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Natural Lighting Study of the Smith Alam Sutra Building, Tangerang City

Studi Pencahayaan Alami Gedung Smith Alam Sutra, Kota Tangerang

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Abstract

In architectural planning, natural lighting systems need to be considered. With the right program, natural light has an impact on occupant productivity and satisfaction. Apart from having advantages in terms of energy efficiency, lighting use must be controlled to control the glare effect in the room. The application of minimalist facade systems without additional shading elements is increasing in number and the form is increasingly minimalist. Minimalist facade designs are not suitable for use in tropical countries with abundant sunlight. Apart from increasing the cost of electrical loads, sunlight penetrating buildings through transparent walls or glass also causes a glare effect in space. So, the lighting system needs to be studied and implemented correctly so that the room atmosphere has good quality. The research method uses a mix method approach, carried out using an explanatory sequential strategy. The analysis process begins with a qualitative research stage then followed by quantitative research. Research data was obtained from literature studies, observations and interviews with planners, owners, and residents. Referring to SNI no. 03-2396-2001 method to reduce the effect of glare in each room, the simulation results of the installation of shading (horizontal, vertical, and combined) on the west side obtained information on the value of light exposure received by the building mass of the Smith building does not show a decrease in value. So based on the activities Measurements on units that are already operational, and which are still in standard condition have informed us that proper interior implementation contributes to decreasing light intensity values in office, Soho and apartment spaces.

Keywords: glare, building, interior.

***SDGs*:**

11 SUSTAINABLE CITIES AND COMMUNITIES

Abstrak

Dalam perencanaan arsitektur Sistem pencahayaan alami perlu diperhatikan. Pada program yang tepat, cahaya alami berpengaruh terhadap produktivitas dan kepuasan penghuni. Selain mempunyai keuntungan dalam hal efisiensi energi pemanfaatan pencahayaan harus dikontrol untuk mengendalikan efek silau dalam ruangan. Penerapan sistem fasad minimalis tanpa tambahan elemen peneduh jumlahnya semakin banyak dan bentuknya semakin minimalis. Desain fasad minimalis tidak cocok diterapkan di negara beriklim tropis yang berlimpah cahaya matahari. Selain meningkatkan biaya beban listrik sinar matahari yang menembus dalam bangunan melalui dinding transparan atau kaca juga menimbulkan efek silau (*glare*) dalam ruang. Sehingga sistem pencahayaan perlu dipelajari dan diterapkan dengan benar agar suasana ruangan mempunyai kualitas yang baik Metode penelitian memakai pendekatan mix method, dilakukan dengan dengan strategi sekuensial eksplanatoris. Proses analisis diawali dengan tahapan penelitian kualitatif kemudian diikuti dengan penelitian kuantitatif. Data penelitian diperoleh dari studi pustaka, observasi dan wawancara kepada perencana, owner dan penghuni.Mengacu kepada SNI no. 03-2396-2001 metode untuk mengurangi efek silau pada setiap ruangan, hasil simulasi pemasangan shading (horizontal, vertikal dan gabungan) di sisi barat diperoleh informasi nilai paparan sinar yang diterima oleh massa bangunan gedung the smith tidak menunjukan penurunan nilai.Sehingga berdasar dari kegiatan pengukuran pada unit yang sudah operasional dan yang masih dalam kondisi standar sudah menginformasikan bahwa penerapan interior yang tepat berkontribusi terhadap menurunya nilai intensitas cahaya di dalam ruang office, Soho dan apartment.

Kata Kunci: silau, gedung, interior.

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1. INTRODUCTION

In an architectural space program, lighting is one of the factors that needs to be considered, namely natural lighting and artificial lighting. Natural lighting systems have advantages in terms of quality and energy efficiency at certain times (Wiyanto, 2021). With the right program, natural light has an impact on occupant productivity and satisfaction (Avci and Akbay, 2022). Sunlight enters through the facade into the room making the room look bigger (Michael and Heracleous, 2017; Trajkova and Namichev, 2022).

