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# Energy use Intensity and Assessment of Electrical Savings in Lighting and Air Conditional Systems within Academic Buildings

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**Abstract:- This study focuses on the assessment of energy use intensity and the potential electrical savings in the lighting and air conditioning systems of academic building. The approach utilizes the Indonesia National Standard (SNI) ad a frameworkm specially employing the Energy Use Intensity (EUI) metric. Findings indicate that a condiderable number of rooms on each floor in the academic building do not meet the criteria set by the Indonesia National Standard for both lighting and air conditioning. Furthermore, the audit of Energy Use Intensity (EUI) in the air conditioning system reveals a classification of "Highly Inefficient," with an average EUI value of 24.84 kWh/year. Recommendation includes the establishment of a dedicated team and the implementation of an energy management system to ensure the efficient and effective use an equipment and sytems. The study emphasizes the significance of adopting energy efficiency measures in academic buildings to achieve notable electrical savings and comply with established standards.**

***Keywords:-*** *Energy use Intensity; Lighting; Air Conditioning; Electrical; Efficiency.*

## I. INTRODUCTION

In 2019, the electricity consumption of end consumers globally surpassed 22,850 TWh, constituting 21% of the final energy consumption. The energy usage was distributed among three sectors, with buildings contributing over 10,900 TWh (10%), industry exceeding 9,500 TWh (9%), and transportation accounting for over 420 TWh (0.4%) (IRENA, 2022). In 2014, Indonesia experienced an economic growth of 6.1%, coupled with a population growth of 1.1%, leading to an anticipated 7% rise in energy demand. Fossil fuels dominated primary energy availability, comprising 46% across various sectors, with coal at 29%, natural gas at 21%, and the commercial sector contributing 4.4%. Assuming an average annual electricity growth of 7% over 30 years, Indonesia's final energy consumption in 2021 reached 123.1 MTOE, with the transportation sector at 54.4 MTOE, industry at 41.2 MTOE, households at 20.1 MTOE, business at 5.9 MTOE, and other sectors at 1.5 MTOE (EBTKE, 2014).

In Indonesia, the electricity consumption in buildings is divided into approximately 40-70% for cooling systems, 10-20% for lighting, and 2-10% for electronic devices. This distribution poses significant challenges in terms of energy availability, consumption, and costs, affecting operational, social, and economic aspects.

In 2018, lecture buildings consumed a total of 724,977 kWh of electricity, with 599,792 kWh utilized during off-peak hours (LWBP) and 125,185 kWh during peak hours (WBP), calculated between 18:00 and 22:00. The primary electricity source for these buildings is the state-owned electricity company (PLN), with an installed capacity of 865,000 VA (1,600 A). Given the buildings' age exceeding 10 years, there is a suspicion that the efficiency of electrical equipment has declined, resulting in increased electricity consumption. This has implications for the safety and comfort of the building, particularly in terms of energy efficiency, productivity, and the well-being of employees, students, and the community using the building.

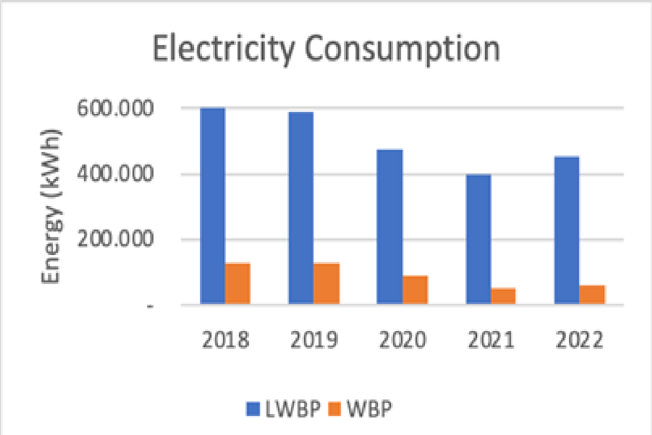


Fig 1 Electricity Consumption 2018-2022

The trend in electricity consumption can be assessed by comparing the installed capacity with actual usage during specific periods. The cost of electricity usage from 2018 to 2022 displays a fluctuating pattern, indicating a tendency to rise and fall or remain unstable. From a technical perspective, this trend appears to stem from inadequate power-saving initiatives, such as not turning off lights and unused electrical devices, neglecting electronic devices in standby mode, and frequently using energy-intensive electronic and electrical devices. However, from a non-technical standpoint, it results from consumer behavior overlooking energy-saving practices.

