Performance of LED Lights Installed on DKI Jakarta Streets (Case Study on Pattimura Street & Satrio Street, South Jakarta)

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(Case Study on Pattimura Street & Satrio Street, South Jakarta)

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***Abstract*—This research analyzes the performance of LED lights installed on Pattimura street, which are in front of PW building, in front of Al-Azhar building, and in front of house compounds, and on Satrio street, which are in front of and across CityWalk Mall and across Ciputra World I building. The testing is done by measuring the illuminance (the unit is lux) with luxmeter on the measurement zone which has certain measurement points. The LED lights on Pattimura street have power of 237 watt, light distance of 50 meter, pole height of 9 meter, and street width of 6.9 meter. The testing result shows that the lighting on street surface is SNI compliant, which means the LED light can be used for street lighting. But there is high illuminance on measuring point which is perpendicular to light and it means *light pollution*. On the contrary the illuminance decreases significantly on the zone between the light pole and it is not SNI compliant. For this reason, the distance between light pole and the light power should be decreased. The result also has the isolux drawing and it is designed with Dialux software. The branches of trees on both streets cover the light so that the illuminance of street surface decreases. And this matter should be handled by DKI Jakarta government.**

Keywords—illuminance, isolux, LED light, performance, SNI

I. INTRODUCTION

The LED (Light Emitting Diode) Light is the latest light generation and it has different technology compared to previous lights. LED is semiconductor diode which emits light when it is energized or powered. Its producer states that it is future light because its age is up to 100,000 hours [1], which is the longest one compared to previous lights but is equal with induction light. It also has more 100-110 watts effication compared to other street ligh (HPS and induction light). LED light is environmental friendly because its tube contains no mercury. It cannot shine through long distance; one of the weakness of LED light. To shine through long distance, LED light needs good housing. It also needs a well-protected light housing (High Index Protection) so that the electronics system inside can work well.

Many people have used LED light for indoor lighting, such as lighting for supermarket, office, housings, and also for outdoor lighting, such as lighting for major street, local street, parking lot, advertising board, etc. And up to now Agency of City Lighting for DKI Jakarta Energy & Industry Department and Jasa Marga have used only a few LED lights for street lighting in Jakarta. The lights installed right now are HPS lights and mercury lights for major street, TL lights and PL/CFL (Compact Fluorescent Lamp) lights for local street. Source of power for LED lights on Pattimura street and Gatot Subroto street comes from solar panel but source of power for other kind of lights on these streets doesn't come from solar panel. There aren't many LED lights using PLN current as source of power. Some of them are the ones installed on Pattimura street and Satrio street (Casablanca). There aren't many LED lights installed on the streets although they have many advantages (and disadvantages too). Based on this reality, the use of LED lights for street lighting should be increased. A research on LED light as street lighting should be created in order to optimize its use. The rapid development of cities in Indonesia requires the improvement of facilities, such as public street lighting (PSL). The main consideration for PSL is the use of energy saving and environmental friendly lights. In the mean time the aims of public street lighting, which are to direct the way, to secure the traffic, to minimize crimes on the street, and to provide the pleasant surroundings, can be achieved.

This research uses CIE 115 standard, ANSI/IESNA RP-0-800 standard (American National Standard Practice for

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Roadway Lighting) and SNI 739, 2008 standard, as it is shown in Table 1. ANSI/IESNA RP-0-800 standard is international standard for street lighting. SNI 739, 2008 is Indonesian standard by BSN (National Standarization Committee).

Table 1. Lighting quality for public street lighting [5]

Jenis/ klasifikasi jalan	Kuat pencahayaan (Iluminansi)		Luminansi			Batasan silau	
	E rata-rata (lux)	Kemerataan (Uniformity) g1	L rata-rata (cd/m2)	Kemerataan (uniformity) VD	VI	G	TJ (%)
Trotoar	1 - 4	0,10	0,10	0,40	0,50	4	20
Jalan lokal : - Primer - Sekunder	2 - 5 2 - 5	0,10 0,10	0,50 0,50	0,40 0,40	0,50 0,50	4 4	20 20
Jalan kolektor : - Primer - Sekunder	3 - 7 3 - 7	0,14 0,14	1,00 1,00	0,40 0,40	0,50 0,50	4 - 5 4 - 5	20 20
Jalan arteri : - Primer - Sekunder	11 - 20 11 - 20	0,14 - 0,20 0,14 - 0,20	1,50 1,50	0,40 0,40	0,50 - 0,70 0,50 - 0,70	5 - 6 5 - 6	10 - 20 10 - 20
Jalan arteri dengan akses kontrol, jalan bebas hambatan	15 - 20	0,14 - 0,20	1,50	0,40	0,50 - 0,70	5 - 6	10 - 20
Jalan layang, simpang susun, terowongan	20 - 25	0,20	2,00	0,40	0,70	6	10

