

Indonesian National Standard Based Comparison of Classroom and Library Illuminance in A Junior High School

Aulia Rahma Efendi^{1}, Boedi Rahardjo², Aura Aldamah Dea Putri³, Azizah Nur Kamila⁴,
Azizah Virnanda P⁵, Hartini⁶*

^{1,2,3,4,5} Building Engineering Education, Universitas Negeri Malang, Malang, Indonesia

⁶ School of Business, Universiti Teknologi Brunei, Bandar Seri Begawan, Brunei Darussalam

^{1*} auliarahma@students.um.ac.id, ² boedi.rahardjo.ft@um.ac.id, ³ aura.aldamah.2405216@students.um.ac.id,

⁴ azizah.nur.2405216@students.um.ac.id

⁵ azizah.virnanda.2405216@students.um.ac.id, ⁶ hartini.mashod@utb.edu.bn

ABSTRACT

This study compares illuminance performance in a junior high school classroom and library using measured afternoon data and the illuminance criteria of Indonesian National Standard (SNI) 6197:2020. The classroom (9 m × 7 m) was evaluated at 80 points, whereas the library (11 m × 7 m) was evaluated at 82 valid points because of its irregular corner. Measurements were recorded from 13:00 to 15:00 at 20 min intervals. Raw data from the uploaded workbook were recalculated from point readings; for the library sheet, the recorded values were converted from a ×10 scale to lux before analysis. The analysis used average illuminance, minimum and maximum values, uniformity (Emin/Eavg), temporal comparison, and compliance with the 350 lux standard for classrooms and library reading rooms. The results show a very large performance gap between the two spaces. The classroom achieved an average of 27.48 lux, or 7.85% of the SNI target, and none of the observed points reached 350 lux. By contrast, the library achieved an average of 652.93 lux, exceeding the standard by 86.55%; however, its distribution was highly uneven, with strong peaks near daylight-dominant zones and several underlit edge areas. These findings indicate that the classroom requires immediate lighting improvement, while the library requires daylight control and redistribution rather than additional light output. The study provides practical evidence for evaluating school lighting conditions based on field measurements and SNI benchmarks.

ARTICLE INFO

Article History:

Submitted 23 March 2026

First Revised 18 April 2026

Accepted 26 April 2026

Available Online 30 April 2026

Publication Date 30 April 2026

Keywords:

Classroom illuminance; Junior high school; Library lighting; SNI; Visual comfort

1. INTRODUCTION

Lighting quality is one of the most influential environmental variables in school buildings because it affects visual comfort, reading accuracy, learning endurance, and the efficient use of educational space. In Indonesia, the performance of indoor lighting systems is commonly evaluated with Indonesian National Standard (SNI) 6197:2020 (Badan Standardisasi Nasional, 2020), which recommended a minimum average illuminance of 350 lux for classrooms and library reading rooms. This standard serves as an important for maintaining Indoor Environmental Quality (IEQ), as the physical conditions of learning spaces significantly impact students' well-being and academic concentration (Akanmu et al., 2021; Tran et al., 2023). For educational facilities, compliance is not only an energy issue but also a functional requirement because teaching and reading activities depend on adequate visibility and stable light distribution.

Previous studies have shown that poor classroom lighting can reduce visual comfort and create fatigue, while well-balanced lighting supports concentration and lowers unnecessary electricity consumption. Recent research has examined classroom lighting optimization, daylighting performance, glare control, control systems, and the integration of daylight with artificial lighting in improving educational environments (Aghajari & Chen, 2025; Chiou et al., 2020; Hidayat, 2022; Luo et al., 2024; Michael & Heracleous, 2017; Miranda et al., 2024; Tran et al., 2023). In addition, the evaluation of lighting perceptions and energy-saving strategies in school facilities has become an integral part of sustainable school infrastructure development (Awang et al., 2020; Tunahan et al., 2022). Other studies have emphasized that visual comfort depends not only on average lux levels but also on uniformity, shading strategy, surface reflectance, and the interaction between daylight and electric lighting, including energy-saving operation in teaching buildings (Awang et al., 2020; Bian et al., 2023; Costanzo et al., 2017; Šujanová et al., 2019; Tunahan et al., 2022).

