific method implementation searching facts and experimenting practical problem which needed problem solving such action involving collaboration and cooperation from researcher and member of relevant organization. Dick (2002) argued that action research was research methodology focused on obtaining dual outcome of research and action. This method was not only used for social disciplines and society, but also in business organization, for study about production and operations management (e.g. Coughlan and Coughlan, 2002), and for information systems (e.g. Grant and Ngwenyama, 2003). Furthermore, technology solution development for eco-campus realization was conducted through several alternatives. So that, the alternatives needed to be well selected. In detail, there were two steps in developing the solution such as measuring and analyzing the luminous intensity; and designing controller system module.

III. RESULT

1. Luminous Intensity Measurement and Analysis

As a pilot project, class rooms of Engineering Faculty were chosen. It consisted of large room with capacity of 120 students. Figure 1 showed the condition of observed class before implementing the module. In this existing condition, there were 4 units of air conditioning and 48 LED lamps in large room controlled by four switches; and 3 units of air conditioning.

Figure 1 Existing Condition of Observed Class

Based on the existing condition, it was necessary to analyze the equalization of luminous intensity as lamps grouping consideration. 48 LED lamps in existing condition were grouped into 4 blocks and controlled by 4 switches. In term of equalization of luminous intensity, measurement of luminous intensity was conducted in certain points such as follows.

	White board		
2	3 S2	6 S4	7
	S1	S3	
1	4	5	8

Data harvesting was conducted by student employee briefed by revealing the goal and step of this research. Thus, they knew about their role and contribution. Luminous intensity measurement was noted and displayed as intensity distribution in contour plot for large room and small room. It was graphically presented by figure 2.

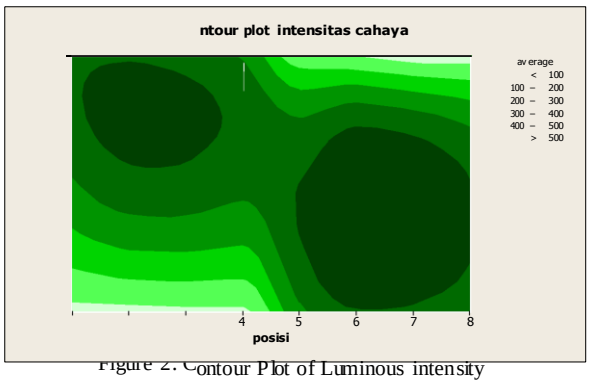

Figure 2. Contour Plot of Luminous Intensity

Based on figure 2, differences in luminous intensity emerged from some certain areas in classroom. Those differences were probably caused by outer coruscation. In case of attaining a good luminous intensity, class participant would congregate in certain area. Thus, the lamp position needed to be considered to contribute the over whole luminous intensity in classroom. Whereas, the initial setting of switch system for lamps was using two block systems. First block was used for 24 front lamps and second block was used for 24 rear lamps. Besides the luminous intensity data and switch system, other obtained fact was class participant deployed unevenly in the classroom. Therefore, ignition all of the lamps during class activities would be inefficient thing. In fact, not only the ignition all of the lamps, but also the ignition of others supportive resources for class activities which was in overused. In ideal situation, the use of resources was adapted based on the needs. Therefore, switching system was rearranged by considering the following provision:

- There are 2 class sides having numbers of window so the outer light is able to penetrate the class since morning to evening
- Class front side, place for LCD Projector, needs higher luminous intensity than the place where students seat in order the students will get clear appearance
- Foremost seats are exactly placed under the third-row lamp counting from front side
- Class side which is windowless, especially in hook side, has the lowest luminous intensity

In execution, lamps grouping were conducted as follows.

- 48 LED lamps were grouped into 6 blocks and controlled by 6 switches
- Luminous intensity for place where students seat was set on range of 250-350 lux, whereas for LCD projector area (front side) was set on range of 100-200 Lux
- If there was no penetration from outer light (in case of night or cloudy), then either all six lamp groups should turn on or lamp groups of A, B, C, E and F should turn on. It depends on luminous intensity of LCD projector screen.
- If any outer light penetrated from class-left-side window, then only lamp groups of A, B, C and F should turn on
- If any outer light penetrated from class-right-side window, then only lamp groups of A, C, E and F should turn on
- If any outer light penetrated from class-left-side window and class-right-side window, then only lamp groups of A, C and F should turn on

Figure below showed the setting of lamp groups.

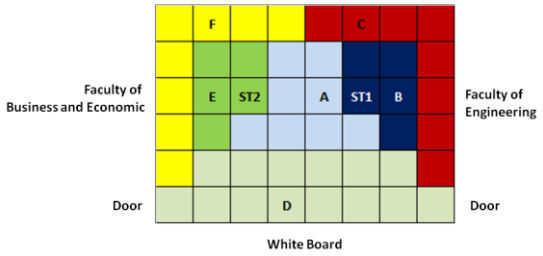

Figure 3. Layout of lanp

2. Controller system module design

Presently, various hardware assortment modules are available in market which is able to be used for room controller. There were three alternatives of hardware modules analyzed in this paper which is probably suitable to be used as room controller. They are Arduino UNO R3, Arduino MEGA 2560, and Raspberry Pi2. Here is the comparison of specification among those three hardware modules.

