*International Journal of Research and Review*
*Vol. 11; Issue: 1; January 2024*
*Website: www.ijrrjournal.com*
*Research Paper* *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

# An Implementation of Lighting Control Systems Buildings with Time Based Mapping and AC Light Dimmer Integrated IoT

**Maharani Putri[1], M. Syahruddin[2], Gunoro[3], Moh. Zainul Haq[4], Abdullah[5]**

[1,2,3,4,5]Politeknik Negeri Medan, Medan, North Sumatera Indonesia.

Corresponding Author: Maharani Putri

**DOI: https://doi.org/10.52403/ijrr.20240149**

## ABSTRACT

The use of a building lighting control system is very necessary to regulate lighting in a building to suit needs, because not only low lighting conditions can cause discomfort, lighting conditions that are too bright can also cause discomfort. The problem is that natural light cannot play much of a role in lighting buildings which are generally closed and have minimal ventilation, as well as the availability of lighting which, if not controlled properly, cannot directly meet the lighting needs of the building, whether it is the value of the light intensity produced, mapping the lighting of the lights, setting the duration of the use of lights as lighting or in the case of excessive lighting by turning on all the available lights in the room becomes a problem in terms of efficient use of electrical energy, so a special system design is needed to overcome this problem, namely the implementation of a building lighting control system. with time-based mapping and an AC light dimmer integrated with the Internet of Things which has a specific purpose as a system for controlling building lighting to suit needs, whether it is setting the light intensity value, mapping the use of lights or setting the time of use of lights as lighting. The test results have shown that the implementation system for the building lighting control system with time-based mapping and AC Light Dimmer which has been integrated with the Internet of Things as remote control and monitoring communication has been successfully implemented and is working well according to the specified targets.

***Keywords:*** lighting, AC light dimmer, mapping, Internet of Things.

## INTRODUCTION

Lighting control system by regulating the use of the number of lights and light intensity in a room, such as in a building that is very closed, has minimal light ventilation and has a fairly large room capacity with different lighting concept requirements for events taking place in the building such as seminars, wedding events or music concerts, lighting control system designs continue to be developed.

Some of the problems with lighting in building spaces are that natural light cannot be expected and plays a big role in building lighting which is generally closed and has minimal ventilation, weather changes that can occur at any time and the uneven distribution of natural lighting, especially for large rooms that have depth so that lighting cannot enter the room evenly (Azizah& Iyati, 2017), as well as the availability of lighting which is generally available in large quantities, especially in large and closed building spaces, so that if it is not controlled properly, it cannot immediately meet the building's lighting needs because it is not only low lighting conditions that can create discomfort, as well as lighting conditions that are too bright can also create discomfort (Al Amin, Emidiana, & Nurdiana, 2020), so that the value of the light intensity produced,

mapping the number of lights on, setting the duration of the use of lights as lighting or in terms of lighting Excessive use of turning on all the available lights in the room is a problem in terms of the efficient use of electrical energy which must be controlled so that the building space can be used comfortably and efficiently (Pradanugraha, Rahardjo, Aryani, & Husnayain, 2021).

Therefore, it is very necessary to have a room management system that can work efficiently. In this research, an implementation of a building lighting control system with time-based mapping and AC light dimmer integrated with the Internet of Things is designed, where this system will control building lighting to suit needs, including setting the light intensity value, mapping the use of lights and setting the time to use lights as lighting.

The method used is a mapping technique so that the amount of lighting used can be mapped according to needs, an AC light dimmer concept so that the light intensity value can be adjusted according to needs and time settings so that the duration of use of lights as lighting can be adjusted according to needs. This system has also been integrated with the Internet of Things as remote real-time control and monitoring which can be monitored using only a smartphone which includes an application to support the system's work, namely displaying measurements of lighting intensity values, monitoring mapping of lighting lamps, inputting time values for the use of lighting lamps and also Manual control of the lights is available to turn the lights on and off according to the desired lighting needs so that this system can be implemented in society and industry.

