ANALYSIS OF ILLUMINANCE LEVEL ON PHINISI TOWER BUILDING

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ABSTRACT

Lighting design in buildings is one of the determinants of success. Sunlight is a natural resource that is used daily for use that will produce energy in the building. The purpose of this study is to analyze the space that is directly related to the spaces associated with different spaces. The research method is quantitative with data that underlies the results and is very clear in the form of linear graphs, bar charts, and rounds. Results of research conducted during the day Illumination values in the oriented space to the north are higher than south orientation. The closest area to the building envelope has the highest illumination value. The results of this analysis can determine the illumination values that exist for building satisfaction. Furthermore, further from the opening of the building envelope, the illumination value decreases. The constitution is one of the guidelines in the context of building.

Keywords: *Illuminance level, natural light, energy building*

INTRODUCTION

The optimization of lighting systems in buildings is to consider the integration between natural lighting (sunlight) and artificial (lighting). Maximize the use of natural light into the room, can minimize energy consumption as an artificial lighting source. Some considerations of negative effects, in the use of natural light include: thermal (thermal), glare (glare), ratio (ratio) and the value of brightness (brightness). The Phinisi tower building uses a diagonal and horizontal facade on the building's envelope, so there is no glare and brightness in space. This building is one example of building in designing high building. In terms of aesthetics, building facade is a positive value but needs to be considered the visual comfort of space users so that work productivity can increased (Jamala N, 2017).

The Standard recommendation of illuminance levels in the office room are based on recommendation value by CIE (Commision Internationalde I'Elaire) and IES (Illuminating Enginers Society). These recommendations are national and international standards of illuminance levels for design of lighting design (UNEP., 2006). Building lighting design is designed based on the illumination standard recommended by SNI 03-6575-2001. Illumination value in the work space is 350 lux, meeting room is 500 lux and the hallway is 150 lux. The distribution of light in buildings, can be influenced by the conditions of the sky, position, area and shape of window openings [4]. Based on this recommendation, the designer can determine the number of armature needed in the space, according to

the activity in the space. According to Nurul (2012) that although it does not meet these standards, space users can still do their activities well. Based on this, it is necessary to study the distribution of natural light in selected objects. Newsham et al. (2004) examined quantitative value guidelines, luminance and ratios in office buildings. According to Tomy et al. (2002) stated that the lumination distribution of light in an open plan office using general lighting and light luminance distribution suitability.

According to Satwiko (2009), Indonesia is a humid tropical climate with relatively high characteristics of humidity (60% -80%), high radiation (80% per year), and wind speed (velocity) unstable (between 0-> 30 m / city seconds). Nakamura et al. (1985) have classified into three groups sky condition i.e. overcast, clear and intermediate sky, trying to define the luminance distribution of the intermediate sky. Rahim et al (2014) show that the investigate the accuracy of daylight and solar radiation data gathered during 1995–2000 by comparing data measured from two different sources above. The results of both methods are relatively similar, which indicate that daylight and solar radiation data gathered in Makassar are accurate and useful for various daylight designs and applications. Local Goverment Rules number 38 (2012) explained that the building envelope is a building element that surrounds the building. They are transparent or not transparent walls or the roof.

METHODOLOGY

The object of the research is the Phinisi Tower building, Makassar State University. This building applies the Paraboloid Hiperbolic facade which is a futuristic application of sophistication of science and technology. This building is a 3-storey podium and a 12-storey tower. The shape of this building is a screen metaphor for a boat. The quantitative research by measurement the object of research namely is Phinisi Tower Building UNM on the 8th and 12th floors. Measurements were made during the day between 10.00 and 12:00. Measurement using a lux meter measurement instrument to determine the value of illumination at the planned measurement point.

Furthermore, analyzing the measurement results of illumination values in the space so that it can be concluded how the distribution of light enters the building. Furthermore, analyzing the illumination value using ecotech program to find out how the comparison of illumination values in different oriented spaces, namely the north and south orientation using diagonal and horizontal facade.

Data collection methods are by measurement the space that is the object of research. Measurements are made at the planned point of measurement 3 times in each measurement point. Furthermore, the measurement result data is descriptive, made in table form so that it is easy to observe and analyze the data.

RESULTS AND DISCUSSION

Measurements were made at 10.34 with an intermediate sky condition of 114,000 lux. Illustration value in the area of 50 cm from the building envelope opening is a maximum of 607 lux and a minimum of 202 lux. In the area near the building envelope, it meets the requirements recommended by SNI, namely the illumination value in the workspace of 350 lux, but some points exceed that value. Furthermore, analyzing how the influence of

the building facade on the distribution of light enters space. This analysis will compare the space on the 8th floor, namely the planning meeting room. The space is directly related to the building envelope opening using a horizontal model façade.

