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Evaluation of Natural Lighting Distribution and Visual Comfort at Eplus Co-Working Space Yogyakarta Using Dialux Evo

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ABSTRACT

The rapid growth of co-working spaces in urban areas has increased the demand for high-quality indoor environments that support user productivity and visual comfort. One of the major challenges is the extensive use of glazing with a high Window-to-Wall Ratio (WWR), which often results in uneven daylight distribution, excessive glare, and reduced visual comfort. This study aims to evaluate the daylighting performance of Eplus Co-Working Space Yogyakarta and identify the most effective façade design strategy for improving visual comfort using DIALux evo simulation. A quantitative comparative approach was employed through field illuminance measurements, three-dimensional building modeling, simulation model validation, and comparative testing of several sun-shading configurations, including vertical, horizontal, and egg-crate systems, under equinox and solstice conditions. The results indicate that the existing building exhibits significant daylight imbalance, with illuminance levels exceeding 1,000 lux near the façade, causing glare, while the inner areas receive only 20–150 lux, which is below the recommended illuminance level for office work. Among all simulated scenarios, the 0° egg-crate shading configuration demonstrated the best performance by providing the most uniform daylight distribution, eliminating the risk of over-illumination, and maintaining illuminance levels within the recommended range for office spaces. The study concludes that the implementation of 0° egg-crate shading is the most effective façade strategy for optimizing daylight performance and enhancing visual comfort in co-working spaces, while interior areas with

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*insufficient daylight require supplementary artificial lighting
or carefully designed additional openings.*

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1. INTRODUCTION

The advancement of the digital era and globalization has brought significant changes to the working patterns of urban society, one of which is marked by the proliferation of the co-working space phenomenon as a more flexible workspace alternative (Sulasrar, n.d.). Co-working spaces do not only serve as workspaces but also accommodate various groups, ranging from freelancers and students to entrepreneurs seeking a collaborative environment with a different atmosphere from conventional offices (Sulasrar, n.d.). Along with the Work From Cafe (WFC) trend, the high visitation rate to these commercial facilities strongly demands the availability of a comfortable indoor environment to support work efficiency and reduce burnout or the pressure of work targets (Maheswari, Idham, & Arkan, 2025).

One crucial aspect in creating comfort in commercial workspaces is visual comfort, which is highly dependent on the distribution of natural lighting (Stefhanie, 2021; Ardyanny, 2023). The well-optimized utilization of natural light not only contributes significantly to building energy efficiency but also has a direct impact on psychological well-being, health, and the enhancement of user productivity and morale (Ardyanny, 2023; Maulana & Kusuma, 2022). Conversely, inadequate opening designs can result in uneven light distribution, where light intensity that is too contrasting or excessively bright can trigger glare and cause eye fatigue (Ardyanny, 2023; Maulana & Kusuma, 2022). Therefore, architectural design must be able to meet ideal lighting standards, as recommended in the Indonesian National Standard (SNI) 6197:2020 and SNI 03-2396-2001, where the minimum illuminance level for a conducive reading or working area is 350 lux (Adi, Afiq, & Pamungkas, 2022; Badan Standardisasi Nasional, 2000, 2001; Maulana & Kusuma, 2022).

Natural lighting in workspaces is one of the most important factors in maintaining comfort; hence, an evaluation of lighting performance is required, one of which is through a computational simulation method using DIALux evo software as a highly recommended quantitative approach (Adi, Afiq, & Pamungkas, 2022; Maulana & Kusuma, 2022). DIALux evo is academically and professionally recognized for its highly accurate capability in modeling, calculating, and visualizing the distribution of both natural and artificial lighting inside buildings with precise parameters based on orientation conditions and room materials (Budhiyanto, 2025; Maulana & Kusuma, 2022). Stemming from this urgency, this study aims to comprehensively evaluate the natural lighting distribution and visual comfort levels in Eplus Co-Working Space Yogyakarta using DIALux evo simulation, in order to formulate solution-oriented facade or shading design recommendations to enhance the visual comfort of its visitors (Arrahman & Sudarwanto, 2024; Maheswari, Idham, & Arkan, 2025).