Library spaces present a different lighting challenge. The reading rooms generally require sufficient illuminance for prolonged visual tasks, but they must also avoid excessive brightness contrast and localized glare. Studies on university and public libraries have reported that daylight can substantially improve spatial quality, yet uneven penetration and transparent envelope design may create zones that are either overlit or underlit (Kurnia et al., 2017; Voronkova & Podlasek, 2024). The indoor environment of a library directly influences user satisfaction and overall productivity, making it crucial to monitor these conditions (Aflaki et al., 2023; Zhang, 2019). This means that a room can satisfy the standard on average while still performing poorly in terms of visual distribution.

Despite the growing body of research, applied studies that integrate technical lighting evaluation with real school environments remain limited, particularly those based on direct field measurements. Previous studies, such as those conducted by (Wijaya et al., 2024) and (Dermawan et al., 2024), highlight the importance of field-based evidence in improving learning-related infrastructure and strengthening technical understanding in educational settings.

However, most existing studies still focus on a single room type, simulation-based approaches, or higher education facilities, leaving a gap in comparative analyses at the secondary school level. Based on that gap, this study aims to compare illuminance conditions in one classroom and one library of a junior high school and to interpret the results using the benchmark of SNI 6197:2020. The comparison focuses on three questions: (1) how far each room meets the 350 lux requirement, (2) how illuminance is distributed spatially across the measurement grid, and (3) how the average value changes over time during the afternoon measurement period. The findings are expected to support practical recommendations for school lighting improvement.

2. METHOD

2.1 Research Design

This research used a quantitative descriptive-comparative approach based on field measurement data. Two spaces in the same junior high school environment were compared; which is a classroom and a library. The classroom was represented by a rectangular room measuring 9×7 meters, while the library measured 11×7 meters. The comparison was performed on identical observation hours, namely six 20-minute intervals from 13:00 to 15:00. The classroom plan shows an 8 × 10 grid (rows A–H and columns 1–10), producing 80 measurement points. The library plan shows a grid with letters A–L and points 1–7; because of the room geometry, two corner positions were not valid, resulting in 82 usable points. The layout of the measuring points for the two rooms can be seen visually in **Figure 1**.

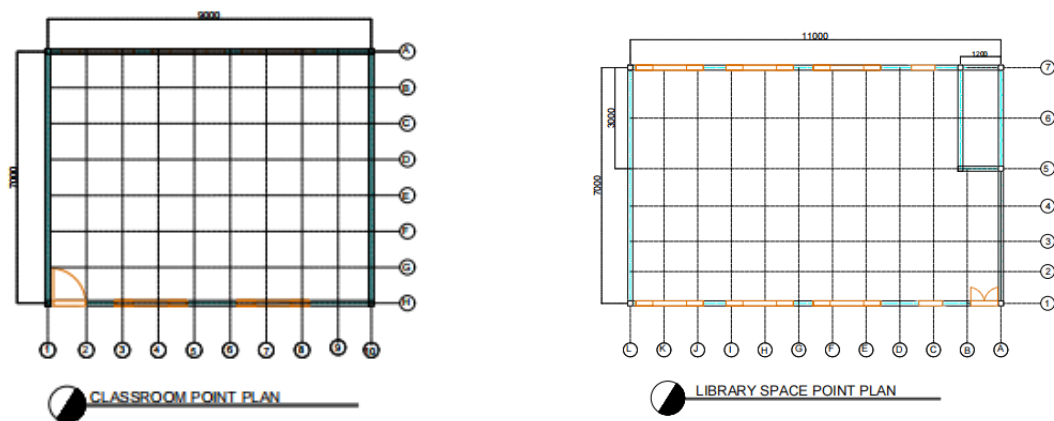


Figure 1. Measurement Grids of The Classroom (left) and Library (right).

