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Application of Software Simulation for Lighting Analysis in the Lab. of Hotel Operations Department UMN

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ABSTRACT

In this study, an analysis of lighting in campus buildings was conducted, specifically for the in the Laboratory of Hotel Operations Department Universitas Multimedia Nusantara (UMN). The main issue identified is visual comfort for occupants in a room, which must comply with the Indonesian National Standard (SNI) 6197-2020. Ensuring proper lighting is crucial for both functionality and occupant comfort, particularly in educational settings where tasks require adequate illumination. The lighting analysis was performed through simulation using Dialux and SketchUp software. The process involved designing a detailed building model based on the room layout, including all relevant architectural and interior features. Once the model was completed, the lighting simulation was executed using Dialux. This simulation entailed determining the optimal position of furniture within the room, selecting appropriate types of luminaires, and strategically placing these luminaires to achieve the desired lighting levels. The results of the simulation indicated that the current lighting levels in the laboratory were below the standards set by the SNI. Specifically, the minimum illumination level required by SNI 6197-2020 for a room functioning as a restaurant kitchen, which is analogous to the that Laboratory, is an average of at least 250 lux. The findings highlight the need for redesigning the lighting system in the laboratory to meet the prescribed standards and ensure adequate visual comfort and functionality for its users.

Keywords : *lighting level, occupant comfort, kitchen area, SNI, DIALux*

ABSTRAK

Dalam penelitian ini, dilakukan analisis pencahayaan dalam bangunan kampus khususnya untuk ruangan Laboratorium D3 Perhotelan UMN. Masalah utama yang diidentifikasi adalah kenyamanan visual bagi penghuni di suatu ruangan yang mana harus sesuai dengan Standar Nasional indonesia (SNI) 6197-2020. Analisis pencahayaan dilakukan melalui simulasi perangkat lunak Dialux dan SketchUp. Simulasi dilakukan dengan merancang model bangunan berdasarkan denah ruangan dahulu lalu menjalankan simulasi pencahayaan menggunakan Dialux. Simulasi pencahayaan dilakukan dengan menentukan posisi perabotan dalam ruangan, jenis luminer, dan peletan luminer. Ditemukan bahwa hasil simulasi pencahayaan memiliki nilai penerangan dibawah standar Standar Nasional Indonesia (SNI). Dimana nilai minimum tingkat pencahayaan buatan pada SNI 6197-2020 untuk fungsi ruangan yang diasumsikan Laboratorium D3 Perhotelan UMN adalah sebagai dapur sebuah restoran yang seharusnya memiliki tingkat pencahayaan rerata minimal 250 lux. Temuan dalam studi ini adalah kebutuhan untuk merancang ulang sistem pencahayaan di laboratorium agar memenuhi standar yang ditetapkan dan memastikan kenyamanan visual serta fungsionalitas yang memadai bagi penggunanya.

Kata Kunci : *tingkat pencahayaan, kenyamanan penghuni, area dapur, SNI, DIALux*

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1. Introduction

In building design, lighting plays a crucial role in ensuring occupants can carry out their activities effectively and comfortably. According to Minister of Health Regulation No. 1405 of 2002, lighting is defined as the amount of light required in a workspace to perform activities effectively (Menteri Kesehatan Republik Indonesia, 2002). However, in demonstration kitchen spaces such as those found in Building D at UMN, there are often challenges in ensuring adequate lighting levels that meet standards to support optimal performance of occupants, without causing glare or visual discomfort (Kwong, 2020; Lee & Saputri, 2021; U.S. Department of Energy, 2015).

To address these challenges, this research proposes an approach using DIALux and SketchUp software simulations. The simulations aim to redesign the lighting in the Laboratory of Hotel Operations Department Universitas Multimedia Nusantara (UMN) to comply with the SNI 6197-2020 standard. The function of this laboratory is a kitchen. Based on the standard, the lighting level or illuminance in the kitchen should be a minimum average of 250 lux (BSN, 2021). The simulation process will involve detailed modeling of the room based on its layout and relevant features. The next steps will include determining the optimal type and placement of luminaires to achieve the desired lighting levels, as well as replacing non-functioning luminaires.

The use of DIALux and SketchUp software simulation methods provides advantages in visualizing various lighting scenarios before implementation in the field (Fernandez-Prieto & Hagen, 2017; Králiková et al., 2022). This approach is expected to enhance understanding of the lighting needs in demonstration kitchen spaces and contribute positively to more efficient and sustainable building design practices.

The analysis will include evaluating the results of the lighting simulations, both in terms of meeting established standards and achieving energy efficiency. From these evaluations, recommendations can be formulated for improvements or adjustments to enhance lighting quality and visual comfort for occupants. Improving lighting quality and visual comfort for occupants is important because it enhances productivity, reduces eye strain, and improves overall well-being (Katabaro & Yan, 2019; Tan & Abdul Majid, 2023)(Hwang & Kim, 2011; Katabaro & Yan, 2019; Tan & Abdul Majid, 2023).