In the baseline of 2021-2022, the funding for electricity in lecture buildings increased by 12%, reaching Rp.58,572,235. The accompanying graph provides a visual representation of the electricity funding.

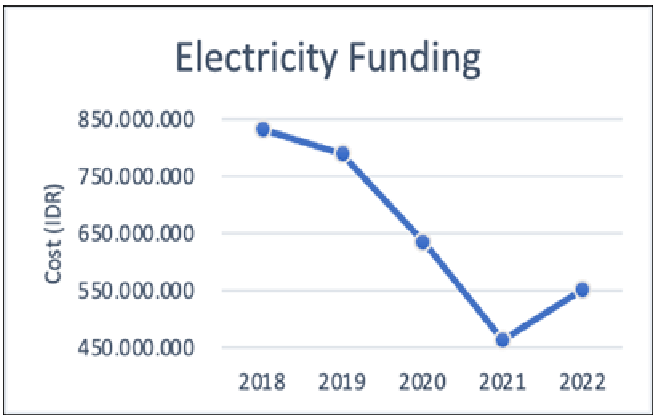


Fig 2 Electricity Funding 2018-2022

The rise is linked to increased activities within the building, resulting in a continual upsurge in electricity consumption in lecture buildings. Therefore, it is imperative for organizations to integrate energy efficiency into their operational culture. An effective approach to achieving efficiency involves the implementation of energy-saving initiatives for electricity usage. Enhancing energy efficiency enables management to optimize energy sources and associated assets, leading to a reduction in both energy consumption and costs.

In this research, the author will apply the Indonesian National Standard (SNI) methodology to reassess the lighting system (number of lights) and air conditioning (AC) system based on room dimensions and lumens. Additionally, the author will examine potential energy savings by comparing the current consumption patterns with the calculated values in this context.

## II. THEORETICAL REVIEW

- *Energy Management*

Energy management entails utilizing energy in a way that is both effective and efficient, aiming to maximize profits, minimize costs, and strengthen competitive positioning. Initiating energy management involves aligning the company's strategy with the implementation of energy management, ensuring that all employees are committed to conserving energy within the organization (Thoriq & Ciptomulyono, 2020). This approach can be executed through ongoing planning, documentation, monitoring, and assessment, maintaining the quality of production and services. The focus of energy management is on overseeing energy-consuming equipment and understanding the economic impact on the business operations of an organization or company (Nugroho, 2017).

- *Energy Use Intensity (EUI)*

Energy Use Intensity (EUI) refers to the energy consumed in a building per month or year per renovated surface area. In essence, Energy Use Intensity (EUI) acts as a reference indicator for gauging building energy usage and investigating possible opportunities for savings. As defined in the SNI 6196-2011 standard, EUI is characterized by the ratio of the energy consumed to the building area over a specified timeframe. In a systematic manner, EUI can be articulated as follows:

$$EUI = \frac{energy\ consumption\ (kWh)}{building\ floor\ area\ (m^2)} \quad (1)$$

- *The ASEAN-USAID established standardized EUI measurements in 1992, and the figures are as outlined below:*

Table 1 EUI Standardization in Buildings

| **Building** | **ECI (kWh/m²/year)** |
|---|---|
| Office (commercial) | 240 |
| Shopping Center | 330 |
| Hotels dan Apartements | 300 |
| Hospitals | 380 |

As per the guidelines for implementing energy conservation, the Energy Use Intensity (EUI) values for a building can be categorized into two criteria, distinguishing between buildings with air conditioning (AC) and those without AC:

