

Simulation Training Using DIALux Evo Software for Estimation of Visual Comfort Level of a Building

Fahmy Rinanda Saputri^{1*}, Linus Gregorius Radithya²

^{1,2} Universitas Multimedia Nusantara, Indonesia

*corresponding author: fahmy.rinanda@umn.ac.id

Received 08-03-2024

Revised 18-03-2024

Accepted 22-03-2024

ABSTRACT

This community outreach aims to conduct simulation training using DIALux Evo to estimate the visual comfort level in a room. Visual comfort is a crucial aspect of building design and management that can impact the occupant's health, comfort, and productivity. However, it is often challenging for interior designers to accurately estimate visual comfort. This activity involves the application of simulation technology using DIALux Evo. Participants will be provided with knowledge and skills in operating this software, covering tasks from designing rooms, placing objects, selecting building materials, and choosing artificial lighting, to analyzing and visualizing the lighting level in a room, also study Indonesian national standards (SNI) related to visual comfort. The program's outcomes provide participants with the knowledge and skills to use DIALux Evo in estimating the visual comfort level before implementation. Finally, they can optimize space design, ensure appropriate lighting quality, and enhance the occupant's comfort and health.

Keywords: DIALux Evo; Visual comfort; Occupants; SNI

ABSTRAK

Program pengabdian masyarakat ini bertujuan menyelenggarakan pelatihan simulasi menggunakan DIALux Evo untuk memperkirakan tingkat kenyamanan visual di suatu ruangan. Kenyamanan visual adalah aspek penting dalam desain dan pengelolaan bangunan yang dapat memengaruhi kesehatan, kenyamanan, dan produktivitas penghuni. Namun, seringkali sulit bagi desain interior untuk memperkirakan dengan akurat tingkat kenyamanan visual. Kegiatan ini merupakan penerapan teknologi simulasi menggunakan DIALux Evo. Peserta akan diberikan pengetahuan dan keterampilan tentang cara mengoperasikan perangkat lunak ini, mulai dari merancang ruangan, menempatkan objek, memilih bahan bangunan, memilih pencahayaan buatan, hingga menganalisis dan memvisualisasikan tingkat pencahayaan di ruangan. Pelatihan ini juga akan mempelajari SNI terkait kenyamanan visual. Hasil dari kegiatan ini memberikan pengetahuan dan keterampilan peserta untuk menggunakan perangkat lunak DIALux Evo secara efektif dalam memperkirakan tingkat kenyamanan visual suatu ruangan sebelum direalisasikan. Dengan demikian, mereka dapat mengoptimalkan desain ruang, memastikan kualitas pencahayaan yang sesuai, dan meningkatkan tingkat kenyamanan serta kesehatan penghuni.

Kata kunci: DIALux Evo; Tingkat kenyamanan; Penghuni bangunan; SNI

INTRODUCTION

Lighting is a crucial aspect of designing and creating a comfortable and productive spatial environment for its occupants. The quality of lighting has a significant impact on health, visual comfort, and human productivity within a room. Therefore, understanding and applying appropriate lighting standards are highly important in designing quality buildings.

In Indonesia, the Indonesian National Standard (SNI) 6197:2020 on Energy Conservation in Lighting Systems has been established as a guideline for the required lighting levels in various types of spaces (BSN, 2021). However, there is still a lack of understanding and awareness regarding the importance of these lighting standards among professionals, practitioners, students, and the general public. This lack of knowledge can negatively affect building designs that do not meet lighting standards, resulting in suboptimal spatial environments. Additionally, there are several negative impacts if the lighting is not applied according to standards:

Failure to implement standardized lighting in buildings and environments can have serious consequences and potential hazards for both occupants and the surrounding environment (Maulana & Kusuma, 2022). Some dangers that may arise due to mismatched lighting include:

1. **Visual Discomfort:** Lighting that doesn't meet the standards can lead to poor visual comfort for occupants. Lighting levels that are too low or too high can cause eye strain, visual disturbances, headaches, and difficulty seeing objects (Boyce & Wilkins, 2018; Hwang & Kim, 2011).
2. **Health Issues:** Lighting that doesn't meet the standards can hurt occupants' health. Suboptimal lighting can affect circadian rhythms, disrupt sleep, and increase the risk of stress and other health disorders (Blume et al., 2019).
3. **Reduced Productivity:** Environments with inadequate or non-standard lighting can decrease productivity and concentration among occupants. This condition can affect work performance, learning, and daily activities (Akbari et al., 2013; Katabaro & Yan, 2019).
4. **Safety Concerns:** Insufficient or non-standard lighting can increase the risk of accidents, especially in areas requiring high visibility such as staircases, dark corridors, or workspaces (Chawre, n.d.).
5. **Aesthetics and Aesthetic Value:** Poorly considered lighting can disrupt the aesthetics of a space and diminish the aesthetic value of a building or environment (Febriyursandi et al., 2019).
6. **Inefficient Energy Usage:** Excessive or inefficient lighting can result in high energy consumption, contributing to negative environmental impacts and higher operational costs (Muhamad et al., 2010).