Relevant research has been conducted by previous researchers, as outlined in the following. This study implements and validates the three-phase method for daylight calculation in DIALux evo, freely available software. This method offers faster annual daylight calculations without sacrificing accuracy compared to previous approaches in DIALux daylight calculations. By providing simple, accurate, and efficient analysis, this new version of DIALux facilitates electrical lighting designers in integrating natural and electric lighting more effectively and efficiently in lighting projects (Hemmerling et al., 2023).

Another study examines the performance of natural lighting, particularly daylight factors in the Engineering Faculty Hall, State University of Gorontalo. The aim is to analyze and enhance lighting in the space through computer simulations using DIALux Evo 9.0. By replacing handrail materials with glass, adding windows on building sides, and installing light shelves inside and outside the building, the engineering design successfully increases natural light intensity on the left and right edges by up to 18%. However, additional adjustments are still needed to achieve optimal lighting throughout the room (Pratiwi & Djafar, 2021).

Other research, they researched natural lighting at GPIB Bethel Bandung to determine its compliance with the applicable lighting standards, which is a minimum of 200 lux (SNI 03-6197-2000) for churches. The method used was quantitative, with data collection through direct observation and simulation using DIALux Evo 10.1 software (Puspita et al., 2023). Similar to the study by Maulanan et al., they examined the availability and feasibility of natural lighting and the level of visual comfort in the Multipurpose Hall of the Imbanagara Raya Ciamis Village Head Office. This research aims to ensure that the available natural lighting meets the applicable standards, namely the Indonesian National Standard (SNI), and to provide recommendations for the use of skylights to enhance natural lighting in accordance with SNI standards (Maulana & Kusuma, 2022).

Based on the related studies mentioned, there is a research gap in the optimization of artificial lighting, particularly in culinary laboratory spaces for hospitality training. These studies predominantly focus on the performance and optimization of natural lighting and its integration with artificial lighting using DIALux software. While DIALux simulations are used to enhance natural light levels and ensure compliance with standards, as seen in university buildings, churches, and multipurpose halls, there is limited in-depth research on optimizing artificial lighting in specialized environments such as culinary labs for hospitality industry training. Artificial lighting is crucial due to specific needs for visual comfort and energy efficiency in active learning environments like kitchens, pastry rooms, and bakeries. This research aims to address this gap by utilizing DIALux simulations to analyze and model lighting levels across various culinary lab spaces, aiming to ensure compliance with the SNI 6197-2020 standards and provide practical recommendations to enhance artificial lighting systems tailored to the specific needs of hospitality training environments.

2. Methods

A good artificial lighting system must consider requirements, such as the correct selection of luminaires suitable for the designated location (room function), to

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achieve light with quality and quantity on the work surface according to applicable visual comfort standards. Indonesia has established visual comfort standards for various types of rooms as stipulated in SNI 6197-2020. Artificial lighting systems are not only determined by calculating the minimum number of light sources (lamps) required, but also require computer simulations to determine the average artificial lighting levels within the room. To conduct computer simulations, commonly used software is required to simulate artificial lighting in a room, such as Dialux Evo.

Dialux software is used to model the lighting in the room. The room is designed according to the floor plan and furnished with furniture positioned accordingly in the Dialux 3D model. The minimum illumination level required by SNI 6197-2020 for the assumed function of in the Laboratory of Hotel Operations Department UMN as a restaurant kitchen is 250 lux.

Before conducting lighting and energy usage simulations in the room, data on the size and arrangement of objects in Laboratory of Hotel Operations Department are necessary. The floor plan serves as the basis for designing simulations and is depicted in Figure 1. This floor plan has dimensions of 22.7 x 11.2 meters with a height of 3.5 meters. The room model design in the simulation will be based on this floor plan, which will be explained in detail in each section of the analysis.

Figure 1. *Floor plan of laboratory*

3. Results

Simulation of lighting using DIALux begins with creating the building shape, where the shape used covers the entire specifically Kitchen Laboratory of Hotel Operations Department, consisting of 9 rooms as shown in Figure 1, and placing kitchen equipment appropriate to the actual room appearance. The number of lamps used is 2 at each point, totaling 30W (15x2). Lighting simulation uses certified lighting sources as follows:

Name: PHILIPS TL-D 36W/54-765 1200mm

Wattage: 36 W

Lumen: 2500 lm

Dimensions: 1200 mm x 28 mm

Light Color: White / Cool Day Light / 6500K

The simulation process generated by DIALux Evo software is as follows in Figure 2.

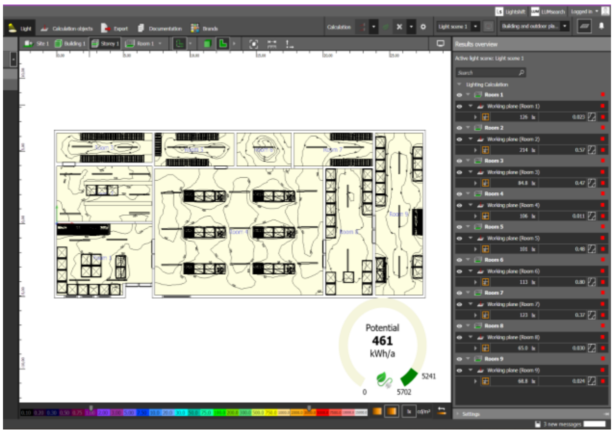

Figure 2. *Simulation of artificial lighting levels in the Kitchen Laboratory*

The rooms in the kitchen lab serve the following functions such as shown in Table 1.