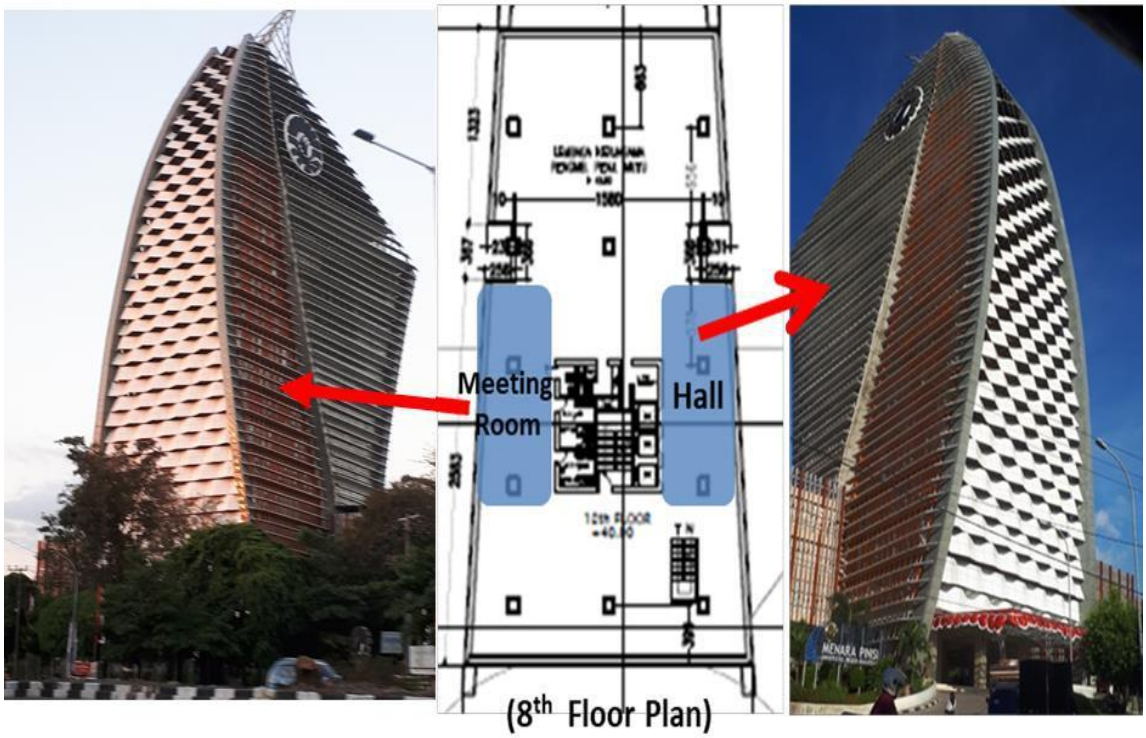


Figure 1. The Meeting Room and Hall Area on 8th Floor

Analysis of the area on the 8th floor is different orientation namely planning the meeting room and hall area. The meeting room is oriented to the south and the hall to the north as shown in figure 1.

Both of these areas have the same building facade, but are oriented differently therefore making it necessary to be analyzed on the distribution of daylight into the building in these two areas.

1. Analysis of the meeting room of section planning (8th floor)

In the Phinisi Tower building, there is a room that is directly related to the building envelope opening, namely the meeting room in the planning field. This room is located on the 8th floor and this room is equipped with a meeting table, bookshelf and blackboard. The area is 96 m2 and the space is oriented towards the south. On the outside of this room, use a horizontal facade building strip.

Figure 2. Meeting Room of Planning Section (8th Floor)

Measurements were carried out at 10:15 a.m. to 10:30 p.m. at 1-9 & A-B measurement points. The A1-A9 measurement point is located at the opening area of the building envelope with a distance of 50 cm, while B1-B9 and C1-C9 are further away from the building envelope, as shown in Figure 3 below. Measurements are carried out repeatedly, namely 3 times the measurement at the same point. Sky conditions at the time of measurement are intermediate sky with an average illumination value in an open area of 144.00 lux.