This community outreach program aims to provide understanding and learning about the importance of standardized lighting and to impart practical skills in using simulation software like DIALux Evo. Lighting simulation with DIALux Evo enables designers and practitioners to estimate the lighting levels that will be achieved in a designed space before its physical implementation (Králíková et al., 2022; Thesis & Davoodi, 2023). Consequently, training participants will be able to assess and select the most appropriate lighting types by the national standard (SNI) and provide recommendations for improvements if the simulation results do not meet the established standards (Mannan, 2020).

Through this training, participants are expected to gain a better insight into the significance of standardized lighting in building design and to integrate this knowledge

into their professional practices. Furthermore, this training also aims to enhance the quality of building lighting design in Indonesia, creating more comfortable, healthy, and productive environments for occupants. With a better understanding of lighting measurement and estimation, it is hoped that future building designs will be more optimal and tailored to the needs of their occupants.

METHODS

This community outreach program activity was conducted in a classroom functioning as a laboratory. The laboratory is equipped with personal computers at each desk. Participants, who are high school students, attended the activity according to the instructions provided by the speaker on-site. Of course, in this activity, the speaker was a lecturer, and students acted as assistants.

Before delivering the material, the speaker first presented the background related to green buildings and the importance of implementing green building practices for the comfort and health of human occupants. The speaker's reference in presenting the material was the activity module and also the Indonesian national standards that discuss the visual comfort standards for occupants. Within these standards, there are specific values set as limits for the level of illumination in buildings. The illumination levels vary for each room. With these standards, participants of the training activity can design rooms and lighting that are appropriate.

The software used in this training is DIALux Evo. This software is pre-installed on all PCs available in the UMN laboratory used as the training location. The DIALux evo software can be utilized to perform simulations and calculations of illumination levels for different types of lamps such as UV-C (Saputri et al., 2022), LED (Kamaruddin et al., 2016), halogen lamps, and even incandescent lamps. This software enables users to design spaces and buildings, ranging from residential homes, and educational institutions (Febriyursandi et al., 2019), to places of worship (Harefa et al., 2020).

Next, participants are instructed to directly practice what is guided by the speaker. The steps to be taken in using the DIALux evo software for participants to obtain estimates of illumination levels are as follows:

1. Creating the room's model and dimensions.
2. Building construction phase.
3. Window and door construction phase.
4. Application of colors and materials in the room.
5. Selection and arrangement of objects or furnishings for the room.
6. Selection of lamps to be placed within the designed room.
7. Arrangement of lamps.
8. Running the simulation.
9. Analysis of the generated simulation results.
10. Visualization of data and documentation.

Table 1. Illumination levels and color rendering based on SNI 6197:2020

Fungsi Ruangan	Tingkat pencahayaan rata-rata (Erata-rata) minimum (lux) ^{a)}	Renderasi warna minimum
Lembaga Pendidikan		
Ruang kelas	350	80
Ruang baca perpustakaan	350	80
Laboratorium	500	90
Ruang praktek komputer	500	80
Ruang laboratorium bahasa.	300	80
Ruang guru	300	80
Ruang olahraga	300	80
Ruang gambar	750	80
Ruang Auditorium (exhibition)	300	80
Lobby	100	80
Tangga	100	80
Kantin	200	80

Catatan: ^{a)} nilai diukur di atas bidang kerja

Source: (BSN, 2021)

After participants have completed the simulation, they are asked to compare the resulting illumination levels with the Indonesian National Standard (SNI) 6197:2020 (BSN, 2021). An excerpt from the standard illumination levels based on SNI 6197:2020 is provided in Table 1. According to Table 1, each type of building and room function will have different standard average illumination levels. If the results do not meet the standards, participants are required to redesign to achieve the desired visual comfort for the occupants. Additionally, participants are also requested to provide recommendations to ensure that the lighting and the designed building align with the SNI.