The problem formulation in this research is how to design and implement a building lighting control system with time-based mapping and AC light dimmer integrated with the Internet of Things, how effective the mapping technique is in regulating the amount of lighting used through a mapping algorithm to suit needs, what is the effectiveness of the AC concept light dimmer in adjusting the light intensity value according to needs and how effective the time setting is so that the duration of use of the lamp as lighting can be adjusted according to needs and how the effectiveness of Internet of Things technology is designed as a real-time remote system control and monitoring feature to ensure the system works well.

## LITERATURE REVIEW.

### 2.1. Lighting Control.

The lighting control system for a room is not only useful in providing comfort to the users of the room, but setting the right lighting according to needs can also reduce the use of electrical energy. Electrical energy is very important and cannot be separated as a daily need for society. Without electrical energy, many things cannot be done and the use of electrical energy continues to increase very significantly every year (Pradanugraha et al., 2021) .

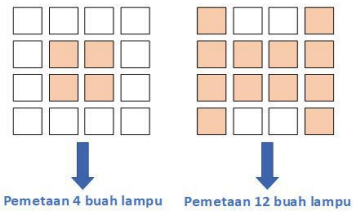
The use of natural light can reduce the use of electrical energy, but there are many factors that cause natural light to be unpredictable and play many roles, including changes in light that can fluctuate and the uneven distribution of natural light into a room so that many parts of a room are poorly lit. not distributed properly and certainly does not meet lighting standards (7062:2019, 2019). A control system for the use of lighting is something that is really needed to meet lighting standards in a room.

### 2.2. Mapping Method

Mapping method or often called mapping algorithm (Chin, Teo, Ibrahim, Othman, & Wahab, 2019), in this research the mapping is carried out on the availability of lighting in a building room in a certain amount but can be turned on/activated only in a certain number of lights. just with the concept of mapping algorithms. Mapping is carried out based on light intensity requirements in regulating the number of lighting lamps used through a mapping algorithm to suit needs, for example if in a building there are

16 (sixteen) lighting lamps, but all sixteen lamps do not always have to be turned on, there could only be 8 lamps, or 12 lamps or other quantities.

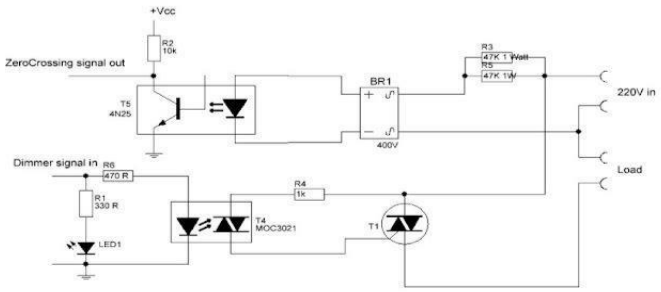
Determining the number of lamp lifetimes is the concept of a mapping algorithm that communicates with a light intensity (lux) sensor. For example, if we need a light intensity value, for example 250 lux and it turns out we only need 4 lights, then only 4 lights are turned on and the same goes for other conditions.




**Figures 1. Several mapping processes were carried out for the availability of 16 lamps**

## 2.3. AC Light Dimmer

A dimmer is an electronic circuit that functions by changing the form of a pure AC signal into chunks of signals so that the chunks of signal can change the output power. The complex dimmer circuit is equipped with a PWM feature, with the aim of producing signal cuts/levels so that precise control can be carried out. AC light dimmer is an electronic circuit that can control the AC voltage value for the light load. Through this AC light dimmer, the time intensity setting can be adjusted from the PWM signal that is connected to the controller (Kardha, Haryanto, & Aziz, 2021). The AC light dimmer circuit can be seen in Figure 2 below.




**Figures 2. AC Light Dimmer Circuit**

Based on the picture above, there is a pin zero crossing feature so that the controller used knows the appropriate time/timing in the process of sending the PWM signal, because if the time/timing is not appropriate it will produce a chaotic signal at the output so that the function of the dimmer circuit does not work.