Figure 1. Building Axonometry
Source: Author, 2026

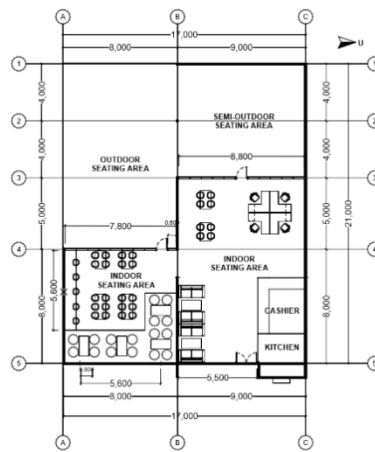


Figure 2. Building Floor plan
Source: Author, 2026

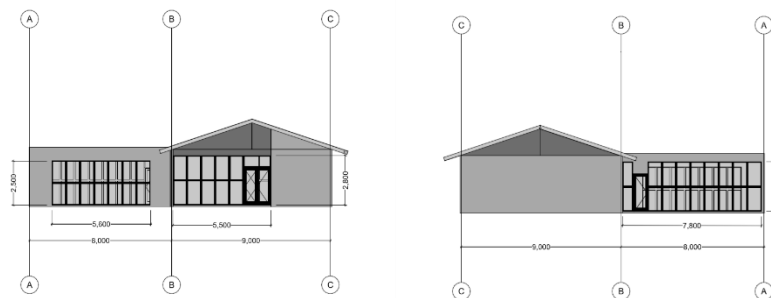


Figure 3 & 4. West Elevation and East Elevation
Source: Author, 2026

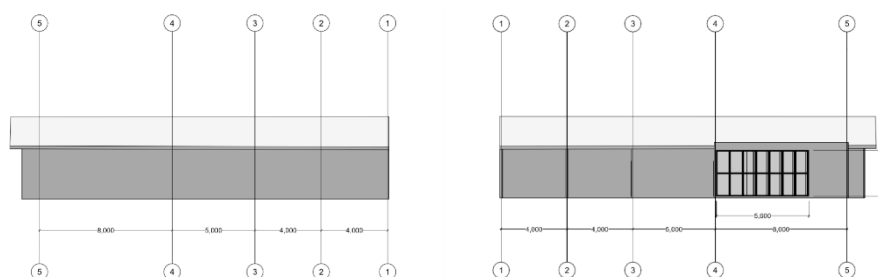


Figure 5 & 6. North Elevation and South Elevation
Source: Author, 2026

Various previous studies have proven that the magnitude of the Window-to-Wall Ratio (WWR) and the orientation of openings on the east and west sides are dominant factors triggering indoor glare and overheating problems, making the addition of sun shading the most effective design solution (Ardyanny, 2023; Budhiyanto, 2025; Rahmah & Jurizat, 2022). A quantitative approach using DIALux evo software has also proven highly accurate in evaluating the effectiveness of facade engineering against workspace visual comfort standards, which is a minimum of 350 lux according to SNI 6197:2020 (Adi, Afik, & Pamungkas, 2022; Maulana & Kusuma, 2022). Specifically, a previous study on Eplus.Co Co-working Space found that the dominance of glass (WWR > 40%) on the building's east and west facades causes radiant heat loads (OTTV) that exceed reasonable limits (Maheswari, Idham, & Arkan, 2025). Stemming from this urgency, although its thermal performance has been evaluated, the impact of the existing glass area on natural lighting distribution and the potential for visual discomfort (glare) among visitors has never been spatially investigated, thus presenting a research gap. This study aims to comprehensively evaluate the natural lighting distribution

and visual comfort levels in Eplus Co-Working Space Yogyakarta using DIALux evo simulation, in order to formulate solution-oriented facade or shading design recommendations to enhance the visual comfort of its visitors (Arrahman & Sudarwanto, 2024; Maheswari, Idham, & Arkan, 2025).

Based on these issues, the research questions in this study encompass how the existing conditions of natural lighting distribution and visual comfort levels are in the Eplus Co-Working Space workspace area, what factors influence this visual comfort, and what the most optimal facade engineering design strategy is to improve visual comfort. In line with these research questions, this study aims to evaluate the existing conditions of natural lighting distribution and visual comfort levels in the Eplus Co-Working Space workspace area using a computational simulation approach such as DIALux evo to determine whether its light intensity has met workspace comfort standards; to identify and analyze architectural factors influencing the visual comfort level in the building; and to formulate and test the most optimal facade engineering design strategy through comparative simulations.

1.1 LITERATURE STUDIES

A) Natural Lighting Standards in Workspaces and Buildings

The utilization of natural lighting is crucial for reducing building energy consumption while simultaneously maintaining the health and morale of its users (Maulana & Kusuma, 2022). In Indonesia, the design reference for natural and artificial lighting systems is strictly regulated within the Indonesian National Standard (SNI). Based on the guidelines of SNI 03-2396-2001, indoor natural lighting is evaluated using the Daylight Factor method, namely the percentage ratio of the indoor illuminance level to the outdoor illuminance (Badan Standardisasi Nasional, 2001). To ensure comfort for workspace, reading room, or office functions, the SNI 6197:2020 standard recommends a minimum illuminance level of 350 lux (Arrahman & Sudarwanto, 2024; Maulana & Kusuma, 2022). The evaluation in this study utilizes this 350 lux benchmark as the parameter for successful lighting distribution.

B) Impact of Window-to-Wall Ratio (WWR)

The Window-to-Wall Ratio (WWR) is the percentage ratio between the area of window openings (glass) and the total exterior wall surface area of a building (Ardyanny, 2023; Maheswari, Idham, & Arkan, 2025). The magnitude of this WWR proportion has proven to be a dominant factor influencing the average quantity of natural light illuminance entering a room (Budhiyanto, 2025). The larger the glass area, the more natural light the building can utilize. However, the magnitude of this opening ratio must be strictly controlled. An excessive increase in the WWR percentage will be directly proportional to a high solar radiation heat gain, thereby triggering an increase in the Overall Thermal Transfer Value (OTTV) on the building envelope (Madina, Tundono, & Rezandi, 2024; Maheswari, Idham, & Arkan, 2025). Therefore, international design standards such as ASHRAE 90.1 recommend a maximum WWR limit of 40% for commercial buildings to maintain a balance between lighting and thermal efficiency (Maheswari, Idham, & Arkan, 2025).