Table 1. *Results of lighting levels in each room*

Room	Function	Lighting Level (lux)
Room 1	Serving Room	126
Room 2	Main Storage	214
Room 3	Main Storage	84.8
Room 4	Kitchen	106
Room 5	Utensil Storage	101
Room 6	Wash Room	113
Room 7	Food Storage	123
Room 8	Pastry Room	65
Room 9	Bakery Room	68

Based on the these room functions, attention should be given to rooms 1, 4, 8, and 9 because they have higher activity levels compared to the others. According to SNI 6197-2020, the minimum lighting level for a restaurant kitchen is 250 Lux. The kitchen, pastry room, and bakery room have lighting levels below the established SNI standard. Insufficient lighting in these rooms affects the activities of their occupants. The exact impacts of insufficient lighting cannot be determined at this time.

We recommend replacing the artificial lighting fixtures to improve the artificial lighting levels in these rooms using the same type of lamp fitting. Our recommended lamp specifications are as follows:

Name: PHILIPS TL-D 58W/54-765

Wattage: 58W

Lumen: 4000 lm

Length: 1500 mm

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Diameter: 28 mm

Light Color: White / Cool Day Light / 6200K

The simulation process produced by the Dialux Evo software is shown in Figure 2.

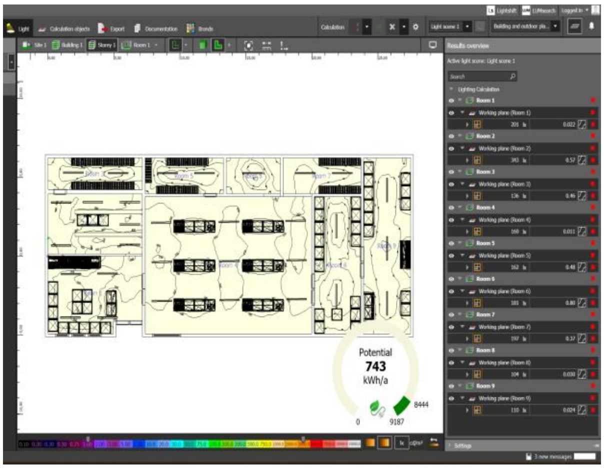

Figure 2. *Simulation of artificial lighting levels in the Kitchen Laboratory*

In the simulation conducted for the replacement of lamps with recommended certification, it is shown in Figure 3 that there are still rooms with high activity levels that have lighting levels below the SNI 6197-2020 standard. To improve the lighting levels in these rooms, we recommend installing new light fittings to increase the number of available lights in the room, which is expected to improve the lighting levels. The simulation process with the addition of lights can improve the lighting levels, as shown in Figure 4.

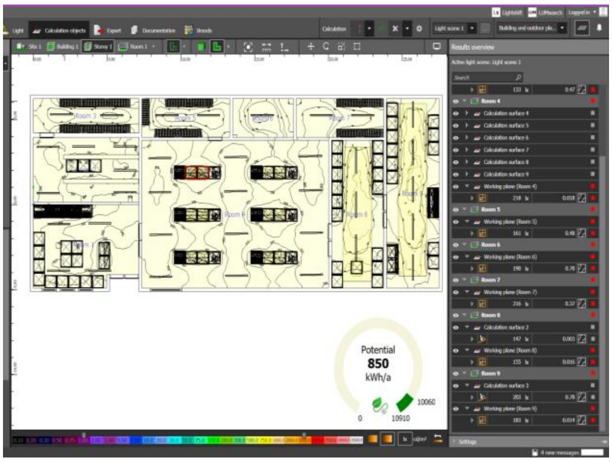

Figure 4 *Simulation of artificial lighting levels with an increased number of lights*

The simulation process with the addition of lights according to the recommended specifications shows that the lighting levels remain below the minimum average required for artificial lighting. Similarly, increasing the number of lamps based on the recommended specifications still results in lighting levels that do not meet the minimum average standards for artificial lighting. These findings underscore the need for further adjustments or considerations in lighting design to achieve adequate illumination levels as per established standards.

3. Conclusion

Measurements and simulations of lighting levels have been carried out in the Laboratory of Hotel Operations Department UMN. The simulation process using Dialux Evo software shows that the simulated artificial lighting levels and recommended lamps are still below the minimum standard for artificial lighting according to SNI 6197-2020. In the simulation, it is necessary to better review the wall color and floor tiles to understand the light reflection factor, so that the simulation can be more accurately conducted using Dialux Evo software.

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