Based on the grid shown in **Figure 1**, measurement points were systematically distributed to cover the entire work area in both rooms. The classroom layout follows a standard symmetrical grid, while the library layout requires a slightly different grid arrangement to accommodate its larger dimensions and specific architectural geometry. This grid arrangement ensures that the collected illumination data accurately represents the light distribution across the floor area of each room. By establishing a consistent measurement framework, this study performance in two different functional spaces.

2.2 Data Processing and Analysis

The dataset consists of point-based illuminance measurements for each room recorded at six time intervals. Classroom measurements were used directly in lux, while library measurements were converted to lux by applying a multiplication factor of ten, as indicated in the dataset. To ensure internal consistency, all summary statistics were recalculated from the raw point data rather than relying on pre-existing worksheet summaries. Three core indicators were employed in the analysis. The first is average illuminance (E_{avg}), representing the mean lux value across all valid measurement points within a room. The second is uniformity (U_0), defined as the ratio of minimum illuminance (E_{min}) to average illuminance (E_{avg}). The third is compliance with the SNI requirement of 350 lux. In addition, time-based averages were analyzed to identify patterns of illuminance variation during the afternoon measurement period.

$$E_{avg} = \sum E_i / n$$

$$U_0 = E_{min} / E_{avg}$$

To support interpretation, this article presents overall comparison tables, time-based averages, and heatmaps of the mean point values for each room. The heatmaps were generated from the six-interval average at each point so that the visual pattern represents the dominant spatial distribution rather than a single moment. The general characteristics of the room analyzed and the measurement setup are summarized in **Table 1**.

Table 1. Room Characteristic and Measurement Configuration

Space	Room size	Grid	Valid Pointes	Measurement Time	SNI target
Classroom	9 m × 7 m	A-H × 1-10	80	13:00-15:00	350 lux
Library	11 m × 7 m	A-L × 1-7	82	13:00-15:00	350 lux

Table 1 provides a clear framework for comparative analysis by aligning the physical dimension of these spaces with standard measurement parameters. By establishing the same time frame and SNI for classrooms and libraries, this study ensures that the resulting data can be directly compared, thereby enabling an accurate evaluation of the performance of each architectural space under identical environmental conditions.

3. RESULT AND DISCUSSION

3.1 Overall Comparison with SNI

The overall comparison immediately shows that the two spaces have very different illuminance conditions. The classroom average was only 27.48 lux, far below the required 350 lux. In practical terms, the room achieved only 7.85% of the recommended level. The library, on the other hand, reached 652.93 lux on average, or 186.55% of the target. Therefore, the library met the standard on average, while the classroom did not. Despite this contrast, neither room showed good uniformity. The classroom had an overall uniformity ratio of 0.10, and the library had 0.09. These values indicate that brightness was

concentrated in limited areas instead of being distributed evenly. For learning and reading tasks, such low uniformity can still reduce comfort because users experience strong local contrast between brighter and darker zones. A summary of lighting performance and a comparison with the SNI for both rooms is presented in **Table 2**.

Table 2. Overall Illuminance Performance Compared with The 350 lux Benchmark.

Space	Eavg (lux)	Emin (lux)	Emax (lux)	U0	Compliance status	Gap to 350 lux
Classroom	27.48	2.80	248.00	0.10	Not Compliant	-322.52 lux
Library	652.93	60.00	5570.00	0.09	Compliant on average	+302.93 lux

Table 2 show a significant difference in lighting adequacy between classrooms and the library. Although the average illuminance value in the library. Although the average illuminance value in the library far exceeds the requirements of Indonesian National Standard (SNI) 6197:2020, the very low uniformity ration (0.09) indicates. In contrast, the classroom does not meet the minimum thresholds for all measured parameters, indicating an urgent need for lighting intervention to achieve the target level of 350 lux. This comparison shows that even if average illuminance standard is met, high-quality, comfortable lighting is not necessarily achieved unless illuminance uniformity is ensured.