II. LIGHT EMITTING DIODE

Nowadays LED lights which are available on the market can produce the light with various different colors, e.g. red, yellow, white, green, blue, and violet, by using the elements such as gallium, arsenic, and phosphor. Generally LED operates at this range of voltage: 1.7 V – 3.3 V, and it causes LED can be installed on solid state circuit. Voltage needed by LED light is lower than the voltage needed by the usual electric bulb. LED light also has a faster response time (in nanosecond). The fast response time makes LED lights very quick to be turned on and turned off from the switch. LED light also has a contrast ratio which is good enough for human sight. Power needed by LED light is ranging from 10 mW to 150 mW with the average age of light is approximately 100,000 hours. LED light also lasts longer than electric bulb. So the advantages of LED lights are low energy consumption, relatively small size, fast switching time, robust physical appearance, and longer life time [1, 4].

Illumination pattern of LED can be seen in Figure 1. Figure 1 shows that the highest light intensity is on the angle 0° (the area in front of LED light) and the lowest light intensity is on the angle 90° (the area beside the light).

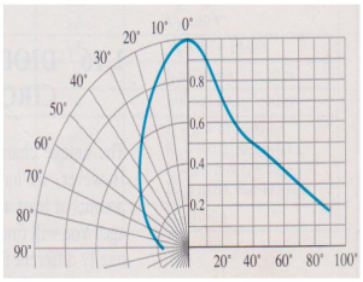

Figure 1. The Illumination Pattern of LED Light

Lighting parameters, which are lighting intensity and illumination pattern in this case, are determined by the road surface. Road surface affects the type of light reflection. Table of road surface classification is available in ANSI/IESNA RP-8-00 standard. Most of major streets in Indonesia, especially in DKI Jakarta, have a road surface made of asphalt (R1 category). Recently the development of technology in civil engineering, especially in transportation, has changed the road surface material from asphalt to concrete.

Other lighting parameters are luminous flux, luminous intensity, illuminance, luminance and luminous efficacy. Luminous flux is the amount of light emitted every second by the light source. The unit of luminous flux is lumen. Luminous intensity is the amount of lumen on one particular angle. The unit of luminous intensity is candela. One candela emits light flux as big as 4π lumens and produces illumination as much as 1 footcandel on 1 foot square area or on the distance of 1 foot from the light source. Illuminance is luminous flux per unit area of a surface, which is measured in lumens per square meter, or lux. Luminance is the brightness of a surface illuminated by the light source. Luminance is measured in candela per square meter. It is directly proportional to to the product of the illuminance and the surface reflectance. The term "efficacy" means the device ability to provide the desired result. Luminous efficacy, for LED, means ratio of the amount of lumens produced for every watt of power provided. The formulas are given below:

$$\varphi = \frac{Q}{t};$$

$$E = \frac{\varphi}{A};$$

$$I = \frac{\varphi}{\omega};$$

$$K = \frac{\varphi}{P}$$

where φ is the luminous flux in lumen, Q is the quantity of light in lumen second, t is time in second, E is the illuminance in lux, A is the surface area in square meter, I is luminous intensity in candela, ω is the solid angle through which flux from point source is radiated, K is luminous efficacy in lumen per watt, and P is the poer provided in watt.

The formula which describes the relationship between luminance and illuminance is given below:

$$L = E\frac{\rho}{\pi}$$

where L is the luminance in candela/meter2, E is the illuminance in lux, and ρ is the surface reflectance.

Basically the amount of light seen by the driver is part of the light reflected by the road towards the driver. The type of road surface itself also determines the characteristic of light reflection. Because of the two reasons mentioned just now, every type of road surface needs different level of lighting. It is shown on Table 2, the uniformity ratio. Uniformity ratio states how contrast the light is in the sight of driver. The veiling luminance ratio needs to be determined to avoid the lighting system which can cause glare. Luminance determines the glare the road surface for the driver's sight. Its value is determined the amount of light reflected by the road surface to the driver's sight.

