Lamp Placement Point Planning using Dialux Evo as an Effort to Reduce Artificial Lighting
(Case Study: Classrooms on the 6th and 7th Floors of the FTSP Building, Universitas Trisakti, Jakarta)

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ABSTRACT
Artificial lighting by using lamps is one of the efforts to increase the power of light that comes from natural lighting in the room, so that activities in the room can run well and comfortably according to the SNI 03-2396-2001 standard. Nowadays, many rooms lightings are turned on when they are used, from morning to evening, regardless of the daylighting conditions. This of course will result in wasteful use of electrical energy for lighting. In addition, there are also many rooms where the placement of lamp is not planned properly, especially in lighting electricity zoning. Dialux Evo is a building performance simulation software that can describe the natural light illuminance in a room under various conditions. The amount of natural light illuminance in the room is strongly influenced by, among other things, sky conditions, space orientation, eaves width, opening area and type of glass. With this simulation, it will be able to see which parts are still lacking in natural lighting and need to add artificial lighting. Thus, the planning of the lamp placement points can be made properly, so that the use of artificial lighting can be reduced and can save the use of electrical energy. The case study to be taken is a classroom on the 6th and 7th floors of the FTSP Building, Universitas Trisakti, Jakarta. Simulations were carried out at 10:00 PM and 02:00 AM assuming the conditions outside were clear sky and overcast with all lamps off. The use of the Dialux Evo simulation can provide an overview of the lighting level in the room and the zoning of the lamp points. By turning off 1 row of rear lights can save electricity costs of Rp. Rp. 32,453.73/day or 16.7%.

Keywords: *Lamp placement points, Dialux evo, Artificial lighting, Classroom.*

1. INTRODUCTION

One of the hot issues at the moment is about climate change and global warming and countries in the world are committed to overcoming these problems. Energy and environmental issues currently focus on the building sector as it represents nearly 33% of global energy consumption and around 20% of CO2 emissions [1,2]. One way to reduce the impact of climate change and global warming is the application of the Green Building concept, which meets the aspects of appropriate land use, energy conservation, water conservation, air and thermal quality, material sources and cycles, building management and the environment. In addition to the above aspects, in building design, a very important thing is a passive design approach and an active design approach. This approach is very important, because a good building design can reduce energy use and the effect of greenhouse gases in the future.

Building Performance Simulation is a multidisciplinary computational modeling and simulation aimed at providing solutions that are close to real-world conditions [3,4]. There are various types of BPS software in the market, that help architects to calculate natural and artificial lighting for indoor and outdoor spaces, such as: Radiance, Dialux, Relux, Sefaira, Velux, etc [5]. The test is located at a height of 0.75 m above the floor [6].

Light is a condition for human vision. Humans need light to move in a healthy, comfortable, and enjoyable way [7]. Good lighting can help increase productivity [8]. How much light is needed by humans depends on what kinds of activities are carried out in space. The recommended lighting level in Indonesia has been regulated in SNI 03-6197-2000 [9]. The standard value of lighting levels based on the type of educational building space can be seen in the following table 1:

Table 1. Workspace light illuminance based on SNI

Room Function	Light Illuminance (Lux)
Classroom	250
Library	300
Laboratory	500
Drawing Room	750
Canteen	200

Buildings with natural light can save significantly, the amount of energy and electricity demand if the lamps are turned off when there is sufficient natural light [10]. Daylight design where permitting natural light into the building and giving access to the outside view through the window opening will contribute to a good indoor environment and occupants comfort [11]. Maximizing natural lighting in buildings can reduce energy consumption, especially from the use of artificial lighting [12]. Electrical features are arranged in a row parallel to the window so that any row can be switched on and off as necessary. The lighting zone should consist of electrical equipment placed in a line parallel to the window in each orientation [10]. Grouping lights are needed so that lighting can be efficient in the room [13].

2. METHODS

In this study, an understanding of the concept of a passive design approach to natural lighting and the ability to use the Dialux Evo program to model and analyze simulation. Simulations were carried out at 10:00 PM and 02:00 AM assuming the conditions outside were sunny (Clear Sky) and cloudy (Overcast) with all lamps off. Simulations are also carried out with all lamps on. The simulation is carried out with a worktable height of 75 cm and a lamp height of 2.80 m. This is to find out how the natural lighting conditions in the classroom under these different conditions.

3. RESULTS AND DISCUSSION

This research was conducted in the Architecture Department classroom on the 6th and 7th floors of FTSP building, Universitas Trisakti, Jakarta which consists of 9 (nine) classrooms on the 6th floor and 6 (six) classrooms on the 7th floor. FTSP Building, Trisakti University consists of 10 floors. FTSP building only face north, east, south, and west [14] (see figure 1-3).