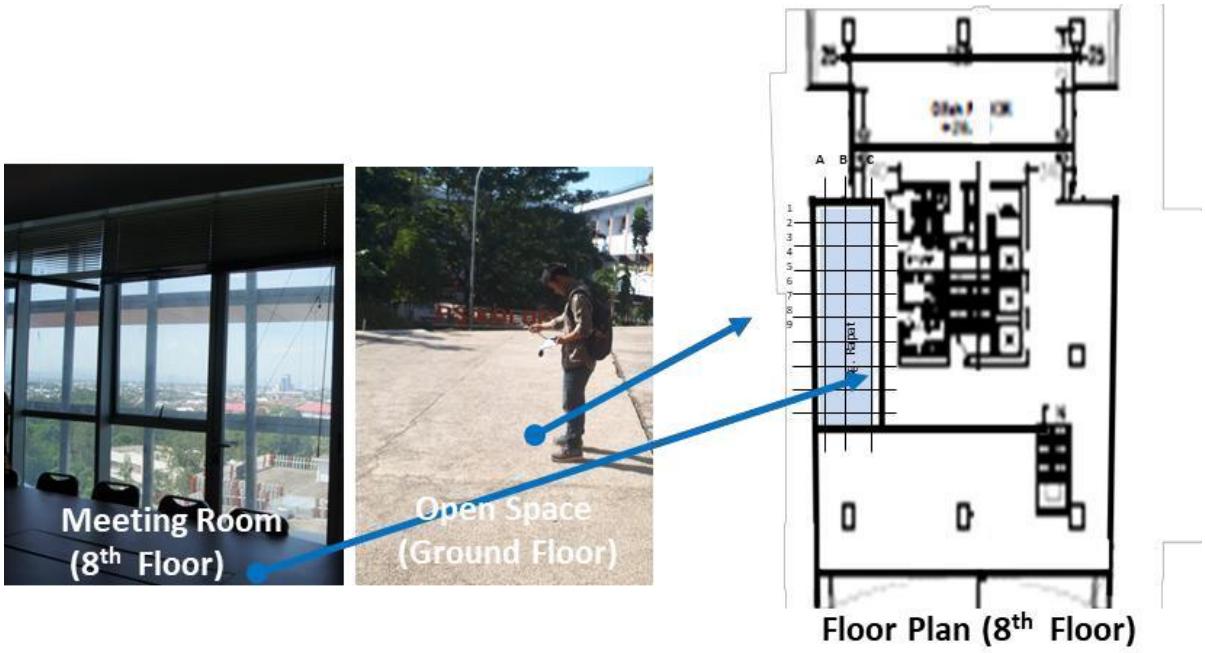
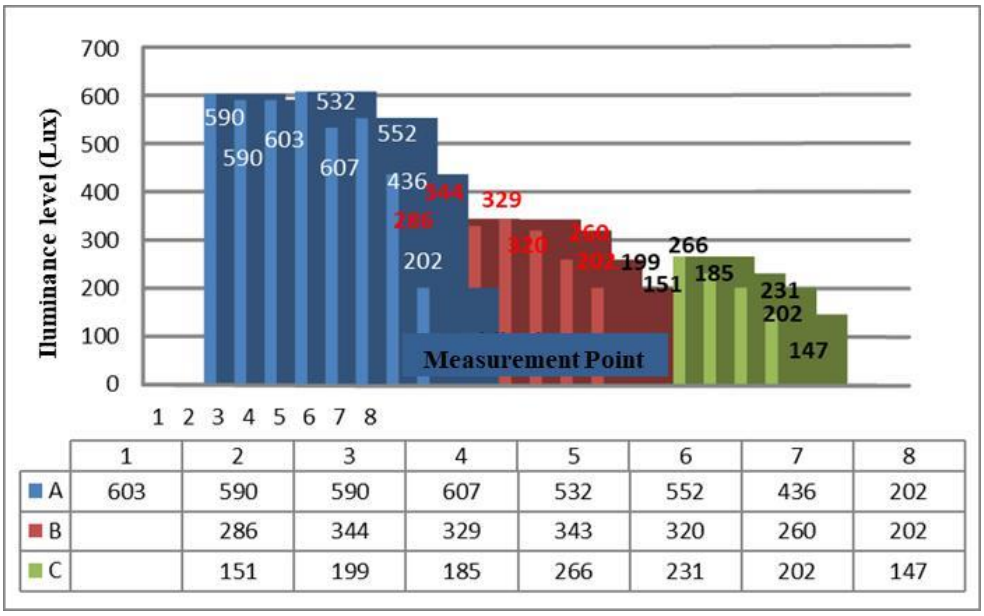


Figure 3. Placement Measurement point in the meeting room (8th floor)



	1	2	3	4	5	6	7	8
A	603	590	590	607	532	552	436	202
B		286	344	329	343	320	260	202
C		151	199	185	266	231	202	147

Figure 4. Graph of illuminance level in meeting room (8th floor)

Figure 4 shows a graph of A1-A9 measurement point has a maximum value of 607 lux and a minimum of 202 lux; (2) the B3-B9 measurement point has a maximum value of 344 lux and a minimum of 202 lux; and (3) the C3-C9 measurement point has a maximum value of 266 lux and a minimum of 147 lux. At the B1-2 and C1-2 measurement points, measurement cannot be carried out because it is a space dividing area using a divider cabinet. The graph shows that the highest illumination value is located along the area close to the building envelope (window) opening, namely the A1-A9 measurement point, compared to the B3-B9 and C3-C9 measurement points. The results of the analysis show that the farther from the opening in the building envelope, the illumination value is lower. Furthermore, analysis the percentage of decline by equalizing the illumination value as in the following graph.