Apart from having advantages in terms of energy efficiency (especially the use of electrical energy during the day) the use of lighting must be controlled to control the effects of glare in the room (Tregenza and Wilson, 2013; Bawazier, 2022).

The application of minimalist facade systems without additional shading elements and eliminating non-transparent walls in multi-storey buildings in urban areas is increasing in number and their shapes are becoming more minimalist as shown in Figure 1 (Dananjaya, Priyatmono and Raidi, 2015).

Figure 1. Buildings that use curtain walls (Dananjaya, Priyatmono and Raidi, 2015)

Minimalist facade designs are not suitable for use in tropical countries with abundant sunlight because they increase electricity costs due to the use of air conditioning systems (HVAC) in the building. Energy use for the cooling load of office buildings in Indonesia is the largest compared to other energy use (Bowo, 2012). Apart from increasing the cost of electrical loads, sunlight penetrating the building through transparent walls or glass also causes a glare effect in the space. For example as shown in Figure 2, the office units located in the West, excessive natural lighting entering at certain times or hours will disrupt activities worker (Eldridge, 2015; Sajjad, 2021; Adamopoulos and Syrou, 2022; Nafakh *et al.*, 2022).

Figure 2. The effect of glare on the workspace causes eye strain when working using equipment (Eldridge, 2015).

Glare occurs because the amount of light entering the eye is greater than the eye's ability to process it (Wienold and Christoffersen, 2006; Joubert, 2013; Sim *et al.*, 2017). Glare causes visual discomfort and reduces the visibility of objects due to inappropriate distribution of brightness in the field of view, glare is generated by high light entering the space (AGC, 2023).

Indonesia, as a country with a tropical climate, should pay attention to the solar responsive concept in architectural design, which is essentially how we avoid heat (heat avoidance) and reject heat (heat rejection) in achieving thermal comfort and visual comfort (Lechner, 2008).

So, the lighting system needs to be studied and implemented correctly so that the room atmosphere has good quality (El-Sayed and Abed, 2021).

This research uses a case study of natural lighting in the Smith building in Alam Sutera, Tangerang city. This study will focus on the problem of glare in lobby areas, commercial areas, offices, Soho and apartments, especially those on the West side.

The aim of this research is to create a guideline to guide interior fitting out activities for tenants in the Smith building.

2. METHODOLOGY

The research method uses a mix method approach. Research data was obtained from literature studies, observations and interviews with planners, owners, and residents. The quantitative data sought was measuring light with a lux meter, dialux evo software, in standard units no renovation or interior decoration has been carried out and measuring at predetermined points, for example: Workbench. Qualitative data was obtained from observing activities in the observation area and interviews with planners, owners, and residents. Mix method is carried out using an explanatory sequential strategy. The analysis process begins with a qualitative research stage then followed by quantitative research.

Research activities were carried out in the Smith Alam Sutera building, Tangerang City. The Smith building is a 33-story building with office, Soho, and apartment functions. To carry out an analysis of glare conditions, the observation area of the unit on the west side which is at the highest elevation was chosen because the area on the west side is considered to receive the most interference from natural lighting rays and there are no other higher buildings that provide shade from the sun exposure received by the masses. building. Two units were selected for observation and measurement activities, one unit was in standard condition (no interior decoration yet) and one unit had interior decoration done (the unit on the west side was selected). In the activity, measuring instruments are needed to answer the formulation of the glare problem in the room. The measuring instruments used are:

1) The results of the study of building mass and shadows using Formit software to determine the effect of glare on the room.
2) Results of a study of natural light intensity in a room by simulating light intensity using Dialux EVO software.
3) Actual measurements of light intensity in the observation and passive design areas have been carried out to reduce the effects of glare based on SNI no. 03-2396-2001.
4) Comparison of standards and field facts is carried out by making tabulations to obtain temporary conclusions regarding field conditions, so that conclusions can be obtained to formulate solutions to problems.