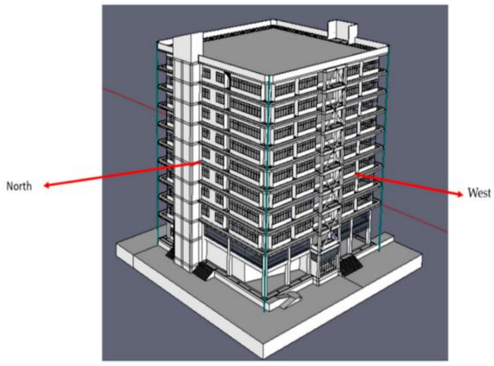

Figure 1 FTSP building, Universitas Trisakti.

The following is the placement of the lamp points on the 6th and 7th floors:

Figure 2 The floor plan of the lamp point on the 6th floor.

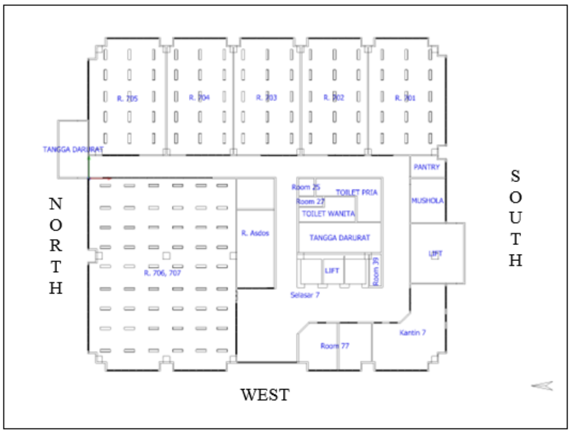

Figure 3 The floor plan of the lamp point on the 7th floor.

Classroom conditions can be seen in the following table 2:

Table 2. Classroom conditions on the 6th and 7th floors

No	Room Name	Number of Lamp	Room Area (M^2)	Room Position
1	601	30 TL 36 W (15 armature)	102	The room is at the corner of building C on the east and south sides. There are two window openings on the east and south sides
2	602	12 TL 36 W (6 armature)	38	The room is in building C. There are no openings to the outside of the building. Opening facing into the hallway.
3	603	18 TL 36 W (9 armature)	56	The room is on the east side of building C. There is one window opening on the east side.
4	604	12 TL 36 W (6 armature)	47	The room is on the east side of building C. There is one window opening on the east side
5	605	18 TL 36 W (9 armature)	56	The room is on the east side of building C. There is one window opening on the east side.
6	606	12 TL 36 W (6 armature)	38	The room is on the east side of building C. There is one window opening on the east side
7	607	30 TL 36 W (15 armature)	102	The room is at the corner of building C on the east and north sides. There are two window openings on the east and north sides.
8	608	48 TL 36 W (24 armature)	156	The room is on the north side of building C. There is one window opening on the north side.
9	609	60 TL 36 W (30 armature)	221	The room is at the corner of building C on the west and north sides. There are two window openings on the west and north sides.
10	702	30 TL 36 W (15 armature)	94	The room is on the east side of building C. There is one window opening on the east side.
11	703	30 TL 36 W (15 armature)	94	The room is on the east side of building C. There is one window opening on the east side.
12	704	30 TL 36 W (15 armature)	94	The room is on the east side of building C. There is one window opening on the east side.
13	705	30 TL 36 W (15 armature)	102	The room is at the corner of building C on the east and north sides. There are two window openings on the east and north sides.
14	706	48 TL 36 W (24 armature)	156	The room is on the north side of building C. There is one window opening on the north side.
15	707	60 TL 36 W (30 armature)	221	The room is at the corner of building C on the west and north sides. There are two window openings on the west and north sides.

The calculation of the cost of using electricity issued by the government can be seen in the following table 3:

Table 3. Electricity cost classification

No	Group	Cost/ kWh (Rupiah)
1	R-1/TR 900 VA	1.352,00
2	R-1/TR 1300 VA	1.444,70
3	R-1/TR 2200 VA	1.444,70
4	R-2/TR 3500 – 5500 VA	1.444,70
5	R-3/ TR over 6600 VA	1.444,70
6	B-2/TR 6600 -200000 VA	1.444,70
7	B-3/TM over 200000 VA	1.114,70
8	I-3/TM over 200.000 VA	1.114,70
9	I-4/TT over 30.000 kVA	996,74
10	P-1/TR 6600 VA -200 kVA	1.444,70
11	P-2/TM over 200 kVA	1.114,70
12	P-3/TR Public Street Lighting	1.444,70
13	L/TR,TM,TT	1.644,52

Universitas Trisakti campus as an educational function is classified in the P-1/TR group 6600 – 200 kVA.