TABEL 1. ARDUINO UNO R3, MEGA 2560, AND RASPBERRY PI2 COMPARISON

Feature	Arduino UNO R3	Arduino MEGA 2560	Raspberry Pi2
Prosesor	ATMEGA 328	ATMEGA 2560	ARM Cortex-A7 (Quad core)
Clock Speed	16 MHZ	16 MHz	900 MHz
Flash	32 KB	256 KB	Eksternal Micro SD Card
RAM	2 KB	8 KB	1 GB
EEPROM	1 KB	2 KB	N/a
Analog input	6 10-bit inputs	16 10-bit inputs	None
Digital PIO	14	54	26
UART	1	4	1
Ethernet	N/a	N/a	10/100
Video out	N/a	N/a	HDMI
USB2.0 port	N/a	N/a	4
Dev IDE	Arduino tool	Arduino Tool	Linux OS
Multi tasking	N/a	N/a	Support
Price	Rp. 363.000,- USD 24.95	Rp. 608.000,- USD 38.69	Rp. 590.000,- USD 35

Room controller module was able to be connected with several sensor (such as temperature and light sensor), several actuator (such as lamps and air conditioning unit), and server computer using wireless communication and LAN (*Local Area Network*). Based on the comparison above, Raspberry Pi2 was chosen as used hardware module controlling the room. The main consideration was Raspberry had higher clock speed, able to use micro SD card to save a huge memory, had Ethernet port, had high RAM (1GB), had many digital IOs (26 units) and had equal price with others

3. Implementation

The mechanism of module after being implemented was explained by following flowchart:

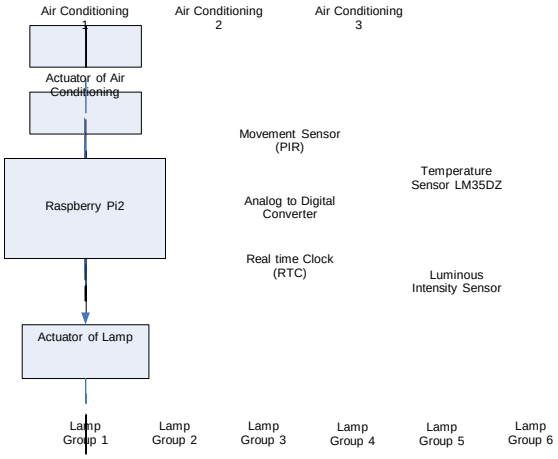

Figure 4. Flowchart of controller module mechanism

Based on the schedule of classroom activities, it was discovered that the class which was facilitated by 48 units of 14W LED Lamps was used every day from 07.00 to 18.30. In this situation, the electrical energy was measured when controller module was not used and was used. Harvesting data was conducted in a week for controller module was not used and a week for controller module was used. The obtained data was presented on Table 2.

TABLE 2. MEASUREMENT OF ELECTRICAL ENERGY

Lamp		Air Conditioning	
No Controller Module	Using Controller Module	No Controller Module	Using Controller Module
1.4	1.1	90	64.1
2.8	1.7	76.2	61.5
0.6	0.7	68.1	65.6
1.8	2.9	38.5	62.3

IV. CONCLUSION

Realizing eco-sustainable campus through technology solution design was conducted by designing controlling system to control ON/OFF system for lamps and air conditioning based on classroom condition, availability of people in room which was detected by PIR motion sensor. By using this controller system, ignition of lamps and air conditioning was based on the needs. Thus, it would result the significant reduction of energy use during the class activities. The alternative module selection process and module design was conducted based on literature study and experiment.

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Chair Welcoming Speech

Welcome to the 8th Widyatama International Seminar on Sustainability (WISS) 2016. It is a great pleasure for Faculty of Engineering, Widyatama University to be hosting this biannual event. WISS 2016 is a right event to declare that Widyatama University concerns about increasing quality of research especially from all Indonesian researcher. It is a great pleasure that WISS 2016 have experienced to held Pre-Seminar Workshop with 4 (four) different topics are ERP Implementation on Healthcare, LEAN in Services Company, Supply Chain Strategy in Emerging Countries and How to be a Good Book Writer, and also WISS 2016 in conjunction with Center for Sustainable Systems (CSS) Widyatama University held Sustainable Energy Panel, as a forum to share experience and engaging community for sustainable development in all emerging countries.

The main purpose of the 8th Widyatama International Seminar on Sustainability (WISS) 2016 with our selected theme "Addressing Global Sustainability Challenges in Business and Industry through Technology, Governance and Culture", is to provide an international community to discuss and solve the problem related with sustainability in the world.

This seminar will have 1 (one) keynote speaker, 4 (four) invited speakers, and has gathered more than 120 papers from more than 10 different countries all over the world. After very strictly review process we have acceptance rate of this seminar is 68,5%. It's means that Widyatama University keep growth to increase the quality of papers in all seminar, and hopefully in WISS 2020 we can reached the acceptance rate less than 40%.

I would like to say thank you for all speakers, contributors, and participants for the generous support. I would also like to thank all members of Steering Committee and Organizing Committee of WISS 2016, and our distinguished international board of reviewers for all of their support and advice. Our thank you to all of our sponsors, supporters, exhibitors, and professional associations for the support through committed funding and any other form of help and support. We also owe our success to the full support of the Chairperson of Widyatama Foundation, Rector of Widyatama University, and all Deans of Widyatama University. Thank you to IEEE Indonesia Section that has supported WISS 2016 to be approved as IEEE Conference.

We wish you a pleasant and memorable stay in Bandung. Thank you and we hope to see you again in the WISS 2018.

Dr. Oktri Mohammad Firdaus, M.T.
Chairman of WISS 2016

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