## 2.4. Internet of Things (IoT).

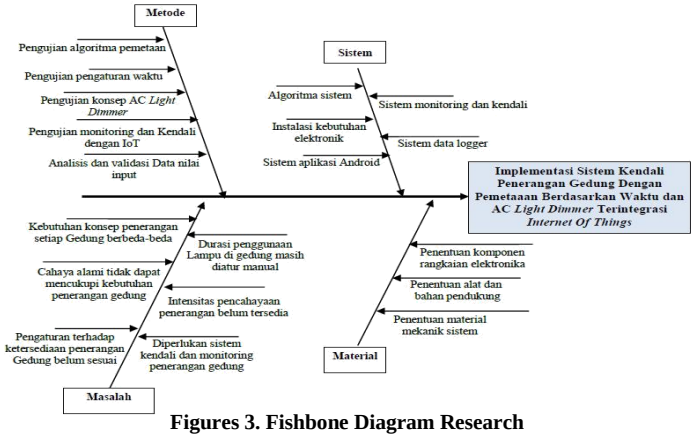
Internet of Things uses the concept of utilizing the internet network to communicate between objects, this communication can be carried out according to needs, such as the process of sending data, recording data, analyzing data (Husna, Hidayat, & Mursyidah, 2019). Through Internet of Things technology, a system can be expanded and developed. Through IoT-based communication, it can facilitate the flow of data information between systems. The process of communication needs to involve humans directly, meaning that a system can stand alone and carry out the communication process according to the algorithm that has been given in the designed system (Rahman et al., 2020). In this research, a building lighting control system was designed so that the Internet of Things concept used can integrate hardware with communication media such as smartphones, meaning that the control and monitoring communication process can take place well and flexibly.

## METHOD

The research method used in this research combines the hardware part and the

software part, where the hardware consists of mechanical design and electronic requirements design. Meanwhile, the software part consists of programming requirements such as mapping algorithms and application feature requirements for the control and monitoring process carried out using Internet of Things-based technology, which utilizes mapping techniques so that the number of lighting lamps used can be mapped according to needs, the AC light dimmer concept so that the value can be adjusted. light intensity according to needs and time settings so that the duration of use of lights as lighting can be adjusted according to needs, the use of the Internet of Things as remote real-time control and monitoring obtained is monitored only using a Smartphone which includes an application to support the system's work.

The implementation of activities is carried out based on the research roadmap on the fishbone diagram which can be seen in Figure 3 as follows.




**Figures 3. Fishbone Diagram Research**

The Fishbone diagram above explains the work flow for implementing a building lighting control system with time-based mapping and AC light dimmers integrated with the Internet of Things so that the implementation of research activities can be in accordance with research achievements, where the problem arises that the lighting concept needs for each building are different depending on the needs of events in the building.

Meanwhile, natural light cannot play a good role in meeting the lighting needs of buildings which are closed rooms, the availability of lots of lighting lamps is not necessarily according to needs without regulation of these lighting lamps, there is still manual regulation of the duration of lamp use and there is no regulation of the intensity of lighting light, So we need a system that can control and monitor building lighting so that it matches what is desired or needed. In this system, building lighting will be controlled to suit needs, including setting the value of light intensity, mapping the use of lights and setting the time of use of lights as lighting using mapping techniques so that the amount of lighting used can be mapped according to needs, the AC light dimmer concept so that it can regulate the value. light intensity according to needs and time settings so that the duration of use of the lamp as lighting can be adjusted according to needs.

This system has also been integrated with the Internet of Things as remote real-time control and monitoring which can be monitored using only a smartphone which includes an application to support the system's work, namely displaying measurements of lighting intensity values, monitoring mapping of lighting lamps, inputting time values for lighting lamp usage and also Manual control of the lights

is available to turn the lights on and off according to the desired lighting needs.

Basically the subject of this research is a system that focuses on controlling and monitoring building room lighting where this system will control building lighting to suit needs. whether it's setting the light intensity value, mapping the use of the lights or setting the time to use the lights as lighting. The method used is a mapping technique so that the amount of lighting used can be mapped according to needs, an AC light dimmer concept so that the light intensity value can be adjusted according to needs and time settings so that the duration of use of lights as lighting can be adjusted according to needs.