Table 2 EUI Criteria

| **Description** | **Electricity Consumption According EUI (kWh/m²/month)** | |
|---|---|---|
| | **With Air Conditioning** | **Without Air Conditioning** |
| Highly Efficient | 4,17 – 7,92 | |
| Efficient | 7,92 – 12,08 | 0,84 – 1,67 |
| Moderately Efficient | 12,08 – 14,58 | 1,67 – 2,5 |
| Slightly Inefficient | 14,58 – 19,17 | |
| Inefficient | 19,17 – 23,75 | 2,5 – 3,34 |
| Highly Inefficient | 23,75 – 37,5 | 3,34 – 4,17 |

- *Lighting System*

The lighting system plays a vital role in buildings, impacting the comfort of work environments through its arrangement. This system is categorized into two types: natural lighting from sunlight and artificial lighting from non-sunlight sources. Efficient utilization and strategic planning of natural light are crucial factors, contributing substantially to electricity conservation efforts. Considerations for artificial lighting systems encompass several aspects: Firstly, the degree of illumination, which includes utilization coefficients and depreciation. Secondly, the measurement of illumination levels. Thirdly, the power of illumination. Lastly, the types of lamps utilized.

- *Air Conditioning System*

Air Conditioning, commonly known as AC, is a device crafted to control the temperature and humidity in a room. Room cooling systems are employed to establish a pleasant environment for the individuals occupying the space. The thermal comfort range in equatorial conditions typically ranges from approximately 22.5ºC to 29ºC, with air humidity maintained between 20% and 50%. The airspeed factor also plays a role in thermal comfort; higher airspeeds tend to have a greater impact on reducing human skin temperature. As per the Minister of Health's Decree of the Republic of Indonesia No. 1405/MENKES/SK/XI/2002, air exchange should be approximately 0.283 m3/minute/person, with an air movement rate ranging from 0.15 to 0.25 m/second. Airspeeds below 0.1 m/second can result in very sluggish air movement, causing discomfort, while excessively high airspeeds lead to a significant temperature decrease within the room.

Energy assessments on room cooling systems are carried out to ascertain the temperature, humidity, and airspeed produced by these cooling devices. In hospital settings, temperature and humidity systems should be precisely designed to deliver air temperatures and humidity levels in accordance with the recommendations outlined in the Ministry of Health Regulation No. 1204/MENKES/SK/X/2004.

- *SNI 6197:2020*

The Indonesian National Standard (SNI) designated as SNI 6197:2020 focuses on energy conservation in lighting systems. This standard is designed to promote energy efficiency in the design, operation, and maintenance of lighting systems, aiming to achieve optimal functionality without compromising the building's purpose, the comfort and productivity of occupants, environmental considerations, and costs. Additionally, it serves as a framework for assessing building lighting, outlining measures for performance enhancement, involving evaluation, index calculations, analysis, and reporting. The prescribed minimum illumination levels that should be adhered to are outlined as follows:

Table 3 Level Illumination

| Room | Minimum Average Illumination Level (Lux) | Maximum Lamp Power Density (Watt/m2) |
|---|---|---|
| **Office** | | |
| Reception room | 300 | 7.97 |
| Director's room | 350 | 7.53 |
| Workspace | 350 | 7.53 |
| Meeting room | 300 | 7.53 |
| Archive warehouse | 150 | 3.88 |
| Emergency stairwell | 100 | 5.27 |
| **Educational institutions** | | |
| Classroom | 350 | 11.95 |
| Library reading room | 350 | 10.33 |
| Teacher's room | 300 | 7.53 |
| Auditorium room | 300 | 6.57 |
| Lobby | 100 | 9.04 |
| Canteen | 200 | 4.31 |
| **Shops / Showrooms** | | |
| Large sales area | 300 | 8.83 |
| Book and stationery shop | 300 | 10.76 |

- *Analysis Methods for Current Energy Consumption*

To analyze electricity consumption in lighting, the total power load for lighting is determined based on observed room usage. The comprehensive lighting power load is computed for both LWBP (Low Voltage Peak) and WBP (High Voltage Peak) throughout the day. Following this, the daily load is multiplied by the number of effective days in a week to calculate the total effective days in a month. The formula for calculating the lighting energy load in one month is as follows:

$$\text{LWBP Load} = \text{LWBP x Number of Effective Days} \quad (2)$$

$$\text{WBP Load} = \text{WBP x Number of Effective Days} \quad (3)$$

$$\text{Total Power Consumption} = \text{LWBP Load} + \text{WBP Load} \quad (4)$$