3.2 Spatial Distribution of Illuminance

The classroom heatmap in **Figure 2** shows that the brightest average values were concentrated mainly near the left side of the grid, especially around points close to rows D-F and columns 1-2. Even the brightest average point remained only 110.23 lux, which confirms that the room was underlit as a whole. Large parts of the center and far side of the room stayed below 20 lux on average. This pattern indicates inadequate daylight penetration and/or insufficient electric lighting support for the full learning area.

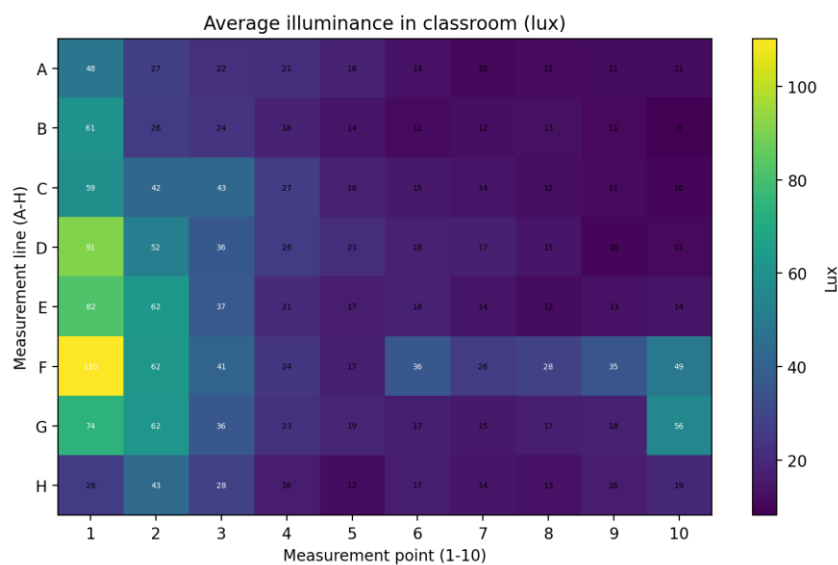


Figure 2. Average Illuminance Heatmap of The Classroom.

The library heatmap in **Figure 3** reveals the opposite problem. Several central and daylight-dominant zones recorded very high average values, with hot spots above 1,000 lux and a peak average point of 1,746.67 lux. At the same time, a number of edge points remained close to or below the standard. Out of 82 valid averaged points, 61 points (74.39%) reached at least 350 lux, which means that average compliance was driven by very bright zones rather than uniformly good lighting across the room.

From a design perspective, this suggests that daylight control, diffusion, and zoning are more important than adding more light output.