This system has also been integrated with the Internet of Things as remote real-time control and monitoring which can be monitored using only a smartphone which includes an application to support the system's work, namely displaying measurements of lighting intensity values, monitoring mapping of lighting lamps, inputting time values for the use of lighting lamps and also Manual control of the lights is available to turn the lights on and off according to the desired lighting needs. The research design carried out was an Arduino Mega which functioned as a processing center for all data, both input and output. The input used in this research design is 5 (five) GY-30 series Lux sensors, these five Lux sensors are distributed evenly in the building room to get an average value of lighting intensity in the building room, so that the Lux value is measured in the room. it's accurate. DS3231 RTS module enabled so that time calculations can be done accurately in real time, Esp32 functions as a designed system WiFi module, so that communication between the system and applications on the Smartphone can be integrated both for control and monitoring.

Meanwhile, the output controlled by the Arduino Mega, namely the AC light dimmer module, is used to regulate the light intensity of each of the 16 lighting lamps in the room. These lighting lamps are controlled based on the lighting needs of the room, meaning mapping the on and off lights, light intensity and the duration of the lighting time setting is controlled based on algorithms input into the Arduino programmer.

## RESULT

### 4.1. Implementation A Building Lighting.

The results and discussion of the research on the implementation of a building lighting control system with time-based mapping and AC Light Dimmer integrated with the Internet of Things consists of seven tests, namely testing the results of sensor-lux readings, testing the percent error of sensor-lux readings, testing the five sensor-lux values for activating the number of lights, testing mapping method without AC Light Dimmer, testing the mapping method with AC Light Dimmer and system testing based on time settings as well as testing the entire Internet of Things integrated system using the Blynk application. The following are the results of the system design in Figure 4.

**Figure 4. System Design Results**

### 4.2. Testing Sensor Lux Reading Results

This test shows the reading results of the five GY-30_Lux sensors in reading the

lighting lux for each activation of the number of lights in the room, which has been processed by the Arduino controller via I2C communication. This test also shows the results of the Lux Meter (Manufacturer) readings on the placement position of each Lux sensor has been designed, with the aim of obtaining accuracy comparison data between the readings of the five system sensors and the Lux Meter (Manufacturer) readings, from the results of these Lux sensor readings which will determine the number of lights activated.

**Table 1. Testing System Sensor Lux Reading Results with Lux Meter Readings (Manufacturer)**

| | | | | | | | | | | Average | Average | Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GY-30 Lux Sensor | | | | Lux Meter Reading (Manufacturer) | | | | | reading | Reading | Activation |
| | | | | | | | | | | Lux Sensor | Lux Meters | Light |
| Lux_1 | Lux_2 | Lux_3 | Lux_4 | Lux_5 | Lux_1 | Lux_2 | Lux_3 | Lux_4 | Lux_5 | GY-30 | (Manufacturer) | |
| 60.5 | 78.79 | 68.28 | 60.20 | 37.51 | 61 | 80 | 70 | 52 | 38 | 59,174 | 60.20 | 1 |
| 136.46 | 142.68 | 142.76 | 125.80 | 101.07 | 135 | 144 | 145 | 102 | 103 | 124,848 | 125.80 | 2 |
| 224.57 | 237.72 | 266.22 | 235.00 | 219.49 | 225 | 240 | 264 | 223 | 222 | 233,846 | 235.00 | 4 |
| 342.05 | 359.16 | 381.18 | 342.40 | 315.35 | 340 | 362 | 379 | 318 | 313 | 342,588 | 342.40 | 6 |
| 421.04 | 441 | 475.15 | 432.40 | 416.85 | 419 | 443 | 473 | 407 | 420 | 432,842 | 432.40 | 8 |
| 557.26 | 588.84 | 598.11 | 547.20 | 495.28 | 560 | 592 | 595 | 491 | 498 | 545,426 | 547.20 | 10 |
| 616.5 | 650.62 | 692.57 | 634.80 | 607.55 | 621 | 654 | 697 | 598 | 604 | 634,168 | 634.80 | 12 |
| 639.29 | 715.03 | 724.06 | 663.80 | 616.77 | 643 | 710 | 720 | 634 | 612 | 664.85 | 663.80 | 14 |
| 795.76 | 830.14 | 864.52 | 808.60 | 772.1 | 792 | 835 | 870 | 770 | 776 | 805,714 | 808.60 | 16 |

Table Description:
Lux_1: Lux1 Sensor, Lux_2: Lux2 Sensor, Lux_3: Lux3 Sensor, Lux_4: Lux4 Sensor, and Lux_5: Lux5 Sensor.