3. RESULTS AND DISCUSSION

3.1. Building A Future Orientation Study

Based on solar simulations on September 21 (the sun is directly above the equator) using formit and sketchcup software, it shows in **Figure 3** that the direct exposure to sunlight received by the building mass on the west side is 80% throughout the year (from the ground floor to the top floor above) without any buildings providing shade around the object.

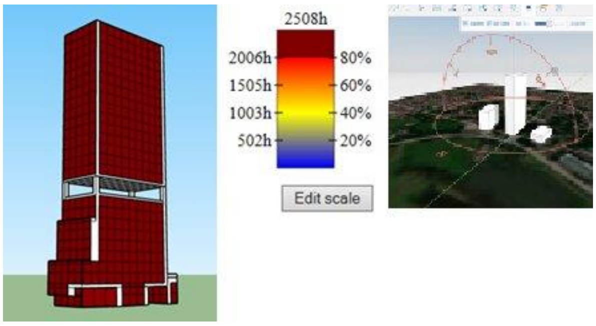


Figure 3. The west side gets 80% light exposure from the lowest floor to the highest floor.

Refers to the standard ideal opening area on , openings for air circulation and sunlight are 10% - 20% of the floor area (Gunadi, 2007; Daryanto and Sjarifudin, 2012; Antou, 2013).

The results of measuring the opening of the facade in each function showed that the wall window ratio in each of the different room functions had a value exceeding the recommended standard, so that the position of the opening of the facade affected the amount of solar radiation entering the building and caused glare interference and an increase in temperature in the interior space, especially at 13.00-17.00 WIB.

Table 1. Facade opening area against standards.

Area	Apartment unit floor areas (m^2)	Standard opening (m^2)	Measurement results (m^2)
Lobby	49	9.8	28
Commercial	29,71	5942	18.9
Office	48.75	9.75	18.94
Soho	45	9	19.6
Apartment	45	9	19.6

The natural lighting that occurs in a room influences the increase in indoor temperature. To reduce the indoor temperature of the building, The Smith applies Sunergy glass to the building facade system. Sunergy glass material is able to ward off UV rays up to 85% because it has 2 layers or coatings (Mintorogo, 2006; Asahimas, 2016; Qori'atunnadyah *et al.*, 2021).

3.2. Lobby Area

1) Based on observation data, activities in the office lobby area have the highest frequency of traffic activity during work entry and exit times. In the apartment lobby area, there is no sitting activity for more than 15 minutes between 13.00-17.00 WIB (Figure 4).

Figure 4. Apartment lobby situation at 14.00 WIB no sitting activity was found for more than 5 minutes.

2) The Indonesian Green Building Council (GBCI) standard for new buildings version 1.2, EEC 2 section regarding natural lighting states that the standard for the use of natural light in a room with a floor area of 30% used for work must be a minimum natural light intensity from 300 lux. From the light intensity simulation data, the intensity of natural light received in the apartment lobby area is 69% and the office lobby on the West side is 88% and on the East side is 80% (Figure 5). So, it can be concluded that the intensity of natural light entering the lobby (apartments and offices) in each observation area exceeds the recommended standard value. The results of field measurements using a lux meter showed that light intensity measurements in the apartment lobby area were 535 lux (SNI standard is 100 lux). So, the light intensity measurement value in the lobby exceeds the recommended value (Figure 6).
3) The light reflection study shows in Figure 7, that sunlight entering through the entire area of the west side glass facade falls on a flat surface (the floor and walls are reflective) and is reflected in one direction and reaches the entire room (Aditiya, 2022).