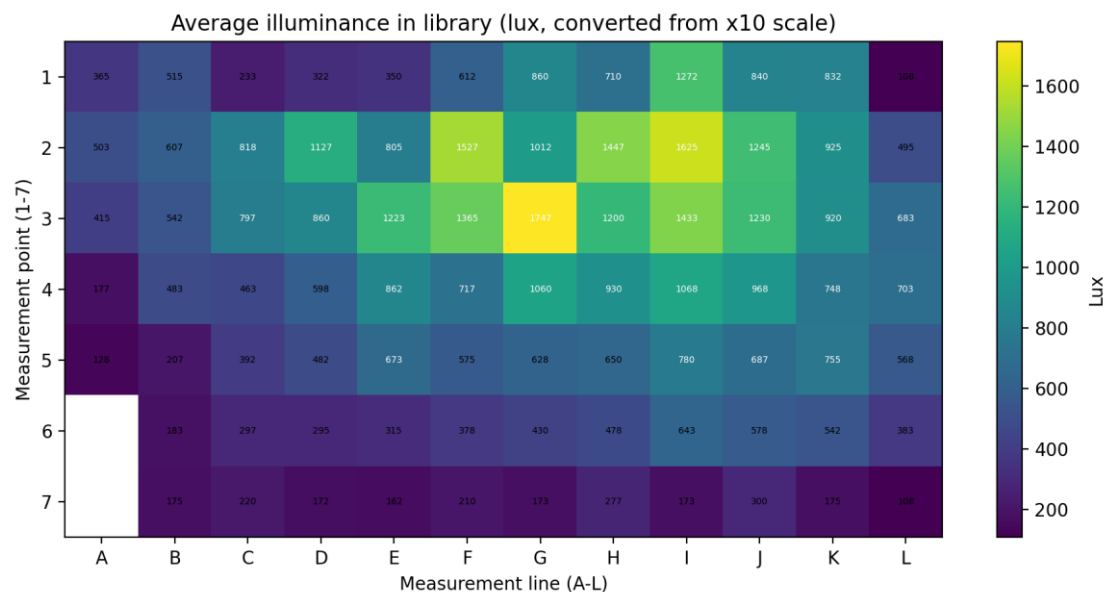


Figure 3. Average Illuminance Heatmap of The Library

The spatial distributions shown in **Figures 2** and **3** illustrate why average lux levels alone are insufficient for evaluating lighting quality. In the classroom, the heat map reveals critical lighting deficiencies across nearly the entire floor plan, while the library's heat map identifies specific areas with extreme brightness that are likely to cause visual discomfort despite high average values. The visual representations provide a diagnostic basis for targeted architectural intervention, such as relocating workstations or installing shading devices in zones with high light intensity in the library. Therefore, to achieve visual comfort in such educational spaces, a strategy is needed to balance illuminance with spatial uniformity.

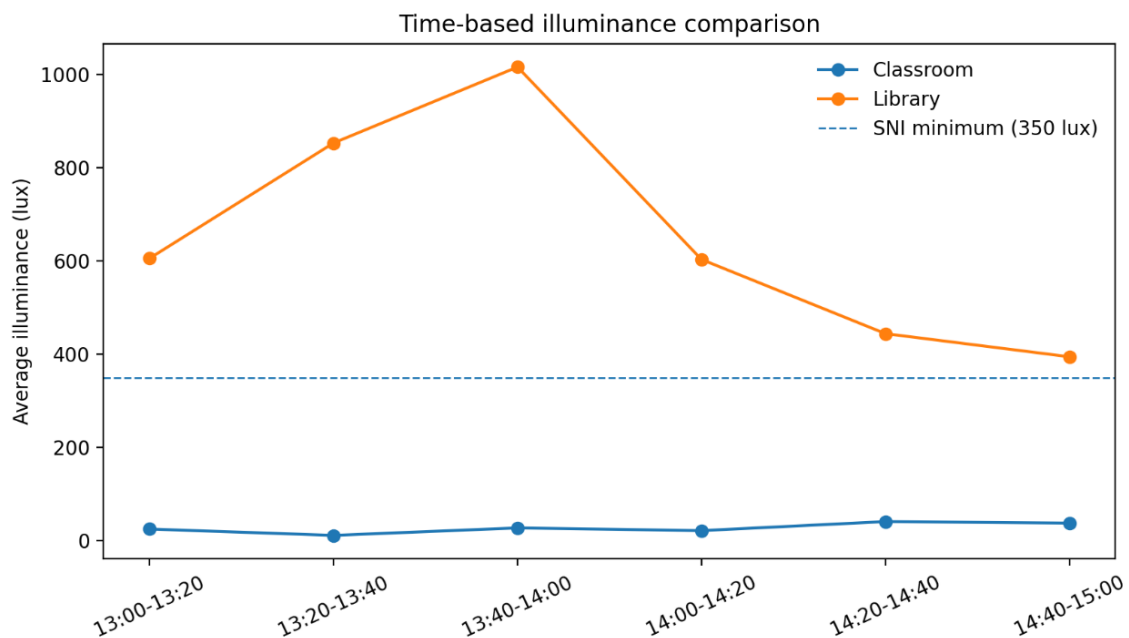
3.3 Spatial Distribution of Illuminance

Time-based averages confirm that the classroom remained below the standard during all six measurement intervals, while the library exceeded the standard during five of the six intervals. The classroom reached its highest mean value at 14:20–14:40 (41.12 lux), but this was still far from acceptable for routine classroom tasks. The library peaked at 13:40–14:00 with an average of 1,016.22 lux, then gradually declined toward 14:40–15:00. This pattern suggests a strong daylight contribution that changed with solar position and facade exposure. A detailed numerical comparison of these time-averaged values is presented in **Table 3**.