The average reading of the GY-30 Lux sensor and Lux meter (Manufacturer) is the average value of the five lux sensors, as a reference value for reading the light intensity (Lux) of the room. The number of lights activated is a test of the lux value reading for each number of lights that are turned on

**Figure 5. Testing the GY-30 Lux Sensor Reading Results against the Lux Meter 5.1.2. Sensor_Lux Reading Percent Error Testing**

This test shows the results of the percent (%) error in the Lux GY-30 sensor readings between the system design and the Lux Meter (Manufacturer), so that we know the level of accuracy between the

readings of the five system sensors and the Lux Meter readings (Manufacturer).

**Table 2. Percent Value (%) Error between System Sensor Readings and Lux Meter Readings (Manufacturer)**

| Lux sensor reading error percentage | | | | | Average Percent Error |
|---|---|---|---|---|---|
| Lux_1 | Lux_2 | Lux_3 | Lux_4 | Lux_5 | sensor reading (%) |
| 0.82 | 1.51 | 2.46 | 2.33 | 1.29 | 1.68 |
| 1.08 | 0.92 | 1.54 | 0.72 | 1.87 | 1.23 |
| 0.63 | 0.95 | 0.84 | 0.79 | 1.13 | 0.87 |
| 0.6 | 0.78 | 0.58 | 0.88 | 0.75 | 0.72 |
| 0.49 | 0.45 | 0.45 | 0.78 | 0.75 | 0.58 |
| 0.49 | 0.53 | 0.52 | 0.68 | 0.55 | 0.55 |
| 0.72 | 0.52 | 0.64 | 0.94 | 0.59 | 0.68 |
| 0.58 | 0.71 | 0.56 | 0.77 | 0.78 | 0.68 |
| 0.47 | 0.58 | 0.63 | 0.51 | 0.5 | 0.54 |

Based on Table 2 above, it can be seen that the percentage error value between the system sensor readings and the lux meter (manufacturer) readings is quite low, it can be seen that the largest percentage error value is 1.68%, which is still categorized as low and suitable for use as a measurement of light intensity.

## CONCLUSION

The conclusions of this research are the results of testing the implementation of a building lighting control system with time-based mapping and AC Light Dimmer integrated with the Internet of Things which has been successfully carried out and works well according to the specified target where the five sensor_lux readings have worked well and have a percent the error is quite low from the comparison results using the manufacturer's lux meter from the reading results of the five lux sensors which have been able to activate the number of lights using a mapping algorithm, with the use of the AC Light Dimmer technique the mapping results with the desired Lux setting results have almost the same value compared to without there is the use of an AC Light Dimmer so that the lux setting value can be the same as the room lux reading results, plus there is a time setting feature so that the time pattern input can be activated and deactivated according to the specified time setting and there is manual control which makes the room lux control concept more flexible and all tests of the entire Internet of Things integrated system in carrying out the setting and monitoring process remotely and can be seen via Smartphone so that the lighting conditions in a room can be regulated and monitored properly and the lighting values can be maintained according to the needs of the room use.

***Declaration by Authors***

**Acknowledgement:** None

**Source of Funding:** None

**Conflict of Interest:** The authors declare no conflict of interest.

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How to cite this article: Maharani Putri, M. Syahruddin, Gunoro, Moh. Zainul Haq, Abdullah. An implementation of lighting control systems buildings with time based mapping and AC light dimmer integrated IoT. *International Journal of Research and Review*. 2024; 11(1): 445-452. DOI: *10.52403/ijrr.20240149*

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