RESULTS AND ANALYSIS

The community outreach program activity successfully achieved its objectives by providing a comprehensive understanding to the participants about the utilization of DIALux Evo software in simulating and estimating visual comfort levels for building occupants. The participants exhibited great enthusiasm and eagerness to comprehend the topic, as evident from their active participation during the demonstration, training sessions, and discussions. It is hoped that the knowledge acquired by the participants will be applicable in their professional and academic pursuits, thereby contributing to enhancing the quality of architectural lighting design in the future. The documentation of the conducted activities is illustrated in Figure 1.



Figure 1. Documentation of the simulation training using Dialux Evo software

Based on the steps taken according to the description in the methods part, the participants can now be considered proficient in using the DIALux Evo software. One of the successful case studies carried out by the participants is as follows:

1. The location used for the case study is a computer practice room in an educational building.
2. The reference standard is the document SNI 6197:2020 concerning Energy Conservation in Lighting Systems, where the standard for a computer practice room is 500 Lux.
3. The simulations conducted involve testing for natural, artificial, and mixed lighting.

In the first step, participants first create a room design along with its lighting. Figure 2 is the work result of a participant with the location being a computer practice room. The participant has successfully built the room, added materials, and included furniture as well as lighting within the room.



Figure 2. Representative computer room as simulation object

Next, before conducting the simulation test of room lighting, the average lighting level will be checked against the standard. For a computer practice room in an educational building, the average lighting level is 500 Lux. Since the design and simulation are intended for the computer room, participants need to be aware of this value as a reference.

In the third stage, participants carry out the testing. The first test involves setting up artificial lighting only, using lamps. Consequently, the simulation results in a lighting level of 372 Lux, as seen in Figure 3. This value falls short of the standard. Therefore, improvements are necessary for both the building system's design and the implemented lighting.

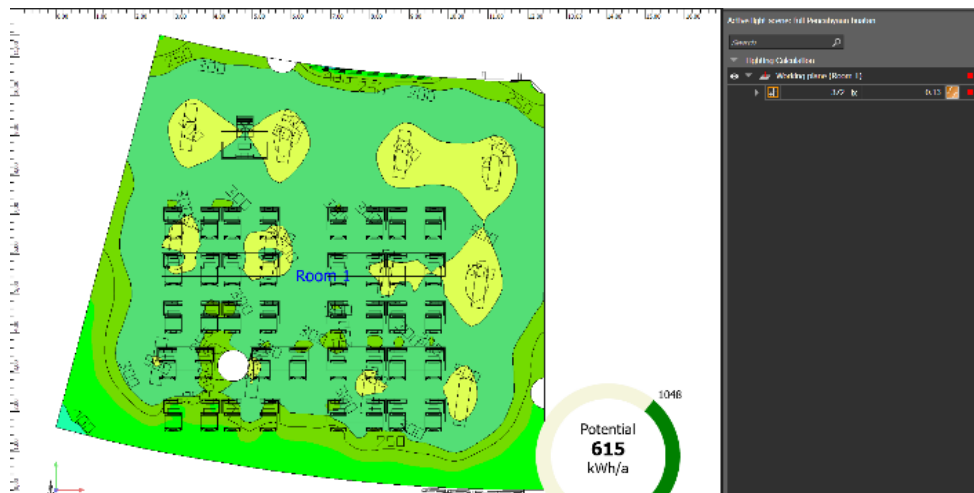


Figure 3. Simulation result with artificial lighting source

The second test was conducted by conditioning the system using natural lighting. This natural lighting depends on the sunlight conditions at a specific location and time. In this case study, the location of Tangerang on April 8, 2023, at noon was used, with average cloud cover. With this setup, a light level of 374 Lux was achieved, as shown in Figure 4. Therefore, there is a need for improvements in both the building system's design and the lighting that has been implemented.