In the simulation, colors will be seen that indicate the amount of light intensity in lux units. The light intensity for classrooms is at least 250 - 300 lux. Here's the color notation with strong lighting (figure 4):

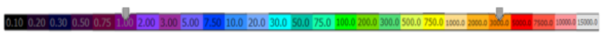

Figure 4 Color notation with light illuminance (Lux).

The simulation results can be seen in the following figure 5-14:

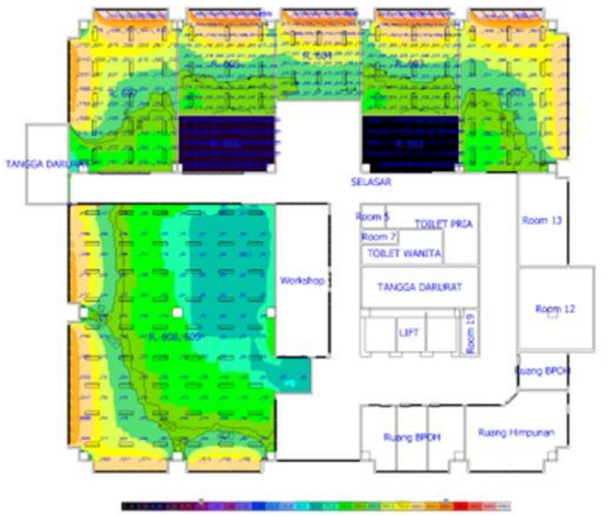

Figure 5 Classroom simulation results 6th floor at 10.00 AM with clear sky condition.

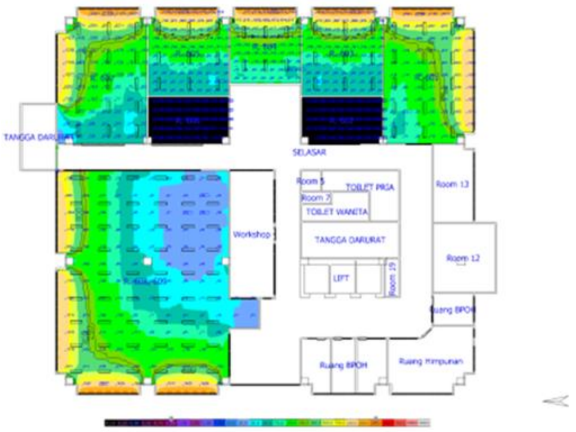

Figure 6 Classroom simulation results 6th floor at 10.00 am with overcast conditions.

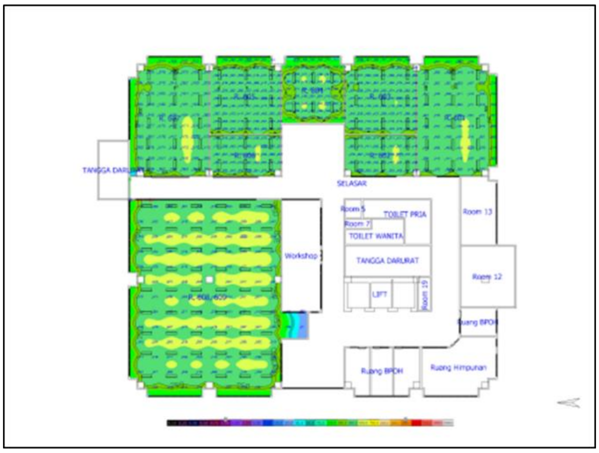

Figure 9 Classroom simulation results 6th floor with all lamps on.

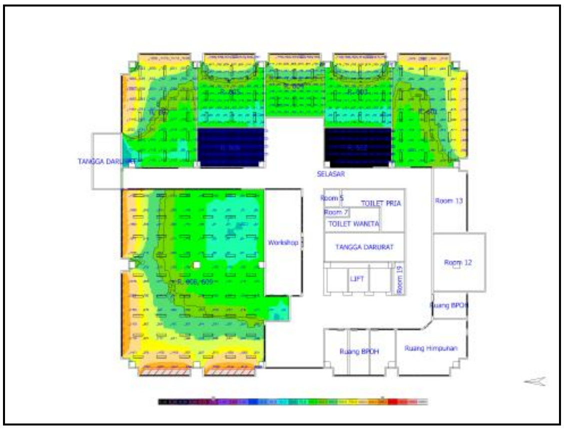

Figure 7 Classroom simulation results 6th floor at 02.00 pm with clear sky conditions.