C) Influence of Building Orientation

In addition to opening dimensions, the orientation of the building facade largely determines the quality of light distribution and the heat load received by the indoor space. Window orientations directly facing east and west are highly vulnerable to the direct penetration of excessive solar radiation during the morning and afternoon (Maheswari, Idham, & Arkan, 2025; Rahmah & Jurizat, 2022). Uncontrolled light exposure on these sides not only creates overheating problems but also triggers overly contrasting light intensities, causing glare that disrupts the visual comfort of users (Rahmah & Jurizat, 2022). Conversely,

north- and south-oriented facades are generally able to provide more stable daylight levels and avoid direct radiation (Purnama, Sangadji, & Nugraha, 2025; Rahmah & Jurizat, 2022). As concrete evidence of the interaction between the two variables above, a previous case study on the Eplus.Co Coffee & Co-working Yogyakarta building showed that the building has a WWR percentage exceeding 40%, specifically on its east and west facades. This glass-dominated facade orientation configuration without adequate shading directly causes the building's radiant heat load to exceed the required standard OTTV limits (Maheswari, Idham, & Arkan, 2025).

D) Facade Optimization through Sun Shading (Shasing Element)

To overcome the negative effects of a high glass opening ratio, design intervention through sun shading devices is highly recommended (Arrahman & Sudarwanto, 2024). Shading elements can take the form of horizontal planes (overhangs), vertical fins, or eggcrate combinations adapted to the direction of the facade's orientation (Purnama, Sangadji, & Nugraha, 2025). Based on simulation studies on glass-dominated facades, the addition of horizontal shading has proven highly effective in minimizing visual discomfort and lowering the OTTV value to meet comfort standards (Maheswari, Idham, & Arkan, 2025). Thus, modifying shading elements on the building envelope is a crucial architectural retrofitting step to balance the need for daylight penetration and glare control (Arrahman & Sudarwanto, 2024).

E) Computational Simulation Using DIALux evo Software

The quantitative approach through software simulation is currently recognized for its validity in architectural lighting research. DIALux evo is parametric lighting simulation software capable of precisely calculating and visualizing technical data and illuminance distribution within a 3D environment (Maulana & Kusuma, 2022). This software allows researchers to input variables in detail, ranging from north orientation, specific building location, and sky conditions to glass materials and the reflectance levels of room surfaces (Budhiyanto, 2025; Rahmah & Jurizat, 2022). Through DIALux evo's output in the form of illuminance values (lux) and color contours of light distribution (isolux), researchers can directly compare the room's lighting conditions with the required SNI standard regulations (Maulana & Kusuma, 2022).

2. RESEARCH METHODS

2.1 Field Data Collection Method

Field data collection is a crucial stage for obtaining primary data of the existing building, which will subsequently serve as the basis for modeling within the DIALux evo software. The data acquisition is focused on the indoor area. The field data collection stage is conducted systematically through direct observation and measurement.

Table 1. Field Data Collection

Data	Parameter	Technique	Instrument	Output
Geometric	Length, width, and height of the indoor area	Direct Measurement	Measuring Tape	3D model
Building Envelope	Total area of exterior walls & glass area	Direct Measurement	Measuring Tape	Existing Window-to-Wall Ratio (WWR)
Illuminance	Natural illuminance level (target min. 300 lux)	Direct Measurement	Lux Meter	Baseline illuminance data (lux) for validation
Workplane	Work area/desk height (0.75 m)	Direct Measurement	Measuring Tape	Workplane height for calculation in DIALux evo
Environmental	Solar orientation & surrounding obstructions	Field Observation	Digital Camera	Existing facade condition & shading map

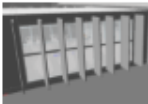
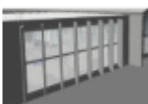
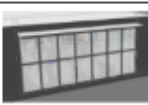
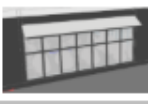
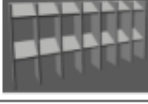
Source: Author, 2026

2.2 DIALux evo Simulation Method

The simulation method utilizes DIALux evo software, which is a computationally based quantitative approach to evaluate, model, and visualize natural lighting performance within interior spaces. The simulation stages include:

1. **3D Geometry & Material Property Modeling:** Reconstructing the 3D model according to its original dimensions and window openings, as well as inputting the physical parameters of materials in the form of surface reflectance and the Visible Light Transmittance of the glass.
2. **Environmental & Plane Parameters:** Setting the location coordinates and north orientation, disabling artificial lighting, selecting a standard sky model, determining the simulation time, and placing the calculation plane (workplane) at a height of 0.75–0.80 meters in accordance with SNI standards.
3. **Baseline Simulation & Field Validation:** Running the initial model calculation to obtain the indoor lux, then validating the results by comparing the output data against real measurement results from a lux meter in the field.
4. **Recommended Scenario Simulation (Alternative Shading & WWR):** Evaluating areas that do not meet the SNI 6197:2020 standard or that possess the potential for extreme glare, then testing architectural modifications such as adjusting the window opening ratio and installing variations of shading elements to optimize lighting.
5. **Data Extraction & Output Analysis:** Extracting quantitative data in the form of average illuminance levels and light distribution contours, as well as analyzing false-color graphic visualizations to quickly identify areas that are too dark or prone to glare.