Table 3. Time-based Average Illuminance

Time interval	Classroom Eavg (lux)	Library Eavg (lux)	Difference (lux)	Classroom status	Library status
13:00-13:20	25.11	605.79	580.69	Below standard	Above standard
13:20-13:40	11.52	853.22	841.70	Below standard	Above standard
13:40-14:00	27.56	1,016.22	988.66	Below standard	Above standard
14:00-14:20	21.73	603.41	581.68	Below standard	Above standard
14:20-14:40	41.12	444.27	403.15	Below standard	Above standard
14:40-15:00	37.84	394.65	356.81	Below standard	Above standard

Figure 4 below compares the average illuminance of the classroom and the library across the six measurement intervals from 13:00 to 15:00. **Figure 4** compares the average illuminance levels in the classroom and the library during the observation period from 13:00 to 15:00. This comparison helps to evaluate the lighting performance in both rooms over time. The temporal variation of illuminance is presented in **Figure 4**.

**Figure 4.** Temporal Comparison of Average Illuminance

The data presented in **Table 3** and **Figure 4** illustrate the stability of lighting conditions during the observation period. Although both rooms experienced fluctuations, the classroom consistently failed to reach the 250-lux threshold, while the library maintained

lighting levels well above the afternoon. This temporal analysis confirms that inadequate lighting in the classroom is a persistent issue regardless of the time of day, whereas the library's performance is highly dependent on the dynamics of natural light.

3.4 Discussion and Practical Implications

The classroom result is consistent with previous studies showing that educational spaces can fail to support visual tasks when daylight penetration is weak or the artificial lighting layout is not designed for the whole work plane (Aghajari & Chen, 2025; Hidayat, 2022; Michael & Heracleous, 2017). The values measured in this study were so low that the problem cannot be solved by minor adjustment alone. The room requires substantial improvement, such as a redesign of the luminaire layout, a review of lamp output and maintenance, better use of daylight openings, and improved interior reflectance on walls and ceilings. The library result needs a more nuanced interpretation. A room that exceeds the standard by average value is not automatically comfortable. The large distance between the minimum and maximum values indicates the risk of excessive brightness contrast, localized glare, and uneven reading comfort. This finding supports the argument of library and daylight studies that transparency, orientation, shading, and diffusion must be balanced carefully (Fanpu et al., 2024; Zhang, 2019). For this case, the main intervention is not higher illuminance but better distribution through blinds, shading devices, glazing control, and zoning between daylight-rich and daylight-poor areas.

The comparison also demonstrates the value of field measurement. If only one indicator is used, such as the average lux value, the library would appear fully satisfactory and the classroom would simply appear deficient. By combining average value, uniformity, time variation, and heatmap interpretation, the diagnosis becomes more useful for design decisions. This is in line with broader literature that recommends integrated evaluation of visual comfort, daylight use, and energy performance in educational buildings (Costanzo et al., 2017; Soares et al., 2017; Šujanová et al., 2019). This study has several limitations. The data represent only one school, two room types, and afternoon conditions between 13:00 and 15:00. The analysis focuses on illuminance and does not include correlated color temperature, glare index, color rendering, or direct occupant perception. Even so, the dataset is sufficiently detailed to show that compliance and comfort cannot be interpreted only from room function labels; spatial distribution and timing remain critical. A summary of the key findings and practical recommendations for area is presented in **Table 4**.

Table 4. Main Findings and Practical Recommendations

Space	Main problem	Priority recommendation
Classroom	Extremely low illuminance and dark interior zones	Increase effective lamp output, redesign luminaire spacing, improve daylight access, and use higher-reflectance interior finishes.
Library	Average illuminance is high but strongly non-	Control direct daylight with blinds or shading, diffuse excessive bright zones, and rezone

Space	Main problem	Priority recommendation
	uniform	reading activities based on daylight availability.