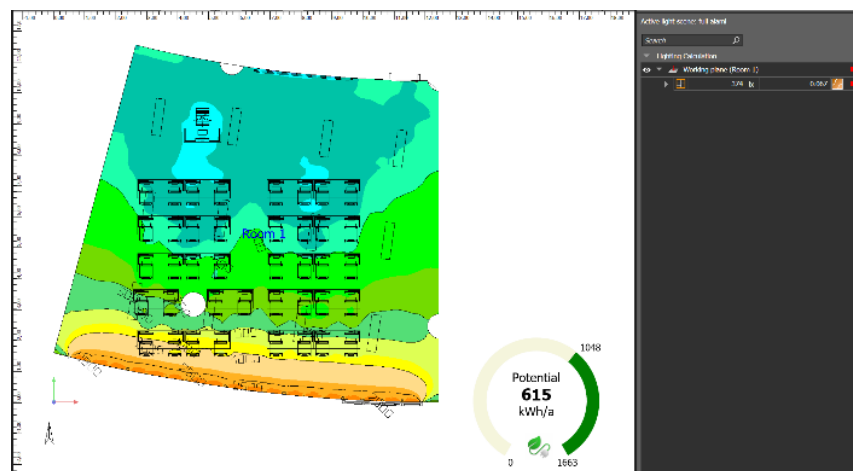


Figure 4. Simulation result with natural lighting source

The third test was conducted by conditioning the room using a combination of lighting sources, namely natural and artificial lighting. Artificial lighting was provided by a designed system, while natural lighting depended on the sunlight conditions at a specific location and time. For this case study, the location of Tangerang on April 8, 2023, at noon, under overcast conditions, was used. With this setup, a lighting level of 992 Lux was achieved, as shown in Figure 5. This value exceeds the standard, indicating a need for design improvements.

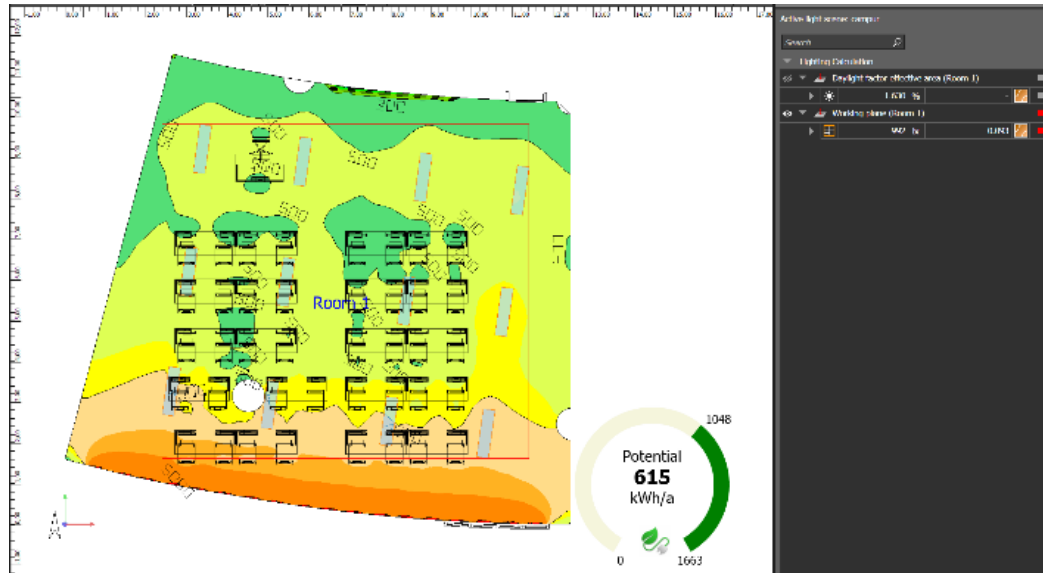


Figure 5. Simulation result with combination lighting source

CONCLUSION

Based on the community outreach program about simulation training using DIALux Evo software for estimation of the visual comfort level of building occupants, the conclusions are as follows:

1. Successfully Conduct DIALux Evo Training: The DIALux Evo training was successful and proceeded smoothly. Participants actively engaged in the training sessions followed the material with enthusiasm and effectively practiced using the software for lighting simulations.
2. Understanding of Green Building and Visual Comfort Components: Through this training, the community gained an understanding of the concept of green building and the importance of related components, particularly in the context of visual comfort levels. Participants acquired in-depth insights into how proper lighting design can contribute to achieving optimal levels of visual comfort.
3. Understanding of Visual Comfort Standards: Training participants successfully grasped the standards for visual comfort levels outlined in guidelines and regulations, with a particular focus on the SNI 6197:2020 document. This understanding aided them in evaluating and planning lighting designs that align with the established standards.

Implementation of Training Results: The training outcomes provided participants with a practical understanding and skills in using DIALux Evo and applying principles of standardized lighting design. With this knowledge and skill set, the community can design and implement lighting solutions that meet visual comfort standards, both in personal and professional project scopes.

ACKNOWLEDGMENT

We extend our gratitude to our university, Universitas Multimedia Nusantara, for providing the facilities for this activity. The facilities, including the rooms, computers, software, and necessary permissions, greatly contributed to the smooth and successful execution of this event.