Table 2. Research Variables

	Variable				
	Shading			Time	
	Type	Form	Dimensions		Angle
Independent Variable	Vertical		0,8 m x 3 m	0°	21 March
				30°	
	Horizontal			0°	21 June
				30°	
	Eggcrate			0°	21 December
				30°	
Control Variable	Existing Building Geometry and Orientation				
	Simulation of Environmental Conditions				
	Measurement Time at Peak Hour (12:00 PM WIB)				
Dependent Variable	DIALux evo Simulation Results				

Source: Author, 2026

2.3 Data Analysis Method

This study uses a quantitative analysis method with a comparative approach, wherein data from field collection and the output from the DIALux evo software simulation will be processed and evaluated. The data analysis process includes:

1. Model validation analysis is the first stage to validate the accuracy of the 3D model within DIALux evo.
2. Evaluation analysis of existing conditions against standards.
3. Visual and spatial distribution analysis of the indoor light distribution mapping using output in the form of isolux contours and false-color visualization from DIALux evo, which aims to observe illuminance uniformity.
4. Comparative analysis of alternative designs.

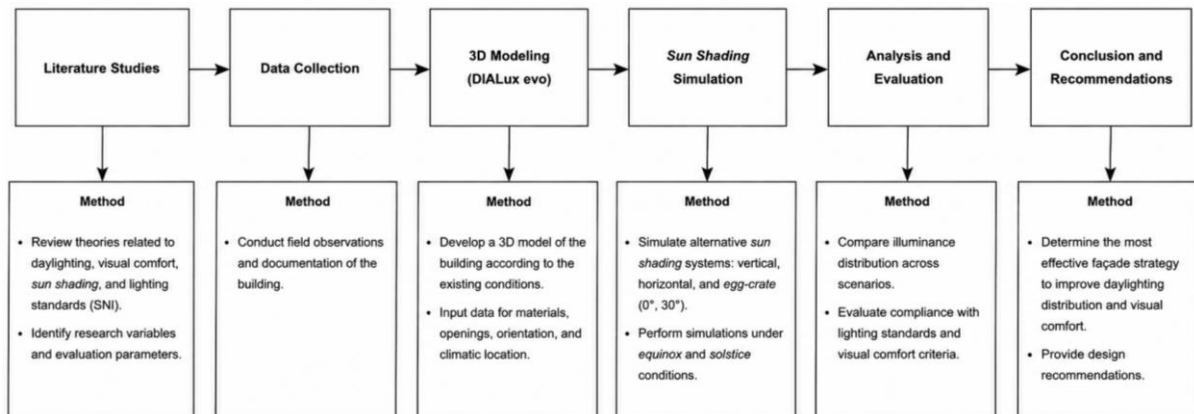


Figure 7. Diagram of Research Methodology and Research Process
Source: Author, 2026

3. RESULTS AND DISCUSSION

3.1 Existing Survey Results

Field measurements at Eplus Co-Working Space Yogyakarta, specifically focused on the building's indoor area, indicate an extreme lighting imbalance between the western perimeter area (Room 1) and the inner area (Room 2) (Ardyanny, 2023; Maheswari et al., 2025). In Room 1, the natural illuminance level ranges from 500 Lux to 2,500 Lux, with the majority of the measured area exceeding the ideal threshold of over 1,000 Lux (Ardyanny, 2023; Supriyadi, 2024). Conversely, Room 2 is dominated by very low light intensity ranging from 20 Lux to 150 Lux, falling far below the minimum workspace lighting standard of 350 Lux (Badan Standardisasi Nasional, 2001; Maulana & Kusuma, 2022).

Based on these findings, the architectural intervention undertaken is the addition of sun shading devices to mitigate exposure to over-illumination and glare. The selection of the simulation time during peak hours (12:00 WIB) is based on the sun's zenith position, which yields the most critical thermal radiation intensity and illuminance throughout the day (Adi et al., 2022; Rahmah & Jurizat, 2022). The 21st of March, June, and December were selected because they represent the equinox and solstices of the sun's annual apparent path, namely the March equinox, the June northern solstice, and the December southern solstice (Purnama et al., 2025; Rahmah & Jurizat, 2022). The fluctuation in the angle of incidence of solar radiation during these peak periods serves as the primary benchmark for testing the effectiveness of shading elements in a tropical climate (Cheng et al., 2025; Dewi, 2023).