The findings summarized in **Table 4** highlight substantial differences in lighting performance between the classroom and the library, indicating that each space requires a distinct intervention strategy. The classroom is characterized by extremely low illuminance levels and the presence of dark interior zones, suggesting inadequate artificial lighting distribution and limited daylight penetration. This condition is critical, as insufficient lighting has been consistently associated with reduced visual performance, decreased concentration, and lower learning efficiency in educational environments (Hao et al., 2024). Therefore, increasing effective lamp output, optimizing luminaire spacing, and improving daylight access are essential measures to enhance both visual comfort and functional learning conditions.

In contrast, the library demonstrates relatively high average illuminance but suffers from poor uniformity, indicating an imbalance in light distribution. This suggests that certain areas are overexposed to daylight while others remain underlit, a condition often associated with uncontrolled daylight and inadequate shading strategies. Previous studies emphasize that excessive daylight and glare can reduce visual comfort and disrupt task performance, particularly in reading-oriented environments (Alkhatabeh et al., 2023). In addition, research on lighting design in educational buildings shows that achieving proper uniformity requires careful integration between daylight and artificial lighting systems, including shading and control strategies (Viula et al., 2023). Consequently, controlling direct daylight through shading devices, diffusing excessive brightness, and reorganizing activity zones based on daylight availability are necessary to achieve a more balanced visual environment. Overall, these findings reinforce that compliance with average illuminance standards alone is insufficient to ensure lighting quality. Instead, spatial distribution, uniformity, and user-oriented lighting design must be considered simultaneously. The recommended interventions presented in Table 4 provide practical and context-specific guidance for improving lighting performance in educational facilities, particularly in optimizing both energy use and visual comfort.

4. CONCLUSION

This study compared the illuminance of a classroom and a library in a junior high school using field measurement data and the benchmark of Indonesian National Standard (SNI) 6197:2020. The classroom was clearly non-compliant, with an average illuminance of 27.48 lux, zero measured compliance with the 350 lux requirement, and a very uneven distribution. This indicates that the classroom requires immediate lighting improvement to support normal teaching and learning activities. The library achieved an average illuminance of 652.93 lux, which means that it met the standard on average. However, the room also showed severe non-uniformity, with very bright zones and weaker edge areas. Therefore, the library

should not be interpreted as fully satisfactory; it requires redistribution and control of light rather than additional light intensity. Overall, the study confirms that average lux alone is insufficient for judging school lighting quality. A more useful evaluation combines average illuminance, temporal pattern, and spatial distribution so that corrective actions can be matched to the real problem in each room.

REFERENCES

- Aflaki, A., Esfandiari, M., & Jarrahi, A. (2023). Multi-criteria evaluation of a library's indoor environmental quality in the tropics. *Buildings*, 13(5), 1233.
- Aghajari, S., & Chen, C.-C. (2025). Optimizing classroom lighting for enhanced visual comfort and reduced energy consumption. *Buildings*, 15(8), 1233.
- Akanmu, W. P., Nunayon, S. S., & Eboson, U. C. (2021). Indoor environmental quality (IEQ) assessment of Nigerian university libraries: A pilot study. *Energy and Built Environment*, 2(3), 302-314.
- Alkhatatbeh, B. J., Kurdi, Y., & Asadi, S. (2023). Multi-objective optimization of classrooms' daylight performance and energy use in US climate zones. *Energy and Buildings*, 297, 113468.
- Awang, M., Tham, C. S., Ruddin, N. M. B., Rahman, M. A. A., Hamidon, N., Ahmad, F., Musa, K., Nagapan, S., & Rahman, M. S. A. (2020). Assessment of energy saving potential and lighting system in teaching building. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, 65(1), 159-169.
- Bian, Y., Chen, Y., Sun, Y., Ma, Y., Yu, D., & Leng, T. (2023). Simulation of daylight availability, visual comfort and view clarity for a novel window system with switchable blinds in classrooms. *Building and Environment*, 235, 110243.
- Badan Standardisasi Nasional. (2020). *SNI 6197:2020 konservasi energi pada sistem pencahayaan*. Badan Standardisasi Nasional.
- Chiou, Y.-S., Saputro, S., & Sari, D. P. (2020). Visual comfort in modern university classrooms. *Sustainability*, 12(9), 3930.
- Costanzo, V., Evola, G., & Marletta, L. (2017). A review of daylighting strategies in schools: State of the art and expected future trends. *Buildings*, 7(2), 41.
- Dermawan, M. R., Kudwadi, B., & Parmono, P. (2024). Tingkat pengetahuan dan sikap siswa SMK DPIB mengenai risiko gempa bumi terhadap kerusakan bangunan. *Jurnal Pendidikan Teknik Bangunan*, 4(1), 25-40.
- Fanpu, M., & Hua, F. (2024). Research on the health lighting scheme of university library reading room. *Heliyon*, 10 (19).
- Hao, H., Xu, J., & Schlangen, L. J. (2024). Evaluation and optimization of annual light variations for visual and non-visual effects within a ground-floor middle school