Figure 4 shows a polynomial linear graph with the line equation Y = 55.5x2 - 378.5x + 833 and R2 = 1. The percentage decrease from the average illumination value at the point of measurement A to B is 42% and from the point of measurement B to C is 36%. In the morning and the space oriented to the south, where the building envelope uses a horizontal strip facade gets the distribution of light into the room by 0.35% (point A).

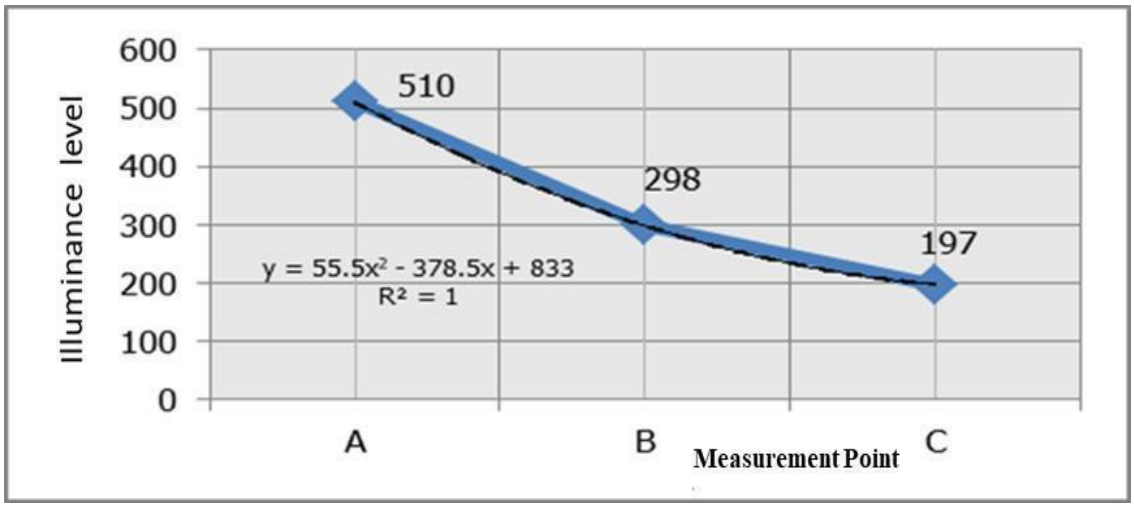


Figure 5. Average of illuminance level in meeting rooms (8th floor)

2. Measurement Results on the Lobby Area (8th floor).

On the 8th floor there is a hallway connecting the space located in the area that is directly related to the building envelope opening in the form of a massive window. This area is also a waiting room for elevator users. The measurement point notation is 1-9 and A-C. The measurement point A is 50 cm from the building envelope and then the measurement points B and C are further away from the natural light distribution source, so the lower the illumination value. The lobby area is oriented to the north, so the next analysis is to find out the difference in illumination values in the space oriented to the north and south.