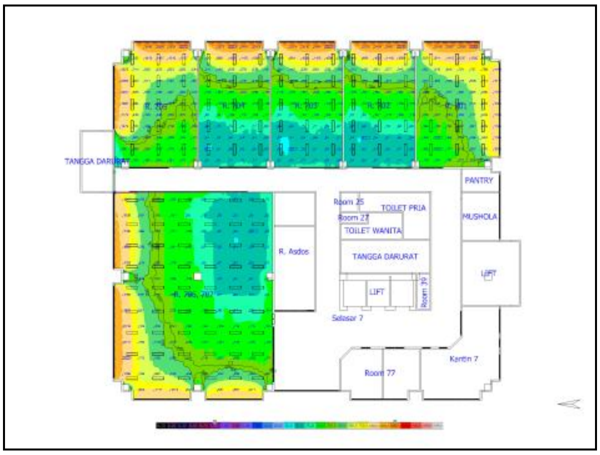

Figure 10 Classroom simulation results 7th floor at 10.00 am with clear sky condition.

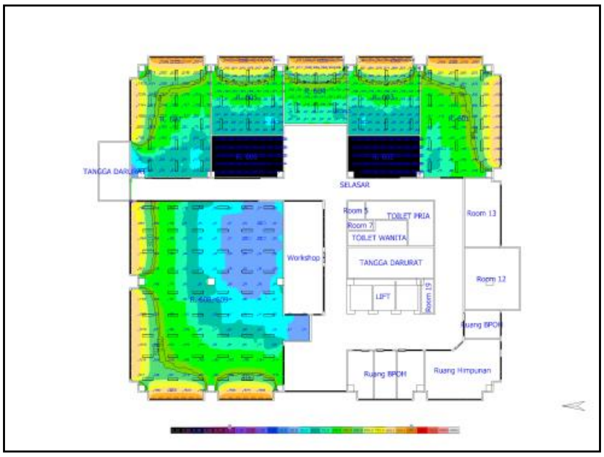

Figure 8 Classroom simulation results 6th floor at 02.00 pm with overcast conditions.

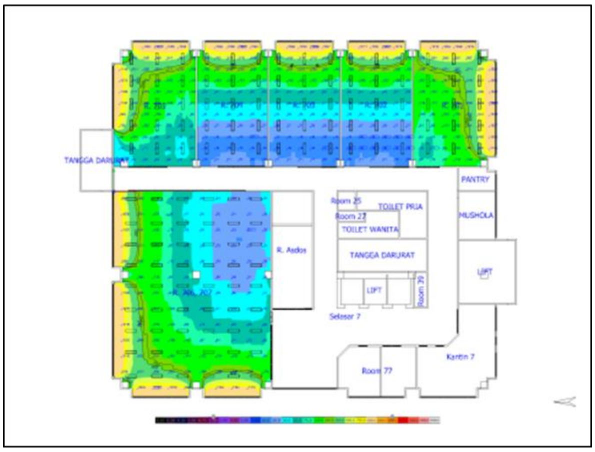

Figure 11 Classroom simulation results 7^{th} floor at 10.00 am overcast conditions.

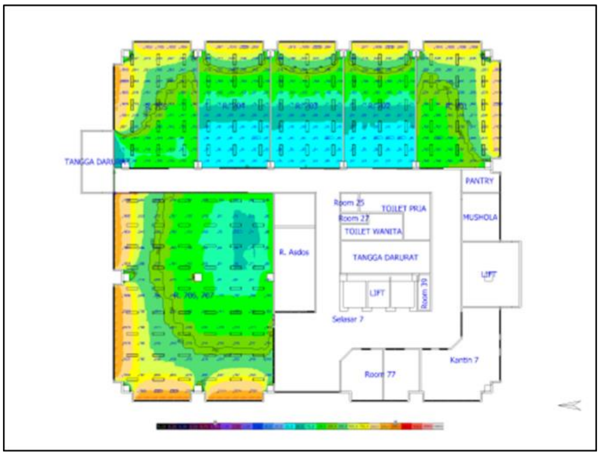

Figure 12 Classroom simulation results 7th floor at 02.00 pm with clear sky conditions.