3.3. Commercial Area

1) Dialux Evo software simulation on commercial units (under standard conditions) shows in Figure 8, the natural light intensity value received is 750 lux for all units. So, the value of natural light intensity entering the commercial unit exceeds the recommended standard value.
2) The results of measuring the average light intensity in active and non-operational residential units at 08.00-17.00 WIB show that the light intensity measurement value in the unit room is still in accordance with SNI standard no. 03-6575-2001 (Table 2).
3) Sunlight entering through the entire area of the west side glass facade falls on a flat surface and is reflected in one direction and reaches the entire space (Figure 9).

3.4. Office Area

1) Software simulation shows in Figure 10, that the intensity of natural light in the room is 59%. So, it can be concluded that the intensity of natural light entering the room exceeds the Green Building Council Indonesia (GBCI) standards.

Figure 5. The sunlight in the afternoon that exceeds the recommended limits for a room causes a glare effect in the room.

Figure 6. Glare situation in the lobby.

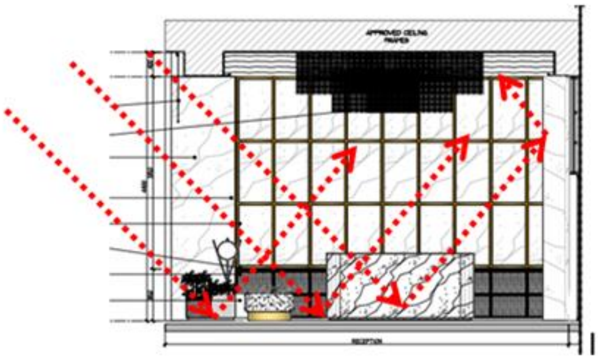


Figure 7. Studying light reflection in the lobby area

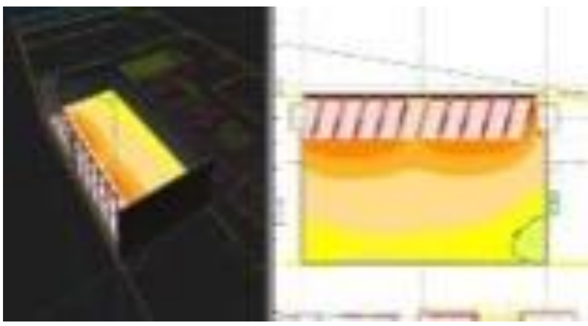


Figure 8. Simulation of light intensity in a commercial area

Table 2. Comparison of light intensity measurement values in operational and non-operational units.

Unit Status	Documentation	Measurement results	Standard (SNI)
Bare Condition		 301 lux	120-250 lux
Interior Installed		 54 lux	120-250 lux

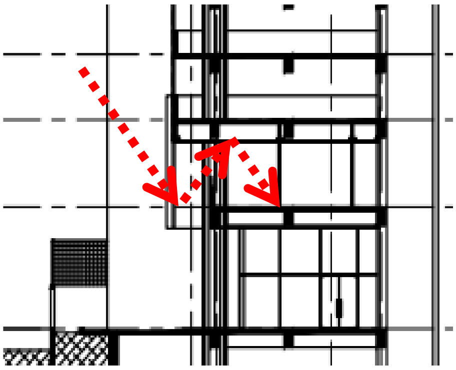


Figure 9. Studies on light reflection in commercial areas.

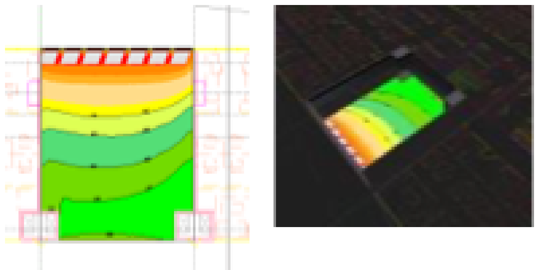


Figure 10. Simulation of light intensity in an office unit.