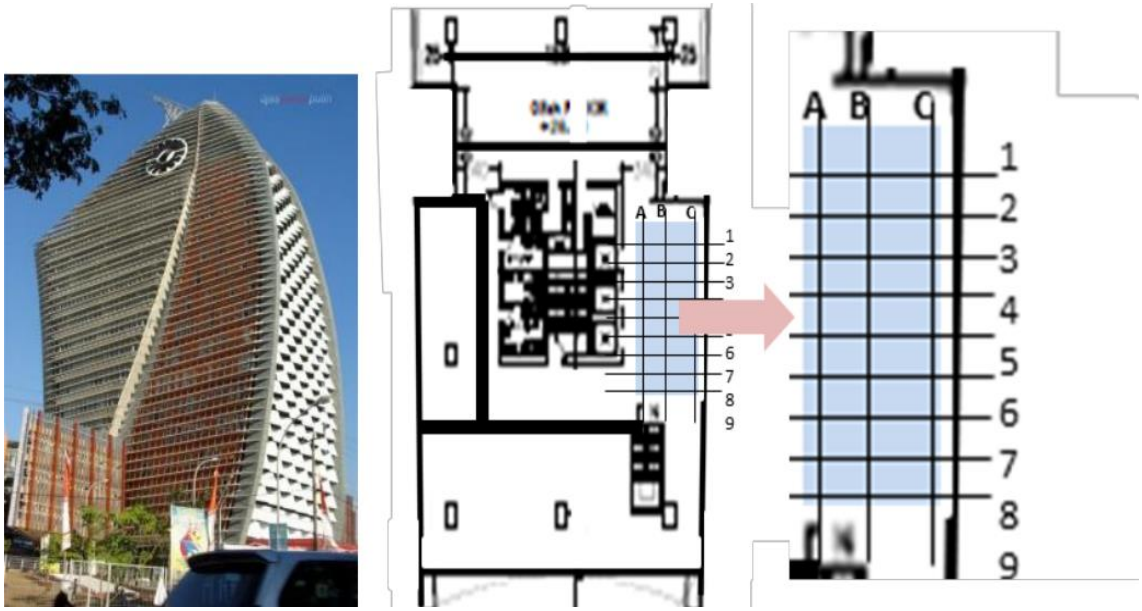
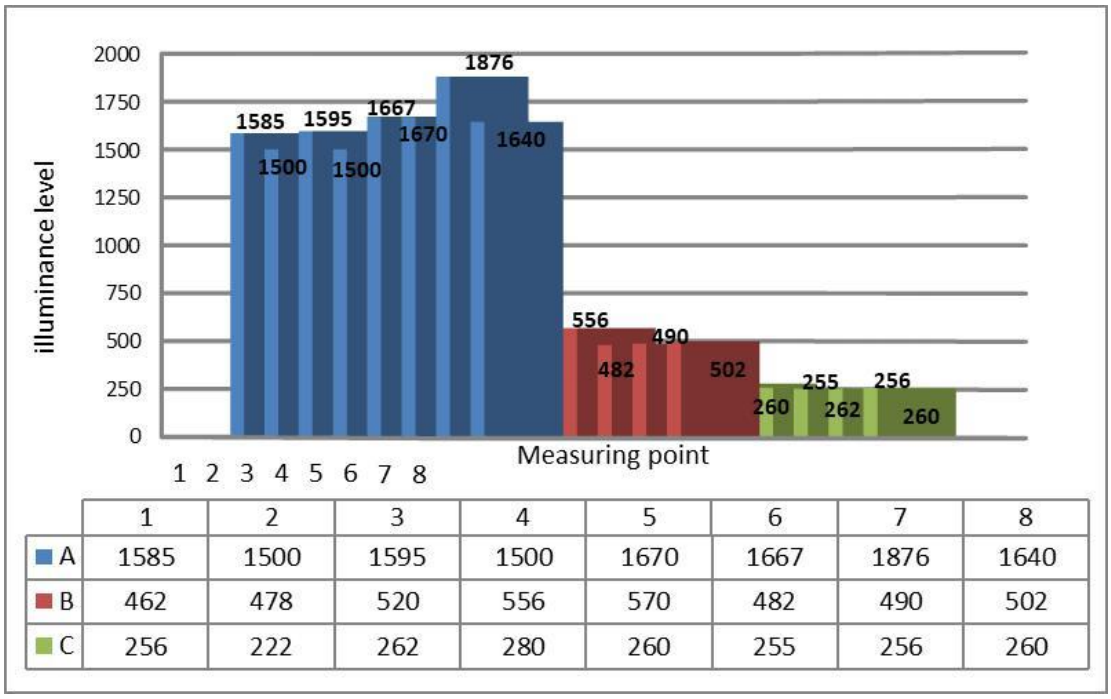


Figure 6. Placement of measurement points in the lobby area (8th floor)

Figure 5 shows the placement of the measurement point in the lobby area on the 8th floor. Furthermore the measurement data is made in tables and graphs to make it easier to analyze the data. Figure 6 shows a graph of the illumination value at the measurement point on the 8th floor as follows: (1) A measurement point of a maximum of 1878 lux and a minimum of 1500 lux; (2) the B measurement point is a maximum of 570 lux and a minimum of 462 lux; (3) the maximum measurement point C is 280 lux and a minimum of 199 lux. This description shows that the illumination value in the area close to the building envelope (measurement point A) is highest among other measurement points.