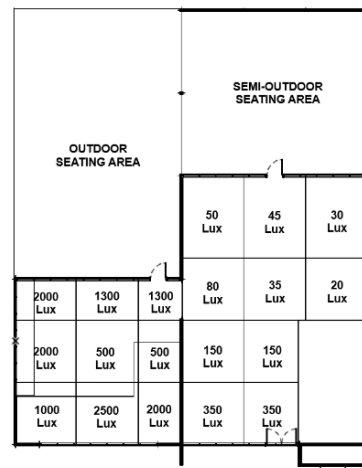


Figure 8. Natural Lighting Intensity Measurement Results at 12:00 WIB
Source: Author, 2026

3.1 Results of Existence Simulation during Peak Hour (12.00 WIB)

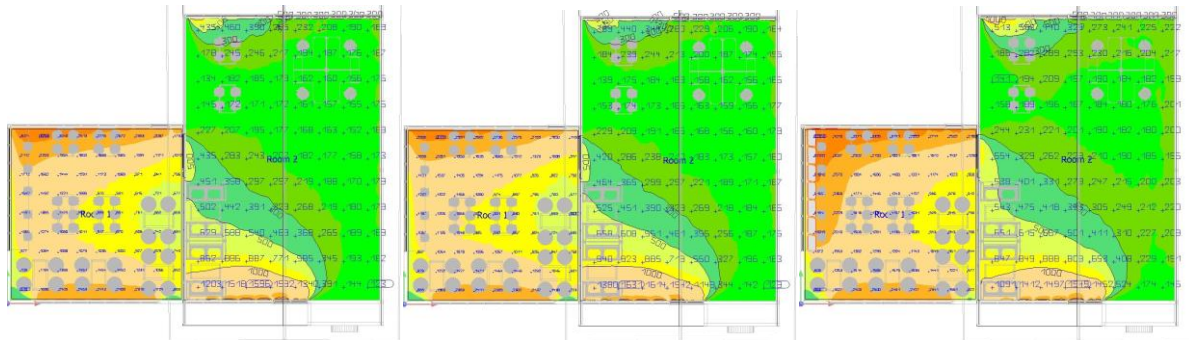


Figure 9,10,11. Simulation Results for March 21, June 21, and December 21, 2025
Source: Author, 2026

The baseline simulation conditions without shading elements indicate that a Window-to-Wall Ratio (WWR > 40%) on the west-oriented facade triggers the uncontrolled penetration of direct solar radiation (Madina et al., 2024; Tawfeeq & Ali, 2024). In the false-color visualization of the DIALux evo software, the Room 1 area is dominated by deep orange and bright yellow color contours with intensities exceeding 1,000 Lux (Budhiyanto, 2025; Maulana & Kusuma, 2022). This excessive lighting exposure directly triggers visual discomfort (discomfort glare) for users and increases the building's radiant heat gain (Overall Thermal Transfer Value/OTTV) (Madina et al., 2024; Rahmah & Jurizat, 2022).

3.2 Simulation Results of Adding Vertical Shading Angle: 0° (12.00 WIB)

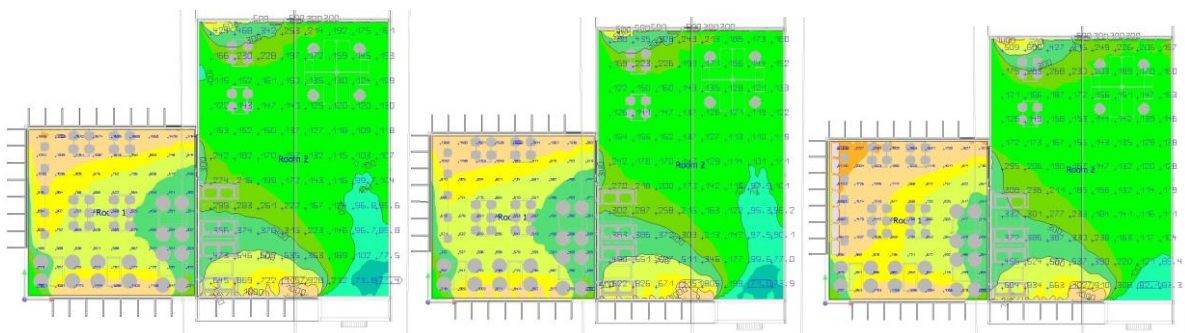


Figure 12,13,14. Simulation Results for March 21, June 21, and December 21, 2025
Source: Author, 2026

The addition of vertical shading with a 0° tilt has proven ineffective in controlling light distribution on this west-oriented facade (Purnama et al., 2025). Perpendicular vertical fins fail to intercept the angle of solar radiation from the front and sides, resulting in over-illumination exposure that still dominates the workspace (Rahmah & Jurizat, 2022). Even in December, this configuration exhibits an extreme glare spike exceeding 60,000 Lux in areas adjacent to window openings due to the low solar elevation angle (Ardyanny, 2023; Rahmah & Jurizat, 2022).