- classroom. *Journal of Building Engineering*, 98, 111293.
- Hidayat, M. S. (2022). The evaluation of daylighting performance in the university classroom: An experimental study. *International Journal of Built Environment and Scientific Research*, 6(1), 73-82.
- Kurnia, K. A., Azizah, D. N., Mangkuto, R. A., & Atmodipoero, R. T. (2017). Visual comfort assessment using high dynamic range images under daylight condition in the main library building of Institut Teknologi Bandung. *Procedia Engineering*, 170, 234-239.
- Luo, J., Yan, G., Zhao, L., Zhong, X., & Su, X. (2024). Evaluation of design parameters for daylighting performance in secondary school classrooms based on field measurements and physical simulations: A case study of secondary school classrooms in Guangzhou. *Buildings*, 14, 637.
- Michael, A., & Heracleous, C. (2017). Assessment of natural lighting performance and visual comfort of educational architecture in Southern Europe: The case of typical educational school premises in Cyprus. *Energy and Buildings*, 140, 443-457.
- Miranda, D. T., Barreto, D., & Flores-Colen, I. (2024). An evaluation of the luminous performance of a school environment integrating artificial lighting and daylight. *Sustainability*, 16(4), 1426.
- Soares, N., Bastos, J., Pereira, L. D., Soares, A., Amaral, A. R., Asadi, E., Rodrigues, E., Lamas, F. B., Monteiro, H., Lopes, M. A. R., et al. (2017). A review on current advances in the energy and environmental performance of buildings towards a more sustainable built environment. *Renewable and Sustainable Energy Reviews*, 77, 845-860.
- Šujanová, P., Rychtáriková, M., Sotto Mayor, T., & Hyder, A. (2019). A healthy, energy-efficient and comfortable indoor environment: A review. *Energies*, 12, 1414.
- Tran, M. T., Wei, W., Dassonville, C., Martinsons, C., Ducruet, P., Mandin, C., Héquet, V., & Wargocki, P. (2023). Review of parameters measured to characterize classrooms' indoor environmental quality. *Buildings*, 13(2), 433.
- Tunahan, G. I., Altamirano, H., Teji, J. U., & Ticleanu, C. (2022). Evaluation of daylight perception assessment methods. *Frontiers in Psychology*, 13, 805796.
- Viula, R., Bokel, R., & Tenpierik, M. (2023). Prediction of discomfort from glare from daylight in classrooms. *Lighting Research & Technology*, 55(7-8), 712-729.
- Voronkova, I., & Podlasek, A. (2024). The use of transparent structures to improve light comfort in library spaces and minimize energy consumption: A case study of Warsaw, Poland. *Energies*, 17(12), 3007.
- Wijaya, E. P., Wibowo, D. E., & Malik, A. (2024). Pengembangan video pembelajaran pengujian sondir tanah untuk mahasiswa program studi pendidikan teknik sipil dan perencanaan. *Jurnal Pendidikan Teknik Bangunan*, 4(1), 1-14.

Zhang, Z. (2019). The effect of library indoor environments on occupant satisfaction and performance in Chinese universities using SEMs. *Building and Environment*, 150, 322-329.