- *Analysis Methods for Energy Efficiency in Lighting and Cooling Equipment*

The utilization of electrical equipment stands out as a pivotal factor impacting the scale of energy consumption within a building. By conducting an energy audit to optimize energy utilization, the goal is to curtail operational costs associated with energy consumption while improving the efficiency of electrical equipment usage. Noteworthy contributors to electricity consumption encompass lighting loads, air conditioning loads, and electric motors. The SNI 03-6575-2001 standard addresses guidelines for the design of artificial lighting in a building. It offers formulations pertinent to calculating the requisite number of lights in a room to attain the desired levels of lighting intensity and efficiency, specifically:

$$E = \frac{F.n.N.UF.LLF}{A} \quad (5)$$

Information:

N = quantity of lighting points within the luminaire
n = quantity of lamp units per
N E = brightness intensity (lux)
A = area of the room (m2)
F = luminous flux of a single lamp (lumen)
UF = light loss factor
UF = utilization factor

- *SNI-91714189 Addresses the Standard for Artificial Ventilation. The Simplified Calculation based on the SNI is Expressed as:*

British Thermal Unit (BTU) =

Room Length x Room Area x 500 BTU (6)

The recommended standard for air handling equipment aims to meet minimum criteria and efficiency, as outlined in the following table:

Table 4 Minimum Efficiency of Air Conditioning

| AC Input Power | AC Output Power |
|---|---|
| ½ HP | 5.000 BTU |
| ¾ HP | 5.000 BTU |
| 1 HP | 5.000 BTU |
| 1,5 HP | 5.000 BTU |
| 2 HP | 5.000 BTU |
| 2,5 HP | 5.000 BTU |

## III. METHODOLOGY

- *Theoretical Framework*

The framework for this research could be seen as follows:

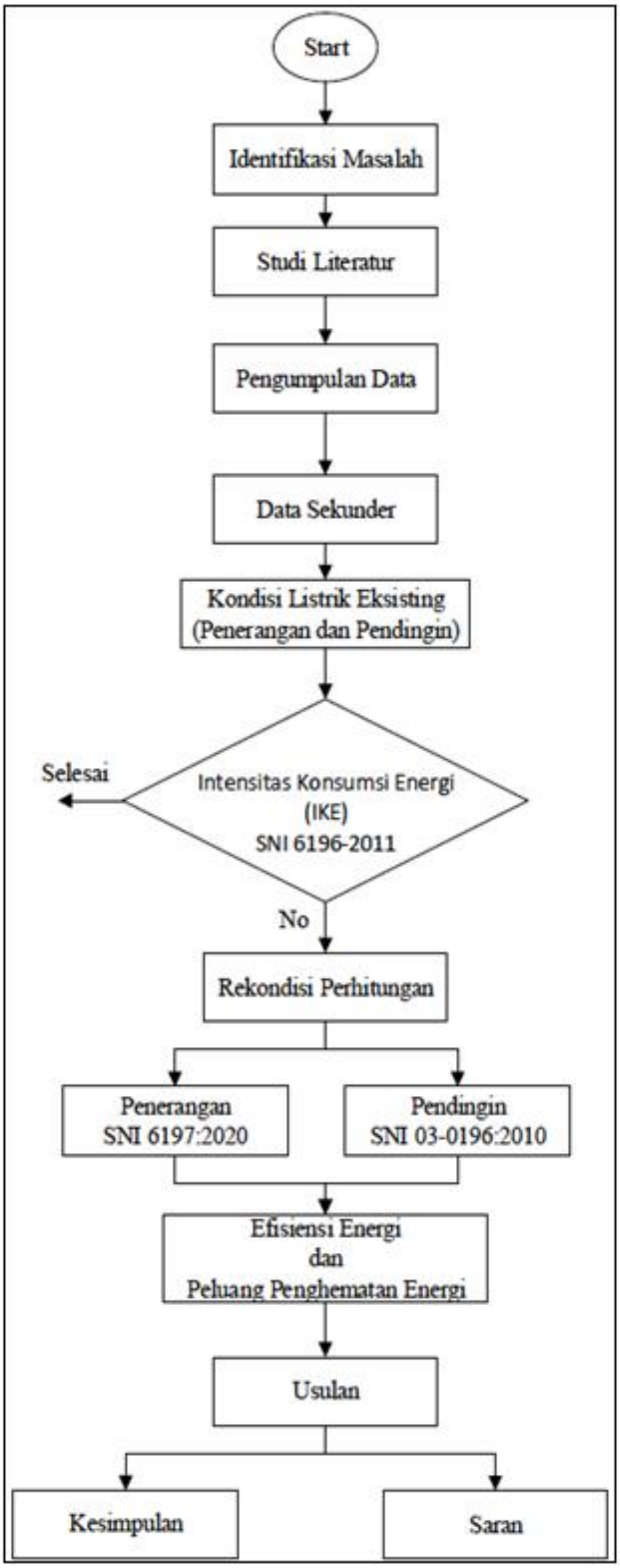


Fig 1 Theorical Framework

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➢ *Idea of Research*

This study entails assessing the energy efficiency performance of lighting and air conditioning systems in lecture buildings, coupled with the theoretical computation of operational expenses. The research methodology encompasses data collection, observation, and a thorough literature review. The theoretical energy performance assessment relies on calculating the energy consumption for each room, utilizing the architectural drawings of the building.

## IV. RESULT AND DISCUSSION

### *A. Energy use Intensity (EUI)*

In the calculations using equation (3-1), the EUI value is determined by dividing the total energy consumed by a building by its total floor area. Data processing reveals that the average EUI value was 30.41 in 2018, falling into the very wasteful category. For 2019, the IKE value is 30.01, still categorized as very wasteful. In 2020, it decreases to 24.57, remaining in the very wasteful category. The EUI value further drops to 17.77 in 2021, considered slightly wasteful, and increases to 21.43 in 2022, falling back into the wasteful category. By focusing on months with the highest EUI values, organizations can identify opportunities to enhance energy efficiency.

The primary factor influencing electrical energy consumption in buildings is the use of air temperature control (AC). The monthly power consumption of AC is observed to be higher than that of lighting. The functionality of AC equipment relies significantly on the temperature difference between the room and the desired temperature. Moreover, inappropriate lighting intensity and room temperatures exceeding established standards contribute to electricity wastage. The result of energy use intensity could be seen in Table 5 below.

Table 5 Energy use Intensity

| Month | Year (kWH/m2/month) | | | | |
|---|---|---|---|---|---|
| | 2018 | 2019 | 2020 | 2021 | 2022 |
| JAN | 27,44 | 31,81 | 33,96 | 17,52 | 17,66 |
| FEB | 30,45 | 30,55 | 30,53 | 17,96 | 16,79 |
| MAR | 24,02 | 24,47 | 28,25 | 16,28 | 19,50 |
| APR | 32,82 | 27,51 | 27,81 | 19,06 | 18,23 |
| MAY | 31,14 | 25,99 | 34,83 | 18,29 | 19,53 |
| JUN | 25,63 | 26,75 | 22,01 | 17,37 | 21,81 |
| JUL | 25,63 | 26,55 | 20,28 | 17,37 | 17,92 |
| AUG | 32,99 | 31,27 | 21,45 | 17,37 | 17,56 |
| SEP | 29,33 | 28,91 | 20,14 | 17,12 | 21,03 |
| OCT | 32,75 | 33,94 | 19,11 | 18,97 | 29,17 |
| NOV | 36,77 | 36,41 | 17,72 | 18,26 | 28,62 |
| DEC | 35,96 | 35,96 | 18,73 | 17,61 | 29,35 |
| **AVERAGE** | **30,41** | **30,01** | **24,57** | **17,77** | **21,43** |
| **NOTE** | **Highly Inefficient** | **Highly Inefficient** | **Highly Inefficient** | **Slightly Inefficient** | **Inefficient** |

### *B. Evaluating the Lighting System and Power usage*

The light flux or light current value of a lamp is commonly indicated on the lamp's packaging. Table 6 illustrates the quantity of lamps in the alternative scenario as compared to the current state.