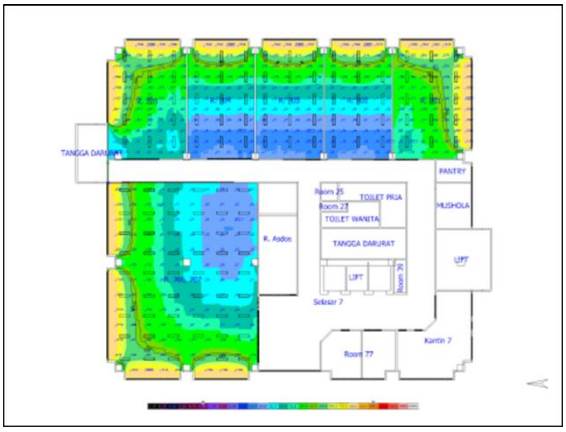

Figure 13 Classroom simulation results 7th floor at 02.00 pm with overcast conditions.

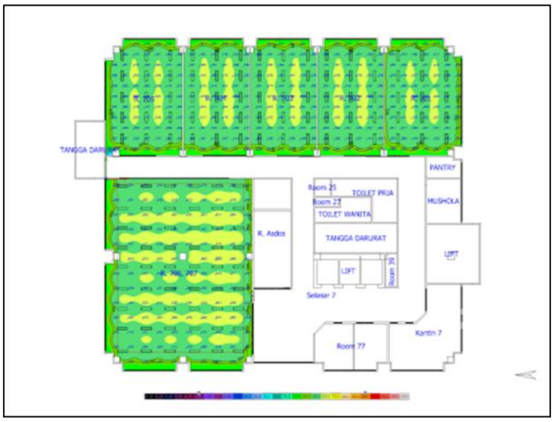

Figure 14 Classroom simulation results 7th floor with all lamps on.

The cost of electricity for the use of lamps assuming they are all on during working hours (8 hours) can be seen in the following table 4:

Table 4. Electricity cost/day for classrooms with all lamps on

No	Room Name	No of Lamps	Usage (kw)	Cost/kwh (Rupiah)	Cost/day (Rupiah)
1	601	30	8.64	1,444.7	12,482.21
2	602	12	3.456	1,444.7	4,992.88
3	603	18	5.184	1,444.7	7,489.32
4	604	12	3.456	1,444.7	4,992.88
5	605	18	5.184	1,444.7	7,489.32
6	606	12	3.456	1,444.7	4,992.88
7	607	30	8.64	1,444.7	12,482.21
8	608	48	13.824	1,444.7	19,971.53
9	609	60	17.28	1,444.7	24,964.42
10	702	30	8.64	1,444.7	12,482.21
11	703	30	8.64	1,444.7	12,482.21
12	704	30	8.64	1,444.7	12,482.21
13	705	30	8.64	1,444.7	12,482.21
14	706	48	13.824	1,444.7	19,971.53
15	707	60	17.28	1,444.7	24,964.42
Total cost					194,722.44

From the table above, the electricity cost for 15 classrooms measured is Rp. 194,722.44/day.

Table 5. Electricity cost/day for classrooms with the back lamps off

No	Room Name	Number of Lamps	Usage (kw)	Cost/kwh (Rupiah)	Cost/day (Rupiah)
1	601	24	6.91	1,444.7	9,985.77
2	602	12	3.456	1,444.7	4,992.88
3	603	12	3.456	1,444.7	4,992.88
4	604	6	1.728	1,444.7	2,496.44
5	605	12	3.456	1,444.7	4,992.88
6	606	12	6.91	1,444.7	9,985.77
7	607	24	6.91	1,444.7	9,985.77

8	608	40	11.52	1,444.7	16,642.94
9	609	50	14.4	1,444.7	20,803.68
10	702	24	6.91	1,444.7	9,985.77
11	703	24	6.91	1,444.7	9,985.77
12	704	24	6.91	1,444.7	9,985.77
13	705	24	6.91	1,444.7	9,985.77
14	706	40	11.52	1,444.7	16,642.94
15	707	50	14.4	1,444.7	20,803.68
Total cost					162,268.71

From the table 5 above, the electricity cost for 15 classrooms measured is Rp. 162,268.71/day.

From the comparison of these 2 conditions, it can be seen the efficiency of electrical energy by turning off 1 row of lamps in each room (except room 602 and 606) at the back which is close to the window. The efficiency obtained is Rp. 32,453.73/day or 16.7%.

4. CONCLUSION

The zoning of the lamps on the 6th and 7th floors is not good and needs to be changed. Currently, the zoning of lights is made in a diffuse manner, so that if the lamps are turned off or on, the efficiency is not optimal. We recommend that the zoning of lights is done based on the zone from the simulation results or based on the position in front, middle and rear. The classroom on the edge of the building (has an exit opening), at the back, the light is strong enough even though the lights are turned off

The use of the Dialux Evo simulation can provide an overview of the lighting level in the room and the zoning of the lamp points. By turning off 1 row of rear lights can save electricity costs of Rp. 32,453.73/day or 16.7%.

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