3.3 Simulation Results of Adding Vertical Shading Angle: 30° (12.00 WIB)

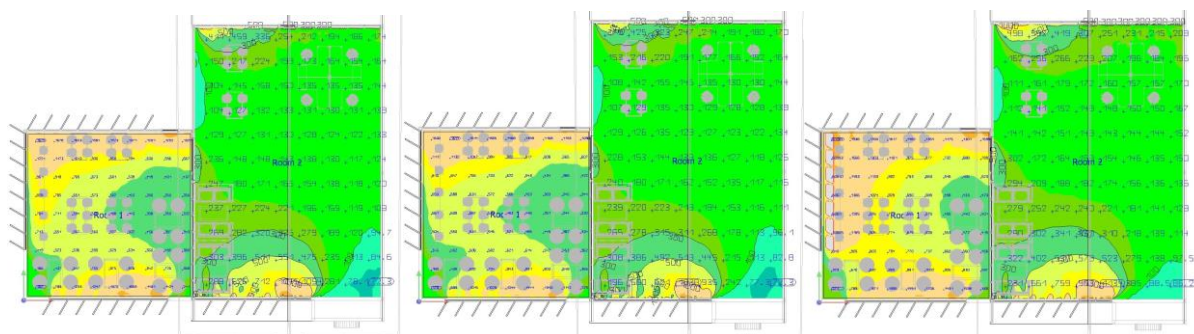


Figure 15,16,17. Simulation Results for March 21, June 21, and December 21, 2025

Source: Author, 2026

Adjusting the tilt of the vertical fins to 30° provides a slight improvement in radiation mitigation performance during certain periods. The 30° blade rotation is capable of expanding the green zone that meets the standard (300–1,000 Lux) in the central desk area in June. Nevertheless, the potential for extreme glare in December in the outer perimeter area remains unavoidable due to the low solar incidence angle aligning with the gaps between the blades (Rahmah & Jurizat, 2022).

3.4 Simulation Results of Adding Horizontal Shading Angle: 0° (12.00 WIB)

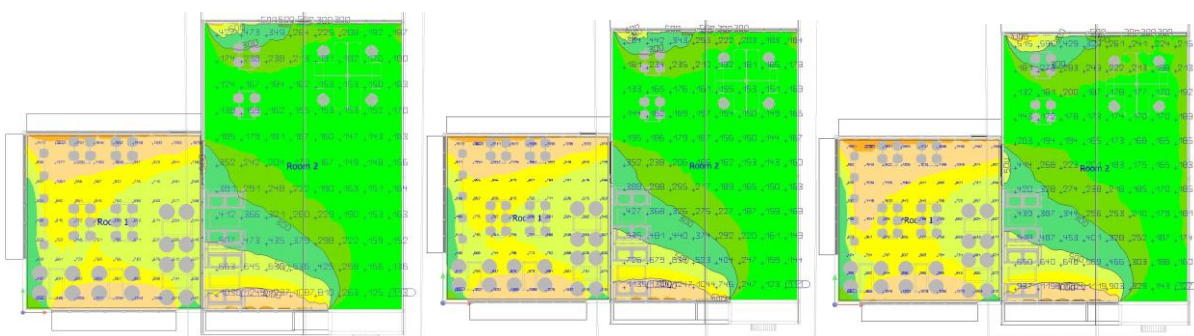


Figure 18,19,20. Simulation Results for March 21, June 21, and December 21, 2025

Source: Author, 2026

The application of horizontal shading with a 0° tilt provides better radiation reduction compared to the vertical variations. Flat blades can effectively intercept solar radiation from high zenith angles, allowing the central area of the room to become cooler (Purnama et al., 2025). However, this variation still allows radiation from oblique angles to penetrate, causing the outermost perimeter area adjacent to the window to remain in a glare condition exceeding 1,000 Lux (Ardyanny, 2023).

3.5 Simulation Results of Adding Horizontal Shading Angle: 30° (12.00 WIB)

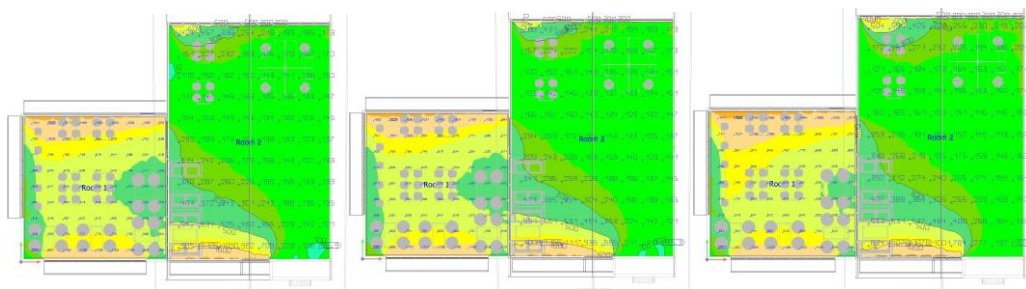


Figure 21,22,23. Simulation Results for March 21, June 21, and December 21, 2025
Source: Author, 2026

Adjusting the blade angle to a horizontal 30° significantly enhances the thermal and visual protection of the indoor space. The 30° tilt successfully reduces the light intensity in the central area of the room, stabilizing it within the ideal range of 400–800 Lux. Nevertheless, the outermost perimeter area directly adjacent to the glass facade still records illuminance values above 1,000 Lux.