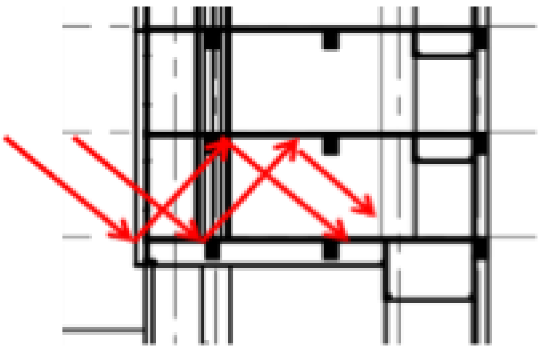


Figure 11. Study of light reflection in office units.

2) The results of measurements in the field using a lux meter, the light intensity measurement value in office units is still adequate but almost reaches the maximum recommended value (Table 3).
3) Sunlight enters through the entire glass facade area on the West side. Based on reflection studies, natural light enters the room and reaches the entire space through the effect of light reflection (Figure 11).

3.5. Soho Area

1) Simulating the light intensity in an apartment unit using software (dialux evo) shows in Figure 12, that the residential area receives a natural light intensity of 300 lux by 47%, so that the light intensity in that space exceeds the recommended standard value.
2) The comparison results of measurements of the average value of light intensity in units that are operational (interior installed) and not yet operational (standard or not yet installed interior in area units) carried out at 08.00-17.00 WIB, show that the measurement results in standard units exceed the specified value recommended and for units operating below the recommended values (see Table 4 and Table 5).
3) Sunlight enters through the entire glass facade area on the West side (Figure 13). Based on reflection studies, natural light enters the SOHO and mezzanine workspace and reaches the entire space through the effect of light reflection on the floor plane (reflective material).

3.6. Apartment Area

1) Simulation of light intensity in an apartment unit using software (dialux evo) shows that in residential areas that receive natural light intensity of 300 lux is 47%, so the light intensity in that space exceeds the recommended standard value (Figure 14).
2) The results on Table 6, the measurements in the field by comparing standard units (not yet installed with interiors) and units that have been filled (using a lux meter) show that the light intensity data in rooms that have had interiors installed is lower than in units that are still installed standard (no interior installation).
3) A study of the reflection of natural light entering the apartment unit shows in Figure 15, that this light reaches the entire room. In the bedroom, the floor finishing material uses brown wood motif vinyl, while the bedroom walls use brown wood wall panels, so that the type and color of the material reduces the effect of the intensity of reflected light in the room.

3.7. Resume of Observation, Measurement and Simulation

1) Solar simulation analysis explains that exposure to sunlight received by buildings has the potential to cause a glare effect on interior spaces.
2) In each unit in the Smith building area (lobby, commercial units, office units, SOHO units and apartments), the Wall Window Ratio calculation value obtained exceeds the recommended standard, so that the light intensity value entering the room is high (exceeds GBCI standard) and has the potential to cause glare effects (see Table 7).

Referring to SNI no. 03-2396-2001 method for reduce glare effect on each room, the results of the simulation of shading installation (horizontal, vertical, and combined) on the west side obtained value information exposure received light by mass building the smith building no showing decline mark (see Table 8).

So that based on activity measurement on existing units operational and still in condition standard Already inform that proper interior implementation contribute to decreased it mark intensity light inside office space, Soho, and apartments.

4. CONCLUSION

To reduce the effect of glare on the room, the interior application in the residential apartment space is to install curtains and vitrees, window film and vinyl flooring material to reduce the intensity of light entering the room, and blinds

Table 3. Comparison of light intensity measurement values in operational and non-operational office units.

Unit Status	Documentation	Measurement results	Standard (SNI)
Bare Condition		 140 lux - 240 lux	120-250 lux
Interior Installed		 138 lux	120-250 lux

Table 4. Comparison of light intensity measurement values in SOHO workspaces.

Unit Status	Documentation	Measurement results	Standard (SNI)
Bare Condition		 441 lux	120-250 lux
Interior Installed		 131 lux	120-250 lux

Table 5. Comparison of light intensity measurement values in SOHO residential spaces.