	1	2	3	4	5	6	7	8
A	1585	1500	1595	1500	1670	1667	1876	1640
B	462	478	520	556	570	482	490	502
C	256	222	262	280	260	255	256	260

Figure 7. Level of illuminance on point measurement on hall area (8th floor)

3. Comparative Analysis of illuminance level in North and South Orientation Room

On the 8th floor there are two rooms that have the same facade, horizontal stripes, but with different building orientations, namely north and south. Both spaces have been analyzed in the previous chapter. Based on the measurement results of illumination values at the planned measurement points, so that it can be known how the illumination values differ in the two spaces as in the following tables and graphs.

Table 1. The level of Illuminance at the measurement point of the meeting room and lobby area (8th floor)

Measurement point		Level illuminance (Lux)								
		1	2	3	4	5	6	7	8	9
Meeting Room	A	479	603	590	590	607	532	552	436	202
	B			286	344	329	343	320	260	202
	C			151	199	185	266	231	202	147
Hall Area	A	1585	1530	1595	1500	1670	1667	1876	1640	1590
	B	462	478	520	556	570	482	490	502	498
	C	256	222	262	280	260	255	256	260	199

Table 1 shows the difference in illumination values in rooms oriented north and south. In the 8th floor meeting room shows the highest illumination value of 607 lux and the lowest of 147 lux, while the 8th floor has the highest value of 1876 lux and the lowest is 199 lux. This description analyzes the difference in illumination values in the east and south orientations. So it can be concluded that the value of illumination affects the orientation of the building.

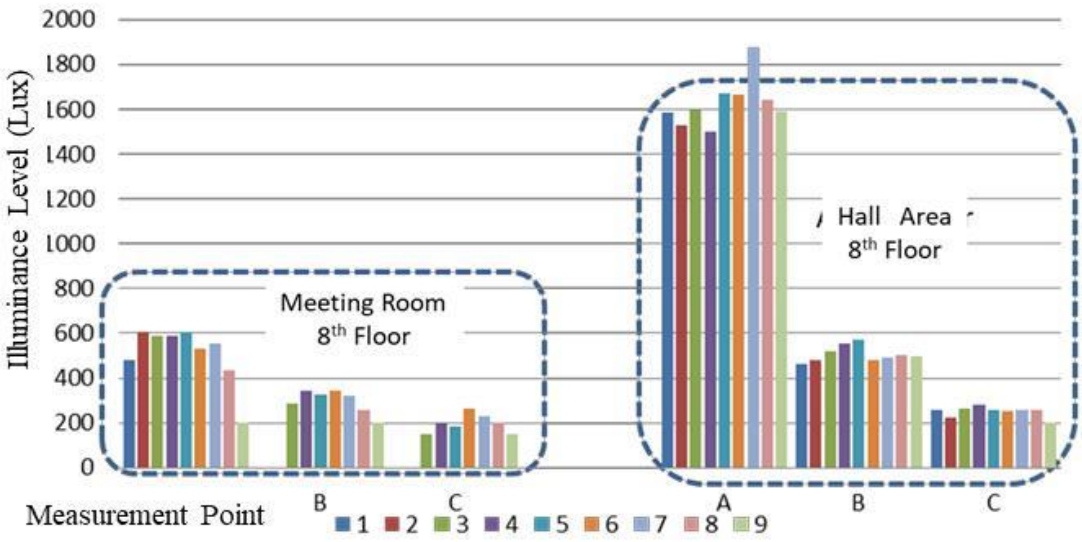


Figure 8. Comparison of illumination value in meeting rooms and hall area (8th floor)

The picture shows the illumination value in the meeting room and the lobby area on the 8th floor. This graph shows that the illumination value in the lobby area (orientation of the north direction) is much higher than in the meeting room (South orientation). Measurements in this space were carried out at 10.00-11.00am. At the measurement point close to the building envelope in these two chambers, the north orientation is much higher while the farther away from the building envelope, the illumination value in both spaces (measurement point C) has an illumination value close to the same. So it can be concluded that the orientation of the building affects the value of illumination in the room.

4. Analysis of Differences illuminance Level in the 12th Floor.

On the 12th floor there is a hallway that forms spatially and uses the same facade, namely a horizontal strip, but has a different orientation which is north and south (figure 8).