3.6 Simulation Results of Adding Eggcrate Shading Angle: 0° (12.00 WIB)

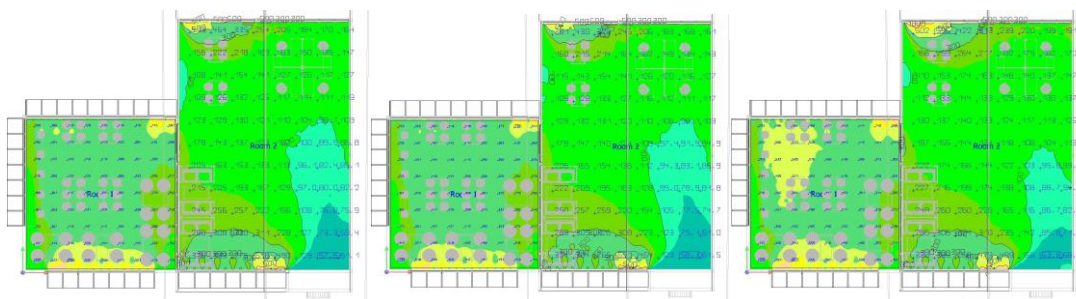


Figure 24,25,26. Simulation Results for March 21, June 21, and December 21, 2025
Source: Author, 2026

The application of 0° Eggcrate-type shading demonstrates the most optimal and balanced natural lighting performance for a tropical climate (Arrahman & Sudarwanto, 2024). The combination of perpendicular horizontal and vertical grids in this configuration effectively blocks the penetration of direct radiation from various solar angles. As a result, this variation successfully eliminates all potential glare (>1,000 Lux) across the entire room area throughout March, June, and December.

3.7 Simulation Results of Adding Eggcrate Shading Angle: 30° (12.00 WIB)

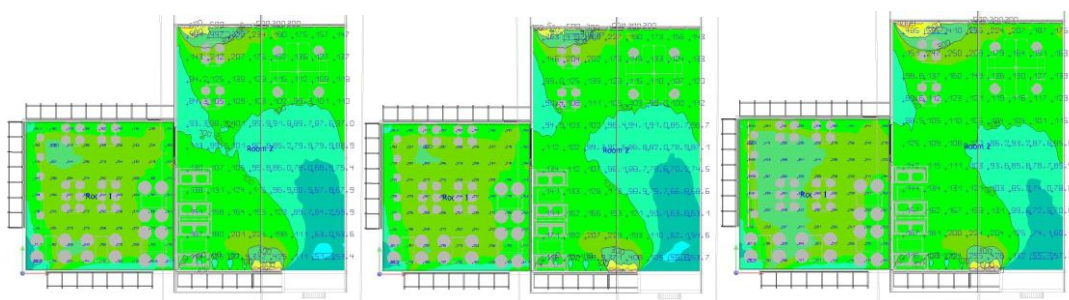


Figure 27,28,29. Simulation Results for March 21, June 21, and December 21, 2025
Source: Author, 2026

Conversely, the application of the 30° Eggcrate variation actually produces an excessive dampening effect (over-shading) (Budhiyanto, 2025). The 30° tilt on the eggcrate grid massively obstructs access to natural light, causing the room to become excessively dim, falling below 300 Lux across almost the entire workspace (Maulana & Kusuma, 2022). Furthermore, this variation unexpectedly still allows the potential for localized glare during certain periods in December due to the gaps created by the blade tilt (Rahmah & Jurizat, 2022).

3.8 Result of The Most Optimal Shading Simulation

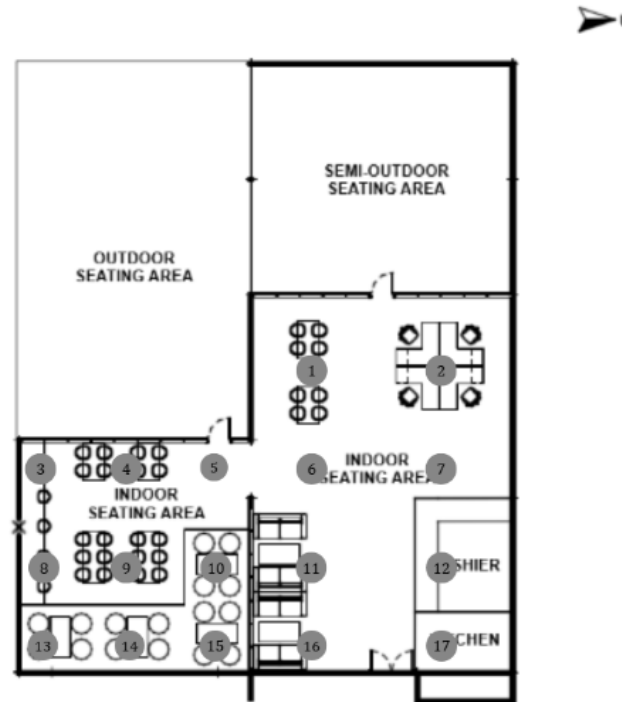


Figure 30. Plan for Determining Results of Natural Lighting Simulation

Source: Author, 2026

To facilitate the quantitative evaluation following the installation of sun shading, the simulation data was simplified into 17 crucial measurement points placed in the study and work areas (user seating). The placement of these measurement points was set at the working plane height of 0.75–0.80 meters from the floor surface to represent the actual natural light intensity level received by the users' eyes while conducting activities (Badan Standardisasi Nasional, 2001; Maulana & Kusuma, 2022).