Unit Status	Documentation	Measurement results	Standard (SNI)
Bare Condition		 143 lux	120-250 lux
Interior Installed		 103 lux	120-250 lux

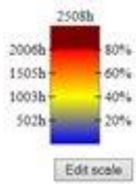
Table 6. Comparison of light intensity measurement values in bedrooms in operational and non-operational units.

Unit Status	Documentation	Measurement results	Standard (SNI)
Bare Condition		 142 lux	120-250 lux
Interior Installed		 29 lux	120-250 lux

Table 7. Methods to reduce the effects of glare on blacksmith buildings.

Methods for reducing glare	Lobby Apartment (LA)	Commercial (CM)	Office (OFF)	Soho (SH)	Apartment (APT)
Making a cantilever					
Plant trees on the facade area	V				
Installing curtains	V	V	V	V	V
Lay out away from light sources			V	V	
Finishing the room is in a shaded color		V	V	V	V
Install shading on the facade		V	V	V	V

Table 8. Simulation of installing shading on building facades.

Whithout Shading	Horizontal Shading	Vertical Shading	Combined Shading	Legend
				

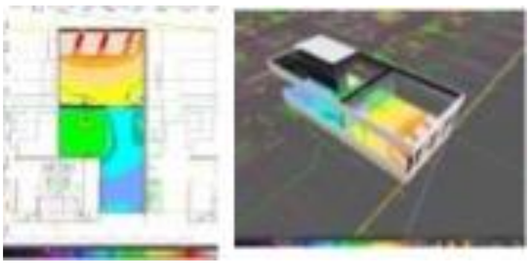


Figure 12. Exposure to natural lighting in SOHO units.

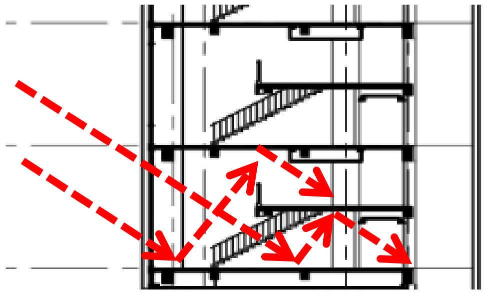


Figure 13. Reflection of light in a SOHO room.

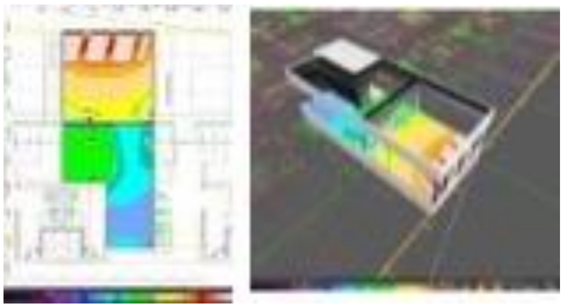


Figure 14. Exposure to natural lighting in an apartment unit.

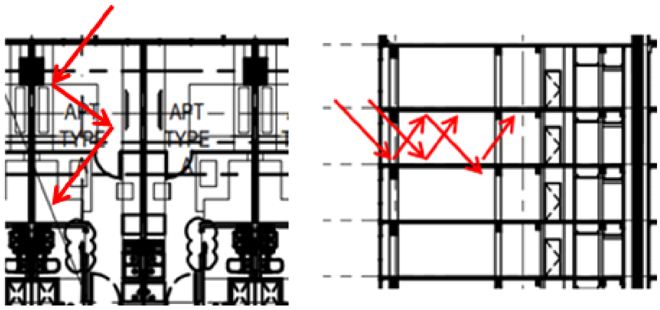


Figure 15. Simulation of light reflection in an apartment unit.

are installed in the office area. Application of shady and non-reflective colors in interior materials to achieve a space intensity value of 100 lux in the lobby and 120 lux -250 lux for bedrooms and work rooms.

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