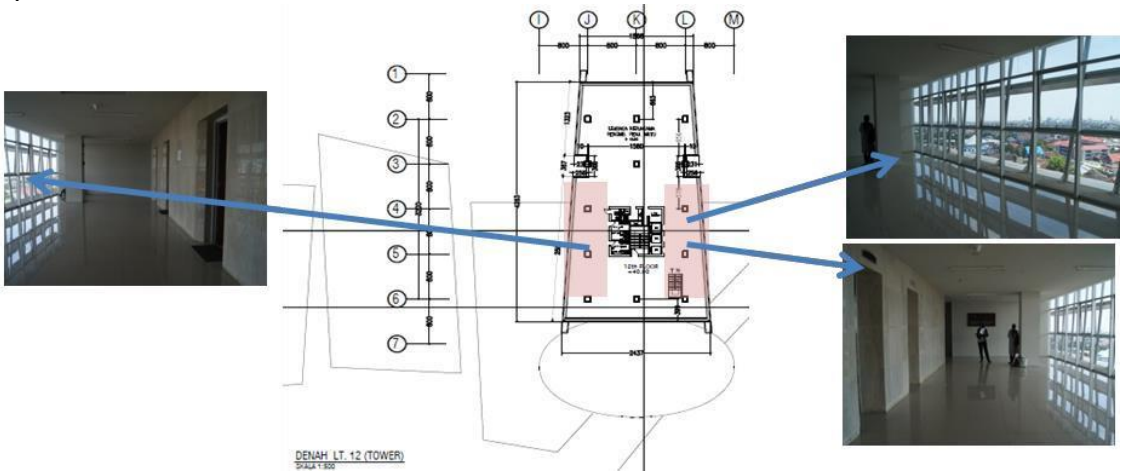


Figure 9. Hall area of A and B on 12th floor

Figure 8 shows the condition of the corridor which forms spatial space. Both of these areas have the same facade form, namely horizontal strips. Placement of the measurement point uses notations 1-7 and A-C as shown in the following 9.

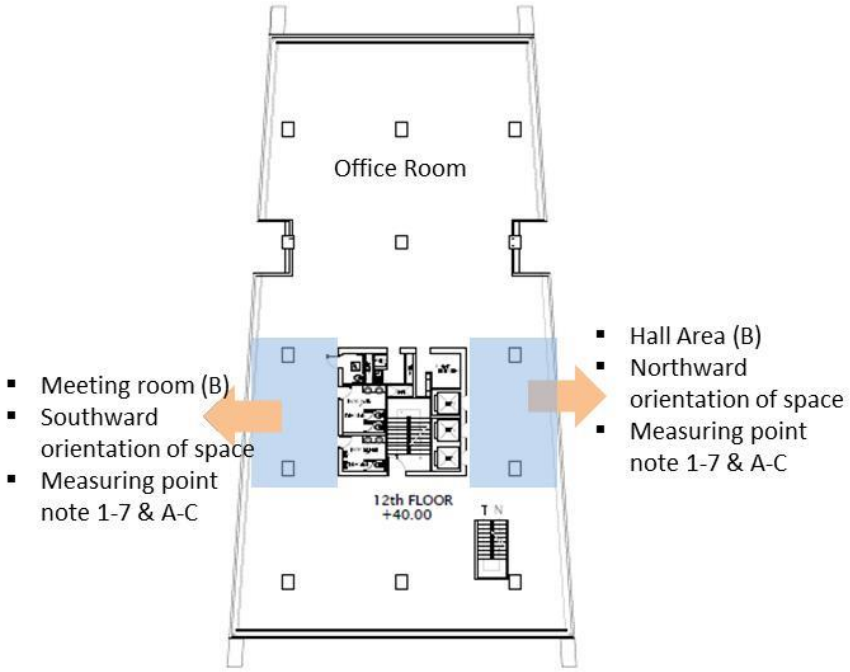


Figure 10. The position of object in the lobby area of the A and B (12th floor)

The mean easier to analyzes the measurement data. Data table at A1 to A7 measurement point between 390 lux to 531 lux while measurement points B1-B7 and C1-C7 are between 241 lux to 260 lux and 172 lux to 255 lux.

Table 2. Value illuminance on hall area of the A and B (12th Floor)

	Measurement Point	Illuminance Level (Lux)						
		1	2	3	4	5	6	7
Hall area (A)	A	531	455	416	390	398	405	420
	B	260	245	250	241	260	258	260
	C	216	200	180	255	172	221	209
Hall area (B)	A	1165	1452	1457	1594	1625	1615	1801
	B	388	406	412	400	430	420	452
	C	186	190	195	193	201	198	205