Table 6 Current Data and Replacement Scenario Lights

| Floor | Existing | | | | Alternative Scenario | | | | Saving | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | | Power per Month (kWh) | | Quantity | | Power per Month (kWh) | | Power per Month (kWh) | Efficiency |
| | CFL (9W) | TL (20W) | LWBP | WBP | LED (9,5W) | TL (17,6W) | LWBP | WBP | | |
| Fl. 2 | 215 | 15 | 213 | 65 | 37 | 186 | 278 | 82 | 82 | 30% |
| Fl. 4 | 128 | 120 | 552 | 22 | 40 | 124 | 397 | 8 | (168) | (29%) |
| Fl. 5 | 244 | 303 | 778 | 128 | 25 | 174 | 583 | 107 | (215) | (24%) |
| Fl. 6 | 321 | 425 | 311 | 12 | 34 | 130 | 262 | 8 | (53) | (16%) |
| Fl. 7 | 566 | 470 | 40 | 0 | 43 | 147 | 109 | 0 | 69 | 173% |

Each floor undergoes a transition from CFL 9W and TL 20W lamps to LED 9.5W and TL 17.6W lamps. Overall, this lamp replacement results in monthly power savings across all floors, showcasing a positive impact. The 4th floor experiences a 29% power reduction, equivalent to 168 kWh. On the 5th floor, there is a 24% monthly power saving of 215 kWh, while the 6th floor sees a 16% power saving of 53 kWh.

The replacement lamp scenario involves fewer lamps than the currently installed ones. This discrepancy is influenced by the chosen light flux values for the replacement lamps. Specifically, the LED 9.5W replacement lamp has a light flux of 1100 lm (lumen), and the TL 17.6W replacement lamp has a light flux of 3100 lm. Light flux represents the total emitted light from a source. Higher lamp efficiency corresponds to greater electrical power savings, increased light flux, and light intensity. In essence, these lamps are more energy-efficient. Continuous monitoring and evaluation are essential to ensure the new equipment performs well and achieves the expected energy savings.

### *C. Evaluating the Air Conditioner (AC) System and Power usage*

The analysis of the alternative AC scenario cooling system indicates savings, as presented in the following table 7:

Table 7 Actual Data and Alternative AC Scenario

| Floor | Eksisting | | | | Alternative Scenario | | | | Saving | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Capacity | Power per Month (kWh) | | Quantity | Capacity | Power per Month (kWh) | | Power per Month (kWh) | Efficiency |
| | (Unit) | (BTU) | LWBP | WBP | (Unit) | (BTU) | LWBP | WBP | | |
| Fl. 2 | 41 | 738.000 | 3.121 | 1.046 | 17 | 353.000 | 1.543 | 547 | 2.075 | 50% |
| Fl. 4 | 33 | 594.000 | 4.638 | 90 | 24 | 390.000 | 2.951 | 50 | 2.951 | 37% |
| Fl. 5 | 29 | 522.000 | 4.781 | 913 | 20 | 473.000 | 2.683 | 614 | 2.397 | 42% |
| Fl. 6 | 33 | 594.000 | 2.948 | 60 | 19 | 365.000 | 1.449 | 24 | 1.535 | 51% |
| Fl. 7 | 28 | 504.000 | 212 | 0 | 32 | 492.000 | 325 | 0 | (113) | (53%) |

According to the table above, each floor undergoes a replacement of AC equipment with varying capacities. The lower AC capacities in the alternative scenario help identify the usage of more energy-efficient equipment. The 2nd floor sees a power reduction of 2,075 kWh per month or 50% after the AC equipment replacement. The 4th floor experiences power savings of 2,951 kWh per month or 37%. On the 5th floor, power savings amount to 2,397 kWh per month or 42%. The 6th floor achieves power savings of 1,535 kWh per month or 51%. On the 7th floor, despite an increase in power consumption, the lower percentage increase of 53% suggests the utilization of more efficient equipment.