Table 2. Illumination recommended for the street [8]

Road and Pedestrian Conflict Area		Pavement Classification (Minimum Maintained Average Values)			Uniformity Ratio	Veiling Luminance Ratio
Road	Pedestrian Conflict Area	R1 lux/fc	R2 & R3 lux/fc	R4 lux/fc	E_{avg}/E_{min}	L_{max}/L_{avg}
Freeway Class A		6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Freeway Class B		4.0/0.4	6.0/0.6	5.0/0.5	3.0	0.3
Expressway	High	10.0/1.0	14.0/1.4	13.0/1.3	3.0	0.3
	Medium	8.0/0.8	12.0/1.2	10.0/1.0	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Major	High	12.0/1.2	17.0/1.7	15.0/1.5	3.0	0.3
	Medium	9.0/0.9	13.0/1.3	11.0/1.1	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Collector	High	8.0/0.8	12.0/1.2	10.0/1.0	4.0	0.4
	Medium	6.0/0.6	9.0/0.9	8.0/0.8	4.0	0.4
	Low	4.0/0.4	6.0/0.6	5.0/0.5	4.0	0.4
Local	High	6.0/0.6	9.0/0.9	8.0/0.8	6.0	0.4
	Medium	5.0/0.5	7.0/0.7	6.0/0.6	6.0	0.4
	Low	3.0/0.3	4.0/0.4	4.0/0.4	6.0	0.4

III. RESULT AND DISCUSSION

The first testing is done on some points on Pattimura street, which are in front of PW (Public Works) Building, in front of Al-Azhar Building in zone1 and zone 2, in front of housing complex in zone 1 and zone 2. LED lights installed on this street have power of 237 watt, protection index (IP) of light is 65, distance between light pole is between 42.5 m to 52 m. Height of light pole is 9 m, and the length of overhang is around 2 m. Data of measurement is taken on horizontal direction for every 5 m except on the last measurement point, and on vertical direction for every 2.3 m. The width of the road is 6.9 m. Figure 2 shows the measurement data for the location which is in front of PW building.

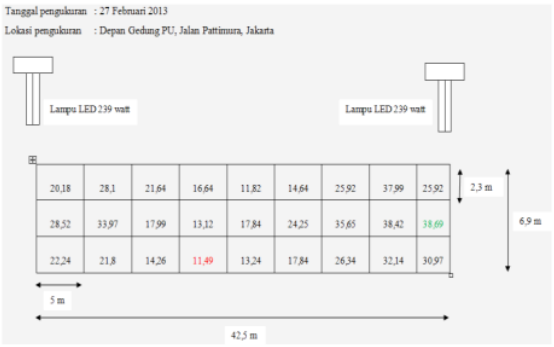

Figure 2. Result of measurement of 237 watt LED light in front of PW building, on Pattimura street, South Jakarta

Table 3. The calculation result of measured data on Pattimura street, South Jakarta

	In front of PW	Al-Azhar Zone 1	Al-Azhar Zone 2	In front of housing Zone 1	In front of housing Zone 2
Street width (m)	6.9	6.9	6.9	6.9	6.9
Pole height (m)	9	9	9	9	9
Hangover length (m)	2	2	2	2	2
Pole distance (m)	42.5	52	52	52	52
LED light power (watt)	237	237	237	237	237
E_{max}	38.6	43	43	40	40
E_{min}	11.9	8	6	11	2
E_{avg}	23.76	17.37	16.2	18.97	18.03
Uniformity Ratio (gl)	0.3	0.19	0.14	0.28	0.05

All the value of E and gl in the area in front of PW building is bigger than SNI standard. For some TU, the value of E is not distributed well. The value of E in the area in front of Al-Azhar building zone 1 is not distributed well. The value of gl is within SNI standard. In the area in front of Al-Azhar building zone 2, there is a value of E which is a lot bigger than SNI standard due to light pollution. The value of gl in this area is within SNI standard. In the area in front of housing zone 1, there is a value of E which is a lot bigger than SNI standard due to light pollution. The value of gl in this area is bigger than SNI standard. In the area in front of housing zone 2, there is a value of E which is a lot bigger than SNI standard due to light pollution. The value of gl in this area is smaller than SNI standard.

The testing location is a primary major street which must have E_{avg} of 11 – 20 lux on the whole road surface and g1 of 0.14 – 0.2 based on SNI. Based on the value of E_{min}, E_{max}, E_{avg} and g1 in Table 3, it is concluded that LED light application on that location exceeds the SNI conditions for most of

measurement points. The testing result still shows the little light from cars and motorcycle although the ideal testing conditions demands no such thing.