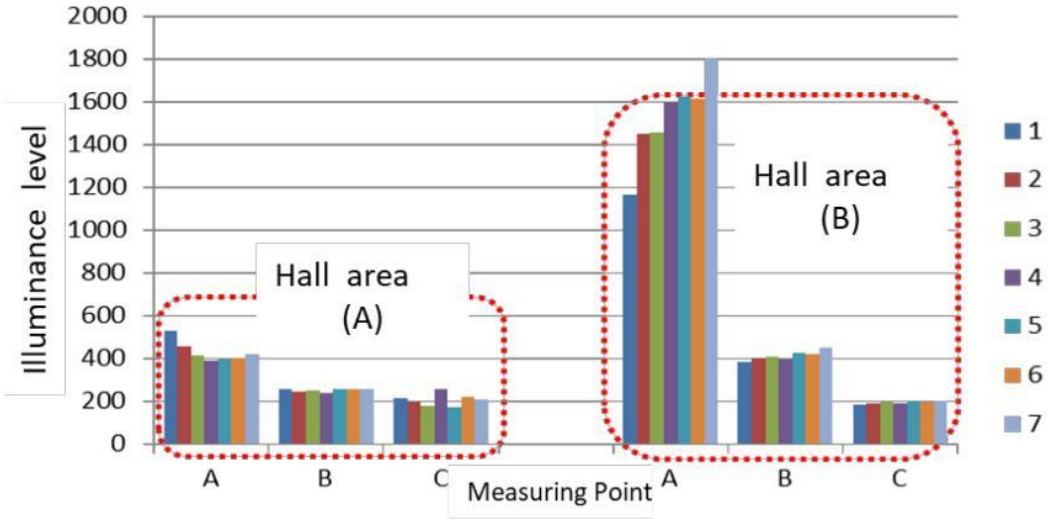


Figure 11. Graph illuminance value in the hall areas A and B (12th floor)

CONCLUSION

This research, shows that the illumination value in the opening area of the building envelope (point A) has a relatively high value compared to the area that is farther away from the opening (points B and C), so it can be concluded that the illumination value affects the distance of the measurement point from building envelope opening. This study also analyzed the difference in illumination values in the space oriented to the north (hall /8th Floor) and south (meeting room /8th Floor), so it can be concluded that the orientation of the building affects the level of illumination in the room. Measurement data analysis formulates a line equation, so that it can conclude the percentage of illumination value reduction in the measurement point zone A, B and C that is a decrease from the measurement point A to B of 42% and the measurement point B to C is 36%.

REFERENCES

[1] Kosman K. A. and Nik Lukman Nik Ibrahim. 2007. Identiti Seni Bina Malaysia: Masalah dan penyelesaiannya. [Sari 25: 279–290.]
[2] Ar Mastor Surat, 2012. Identiti Seni Bina Kebangsaan Melalui Pendekatan Seni Bina Warisan Alam Melayu, [Bengkel Garispanduan Identiti Seni Bina Kebangsaan Royale Bintang, 2012]

[3] lluminating Engineering Society (IES), 1977. Code for Interioir Lighting (London : IES Lighting Handbook)

[4] Illuminating Engineering Society of North America (IESNA), 2004. American National Standars Practice for Office Lighting (New York: ANSI/IESNA-RP)

[5] Indonesia National Standard 03-2396-2001, 2001. The Design of The System of Natural Light in The Building (Original in Indonesia language)

[6] Indonesia National Standard 03-6575-2001.,2001. The Design of The System of Artificial Light in The Building (Original in Indonesia language)

[7] Jamala, N dan Rahim, R.,2017. *Theory and Application of Visual Comfort*, the Publisher of the Makassar State University. (Original in Indonesia language)

[8] Jamala, N., 2017. The Effect building Façade on Natural lighting (Case Study ; Building Of Phinisi Tower UNM), 7th ICMME , Proceeding by AIP Publishing 978-0-7354-1499-0 (American Institute of Physics), Vol.1831 –No.02006

[9] Jennifer A. Veitch, Ph.D., and Guy R. Newsham, Ph.D., 1996. Determinant of Lighting Quality II*: Research and Recomendation*

[10] Lechner, N., 2007. Heating, Cooling, Lighting "Metode Desain untuk Arsitektur", second edition, Jakarta

[11] Nakamura,H., et al., 1985. Luminance Distribution of Intermediate Sky, Journal of light and Vis. Environment, 9 (1), pp.n6-13

[12] Newsham G. R., et al., 2004. Lighting Design for Open Plan Offices (Canada: Construction Technology) No 62

[13] Rahim, R., 2009. Theory and Application of sky Luminance Distribution in Indonesia National Library (Original in Indonesia language)

[14] Satwiko, P., 2009. Building Physics. Yogyakarta, Andy Publisher (Original in Indonesia language)

[15] Sugianto., 1998. Building in Indonesia with a Tropical Climate Humidity from Aspect Building Physics Jakarta (Original in Indonesia language)

[16] Tommy., 2002. Preferred Luminance Distribution in Working Area

[17] United Nations Environment Programmed (UNEP), 2006. Energy Efficiency guide for industry in Asia (India: www.energyefficiensiasia.org) p. 1-43.