Table 3. Results of 18 Natural Lighting Simulations at 17 Measurement Points

Measurement Point	Simulation 1 Simulation 2 Simulation 3			Simulation 4 Simulation 5 Simulation 6			Simulation 7 Simulation 8 Simulation 9			Simulation 10 Simulation 11 Simulation 12			Simulation 13 Simulation 14 Simulation 15			Simulation 16 Simulation 17 Simulation 18		
	Vertical Fins 0°			Vertical Fins 30°			Horizontal Fins 0°			Horizontal Fins 30°			Eggcrate Shading 0°			Eggcrate Shading 30°		
	March	June	December	March	June	December	March	June	December	March	June	December	March	June	December	March	June	December
1	230	223	263	217	216	161	167	165	181	150	152	165	141	143	153	125	125	137
2	159	128	151	135	130	157	153	153	177	141	139	163	120	120	140	112	110	130
3	1646	1368	61135	16750	1600	61284	1472	1513	1591	1344	1382	1441	268	253	253	99	99	3403
4	1699	1556	1863	1473	1468	1482	1552	1558	1727	1402	1420	1536	426	418	477	152	152	178
5	1478	1336	1627	1252	1155	1381	1239	1222	1467	1182	1120	1330	745	734	740	234	231	241
6	182	178	173	127	126	142	179	186	194	153	157	165	129	132	137	98	103	105
7	115	114	135	124	123	144	147	150	168	130	129	146	104	106	117	90	91	104
8	854	613	60872	764	561	60624	468	489	496	355	371	366	189	197	210	129	128	3439
9	628	553	768	488	483	655	698	696	788	533	539	604	391	388	447	244	246	280
10	391	380	477	350	344	440	554	562	624	440	442	487	279	279	314	181	178	201
11	283	287	301	227	220	252	366	368	387	287	296	312	205	209	216	131	133	134
12	124	122	141	159	153	181	190	187	210	156	156	174	97	95	108	80	80	85
13	1001	905	951	795	699	789	936	1027	865	827	909	767	527	518	491	119	118	130
14	1096	941	1096	1372	1244	1451	1254	1289	1279	1123	1128	1134	458	447	467	112	106	121
15	947	765	978	1424	1142	1598	971	913	1063	863	816	934	476	453	494	99	102	114
16	869	826	834	625	560	661	1249	1300	1198	1105	1155	1070	300	384	399	126	100	100
17	232	199	308	281	242	385	263	247	329	228	217	277	129	123	156	111	105	132

Below Standard (<300 lux)

Meets Standard (300-1000 lux)

Above Standard (>1000 lux)

Source: Author, 2026

4. CONCLUSION

Based on the research findings and data synthesis from all simulation scenarios, the natural lighting conditions at Eplus Co-Working Space Yogyakarta indicate a highly significant imbalance in lighting distribution. Areas located near the facade receive very high illuminance levels, even exceeding 1,000 lux, thus potentially causing discomfort glare, whereas the interior areas possess low lighting levels, specifically around 20–150 lux, falling below workspace lighting requirements. These conditions demonstrate that the magnitude of the Window-to-Wall Ratio (WWR) and the facade orientation are crucial factors influencing the visual comfort of the space.

Simulation results of several sun shading alternatives indicate that the 0° egg-crate shading configuration is the most optimal facade strategy. This configuration can reduce the risk of over-illumination and producing a more even light distribution in the workspace. Based on the 17 measurement points, the 0° egg-crate configuration emerges as the most successful alternative in eliminating the potential for excessive lighting above 1,000 lux while simultaneously succeeding in evening out the illuminance distribution at all main work desk measurement points in Room 1 to remain consistently within the ideal SNI 6197:2020 range of 300–1,000 Lux (Badan Standardisasi Nasional, 2000; Supriyadi, 2024).

These findings are reinforced by Desiana et al. (2025), who demonstrate that sun shading strategies and appropriate glazing selection can help improve thermal and visual comfort in buildings in tropical climates. Furthermore, Karimimoshaver and Derakhshan (2026) assert that window orientation has a significant relationship with the occurrence of glare and visual comfort in office spaces. Thus, controlling natural lighting is not sufficient by merely considering the quantity of openings; it also necessitates attention to facade orientation, the user's position relative to the windows, and solar radiation control strategies.

Based on these findings, the primary recommendation of this research is to apply 0° egg-crate shading on facades experiencing over-illumination as a strategy to control glare and improve lighting uniformity. Meanwhile, interior areas or Room 2 that still experience a lack of lighting that naturally fall below 300 Lux due to the limited penetration of passive daylight need to obtain additional lighting through artificial lighting systems or the carefully designed addition of openings (Badan Standardisasi Nasional, 2001; Radevski et al., 2022). Future research is recommended to test combinations of WWR, opening orientation, egg-crate shading configurations, glazing types, and artificial lighting using annual simulations and field validation. This approach is expected to produce a more optimal facade design in balancing daylight availability, visual comfort, glare control, and energy efficiency.

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