REFERENCES

- Akbari, J., Dehghan, H., Azmoon, H., & Forouharmajd, F. (2013). Relationship between lighting and noise levels and productivity of the occupants in automotive assembly industry. *Journal of Environmental and Public Health*, 2013. <https://doi.org/10.1155/2013/527078>
- Blume, C., Garbazza, C., & Spitschan, M. (2019). Effects of light on human circadian rhythms, sleep and mood. *Somnologie*, 23(3), 147–156. <https://doi.org/10.1007/s11818-019-00215-x>
- Boyce, P. R., & Wilkins, A. (2018). Visual discomfort indoors. *Lighting Research and Technology*, 50(1), 98–114. <https://doi.org/10.1177/1477153517736467>
- BSN. (2021). *Penetapan Standar Nasional Indonesia 6197:2020 Konservasi Energi*. 8.
- Chawre, A. (n.d.). *Effects of Poor Lighting at Workplace*. Perfect Pollucon Services. Retrieved March 14, 2024, from <https://www.ppsthane.com/blog/effects-of-poor-lighting-at-workplace>
- Febriyursandi, R., Azryenni, A. Z., & Hamzah, A. (2019). Design Lighting Quality Based on DIALux Evo 8.1. *Journal of Science and Applied Engineering*, 2(2), 42. <https://doi.org/10.31328/jsae.v2i2.1183>
- Harefa, L. A., Feranita, & Ervianto, E. (2020). Redesign of Artificial Lighting with Electricity Saving Aspects. *International Journal of Electrical, Energy and Power System Engineering*, 3(1), 24–29. <https://doi.org/10.31258/ijeepse.3.1.24-29>
- Hwang, T., & Kim, J. (2011). Effects of Indoor Lighting on Occupants' Visual Comfort and Eye Health in a Green Building. *Indoor and Built Environment - INDOOR BUILT ENVIRON*, 20, 75–90. <https://doi.org/10.1177/1420326X10392017>
- Kamaruddin, M. A., Arief, Y. Z., & Ahmad, M. H. (2016). Energy Analysis of Efficient Lighting System Design for Lecturing Room Using DIALux Evo 3. *Applied Mechanics and Materials*, 818(June), 174–178. <https://doi.org/10.4028/www.scientific.net/amm.818.174>
- Katabaro, J. M., & Yan, Y. (2019). Effects of Lighting Quality on Working Efficiency of Workers in Office Building in Tanzania. *Journal of Environmental and Public Health*, 2019. <https://doi.org/10.1155/2019/3476490>

- Králiková, R., Džuňová, L., Lumnitzer, E., & Piňosová, M. (2022). Simulation of Artificial Lighting Using Leading Software to Evaluate Lighting Conditions in the Absence of Daylight in a University Classroom. *Sustainability (Switzerland)*, 14(18). <https://doi.org/10.3390/su141811493>
- Mannan, K. A. (2020). Lighting Design Analysis in an Industrial Workshop Space: Case Study at Jakarta Creative Hub Workshop Space. *Journal of Architectural Research and Design Studies*, 4(1). <https://doi.org/10.20885/jars.vol4.iss1.art1>
- Maulana, A. I., & Kusuma, Y. (2022). Analysis of Natural Lighting and Visual Comfort Multipurpose Hall Building Using Software DIALux Evo 10.0 Case Study: Multipurpose Hall Building of Imbanagara Raya Ciamis Village Chief's Office, West Java. *IOP Conference Series: Earth and Environmental Science*, 1058(1), 0–10. <https://doi.org/10.1088/1755-1315/1058/1/012013>
- Muhamad, W. N. W., Zain, M. Y. M., Wahab, N., Aziz, N. H. A., & Kadir, R. A. (2010). Energy efficient lighting system design for building. *ISMS 2010 - UKSim/AMSS 1st International Conference on Intelligent Systems, Modelling and Simulation, October 2015*, 282–286. <https://doi.org/10.1109/ISMS.2010.59>
- Saputri, F. R., Prastomo, N., & Wijaya, J. P. (2022). Ultraviolet – C Dose Spread Simulation based on the Fixed-Lamp System in Universitas Multimedia Nusantara. *IJNMT (International Journal of New Media Technology)*, 8(2), 79–88. <https://doi.org/10.31937/ijnmt.v8i2.2357>
- Thesis, D., & Davoodi, A. (2023). *Supporting Evidence-Based Design Using Lighting Simulations – A Framework for Lighting Simulation of Visual Comfort in Building Design* (Issue 080).