The replacement of AC equipment on the various floors has proven to be effective in achieving energy savings. Reducing unnecessary AC capacity contributes to improved energy efficiency. This is because the replacement AC considers the BTU of each room relative to the BTU capacity of the replacement AC as per the catalog. Electricity consumption for AC usage tends to increase with a greater number of coolers in a room due to the increased heat absorption by the evaporator. Consequently, the compressor's workload in circulating refrigerant through the AC system becomes heavier, resulting in higher electricity consumption. Continuous monitoring and evaluation play a crucial role in ensuring the optimal performance of new equipment and the realization of expected energy savings.

*D. Operational Cost Analysis*

The replacement of equipment on each floor has led to substantial reductions in power consumption. Monthly power usage on these floors has significantly dropped following the replacement. Moreover, this has positively impacted the monthly operational expenses. The table below illustrates the comparison of energy consumption and operational costs before and after the cost-saving measures:

Table 8 Replacement Power Consumption Operational Costs

| Floor | Existing | | Alternative Scenario | | Saving | |
|---|---|---|---|---|---|---|
| | Monthly Power (kWh) | Monthly Operational Costs (Rp) | Monthly Power (kWh) | Monthly Operational Costs (Rp) | Monthly Costs (Rp) | Percentage |
| Fl. 2 | 4.445 | 5.179.490 | 2.452 | 2.866.283 | (2.313.285) | (45%) |
| Fl. 4 | 5.301 | 5.549.017 | 3.407 | 3.558.883 | (1.990.142) | (36%) |
| Fl. 5 | 6.599 | 7.374.010 | 3.987 | 4.502.998 | (2.871.085) | (39%) |
| Fl. 6 | 3.331 | 3.488.031 | 1.745 | 1.824.192 | (1.663.843) | (48%) |
| Fl. 7 | 252 | 261.311 | 434 | 449.588 | 188.277 | 72% |
| **TOTAL** | **19.929** | **21.851.859** | **12.025** | **13.201.943** | **8.650.079** | **40%** |

Cost deviation is calculated as the disparity between existing operational costs and replacement scenario costs. These floors exhibit a positive cost deviation, indicating successful cost savings after replacing both lighting and AC equipment. Overall, cost savings for the entire building amount to 40% after implementing the equipment replacement. At the floor level, the percentage of savings varies between 36% and 48%.

The data demonstrates a decrease in monthly operational costs on each floor after implementing the replacement scenario. In total, operational cost savings for the entire building reach IDR 8,650,079 per month following the replacement scenario. This information supports the ongoing replacement of equipment on various floors or the identification of other areas in the building that can be optimized. Continuous monitoring and evaluation are crucial to ensuring the effectiveness and sustainability of cost savings.

*E. Proposed Enhancements*

After conducting identification, observations, and calculations, potential opportunities for energy conservation include the following:

➢ *Lighting System Management*

The consumption of lighting energy in commercial buildings varies, constituting approximately 21% of total electrical energy use. Despite not being the primary energy consumer, energy savings within the lighting system contribute significantly to overall energy conservation. This system is categorized into two primary groups: artificial lighting and natural lighting. In the realm of energy planning and management, leveraging natural light yields significant advantages, particularly in reducing reliance on artificial lighting sources during daylight hours. Therefore, in addition to considering the potential of natural light, the design of artificial lighting systems should adhere to the following criteria:

- *Adherence to Recommended Minimum Illumination Levels.*
- *Compliance with the Maximum Allowable Illumination Power Limits.*

Calculating the amount of light emitted by the lighting system can be achieved through the point-by-point and lumen methods. The lumen method bases its calculation on generally applicable brightness standards for rooms, without considering the efficiency of lighting usage. In contrast, the point-by-point method allows for a focus on lighting in work areas without compromising overall lighting standards, ensuring continued comfort in the use of artificial lighting.

Effective lighting is defined by its alignment with the nature of the work, duration and timing of tasks, and other relevant factors. Lowering illumination levels to the recommended minimum presents an opportunity for energy savings in the lighting system. The following outlines recommended standards for effective lighting:

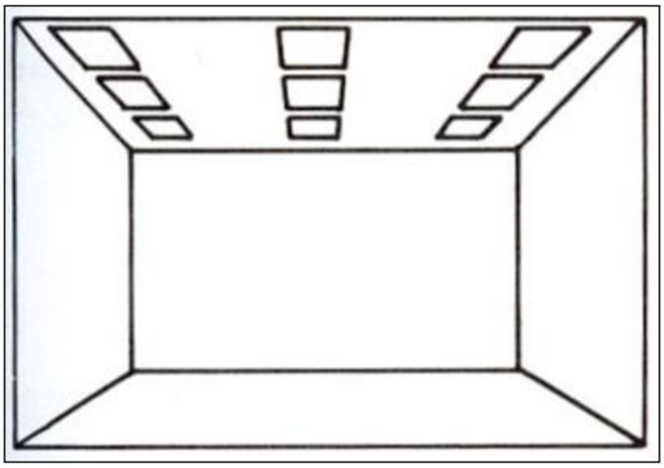

Fig 2 Recommendation of Standard Lighting

➢ *Energy Conservation Management*

Incorporating energy management into a company's organizational structure holds significant importance. Establishing an independent energy management unit within the company is strongly recommended. Here is a proposed design for managing energy efficiency in line with the energy management plan at the Tedja Buana Building:

- *No-Cost Investments*

✓ Raising awareness among the academic community about energy conservation.
✓ Adjusting lighting loads and non-AC equipment.
✓ Managing AC cooling loads.
✓ Controlling AC operational hours.
✓ Managing operational hours for activities.
✓ Regulating room lighting

- *Low-Cost Investments*

✓ Enhancing AC maintenance and servicing
✓ Balancing the electrical loads of AC, lighting, and wiring
✓ Managing AC loads
✓ Repairing fixtures for lighting
✓ Implementing Electronic Ballasts
✓ Balancing electrical loads

- *Moderate-Cost Investments*

✓ Gradually installing Energy-Efficient Lighting
✓ Adjusting electrical loads by eliminating imbalances
✓ Adding control panels and metering systems to some panels with substantial loads

- *High-Cost Investments*

✓ Installing Energy-Efficient Lighting in remaining areas
✓ Installing Timer Control & Auto Timed Switch-off for essential lighting
✓ Regulating electrical loads by eliminating imbalances comprehensively
✓ Improving control panels and refurbishing systems throughout the main panel.

## V. CONCLUSION AND SUGGESTION

### A. *Conclusion*

Based on these results that have been described above, therefore several conclusions which could be drawn from this research are as in follows:

- Based on the analysis findings, it is apparent that a considerable number of rooms, both in terms of lighting and air conditioning on each floor of the academic building, do not meet the Indonesian National Standard (SNI).
- The energy audit results indicate that the Energy Consumption Intensity (IKE) for air conditioning falls into the "Highly Inefficient" category, with an average value of 24.84 kWh per year.
- After re-evaluating the illumination and room cooling through the application of the Indonesian National Standard (SNI), it has proven to be an effective method for devising electrical energy savings. The lighting system exhibits a savings of 285 kWh, considering the initial existing lighting consumption of 2,121 kWh. Similarly, the cooling system shows a reduction of 7,619 kWh compared to the original existing cooling consumption of 17,808 kWh. Consequently, the cumulative energy savings in the lighting and cooling systems total 7,282 kWh from the initial 19,307 kWh. The potential monthly cost savings amount to IDR 8,650,079, reflecting a 40% decrease from the original lighting and cooling system cost of IDR 21,852,022.

### B. *Suggestion*

The suggested advice for this energy audit study involves establishing a team and implementing an energy management system. This can be accomplished through various methods, including straightforward operational and maintenance activities to ensure the efficient and effective utilization of equipment and systems.

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