It also shows that the light distribution is not good. The illumination is big on the measurement points right in front of the lights but the illumination decreases on the side of the lights, which are on the area between the light pole. Figure 3 shows the isolux pattern which describes the area with the illuminance of 10 lux. Based on this figure, the area which is suitable with SNI is the area with magenta color, with the illuminance ranges between 10 – 20 lux. The area coverage is approximately 50%. Other area illuminance even reaches 30 to 40 lux (it is shown with the blue color in Figure 3), which is bigger that SNI standard. It can be concluded that there is excess of lighting, which means the LED light power is too big and it is a waste of energy. There are a lot of tree branches which obstruct the LED light from shining the street, as it is shown in Figure 4, and the illuminance of the particular area of the street has decreased. The result can be seen in Figure 7. When the tree branches are cut off, the illuminance will be bigger. Based on the above explanation, the use of LED light with the power of 237 watt is too much. It will be better if the LED light power is decreased by 30%, and the LED light power will become around 150 W and 160 W. The complete result of the measurement of different zones in Pattimura street can be seen on Table 3. By looking on the result on that table, we can see that the highest illuminance is right under the LED light, and the lowest illuminance is right on the middle point between the light pole. The distance between the light pole is not the same, which differs from 42.5 meter to 52 meter. The difference shows the inaccurate planning. Figure 5 shows the result of Dialux software for 233 watt LED light which is equalized with 237 watt LED light on Pattimura street.

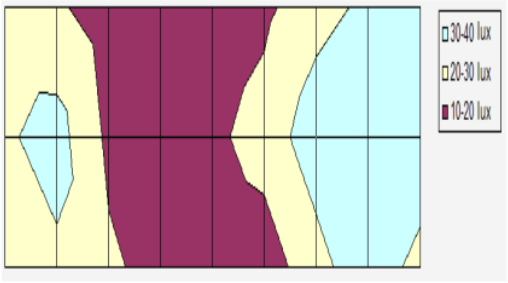

Figure 3. The isolux pattern of 237 watt LED light in front of PW building on Pattimura street, South Jakarta

Figure 4. A lot of tree branches on Pattimura street, in front of PW building

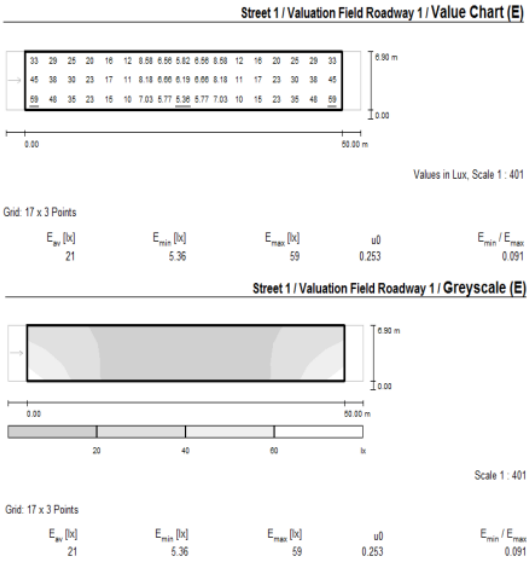

Figure 5. The result of Dialux software of 233 watt LED light which is equalized with 237 watt LED light at Pattimura street, South Jakarta

The second measurement is done on Satrio street and the situation of it is shown in Figure 6. There is a non-toll street right above Satrio street. There are regular lights with the light

pole, and decoration lights with various color on the side of the street supporting beam, along the side of the non-toll street, and under the non-toll street. The decoration lights under the non-toll street are shining directly to the surface of Satrio street. The type of the lights installed are LED lights with 200 watt power. The distance between the light pole varies between 40 meter and 50 meter. The overhang length is about 2 meter. The height of the pole is about 11 meter. There are also tree branches which obstruct the light from reaching the surface of the street. Figure 7 shows one of the measurements done on Satrio street. Table 4 is the result of the calculation based on measurement data on Satrio street which shows that the average illuminance of some locations are above the standard, except for the location across the Ciputra World building (the location with the tree branches). The gap between the minimum and maximum illuminance is also very far, with the minimum illuminance is below SNI standard value, and maximum illuminance is also above the SNI standard value. The value of uniformity ratio is also below the standard value.

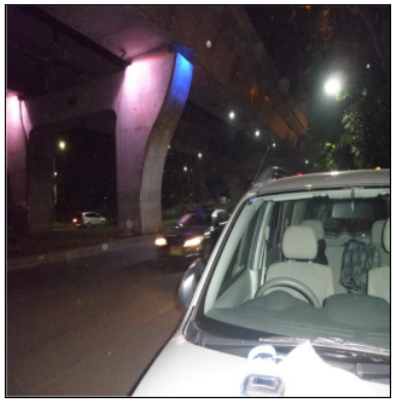

Figure 6. Situation on Satrio street during the measurement

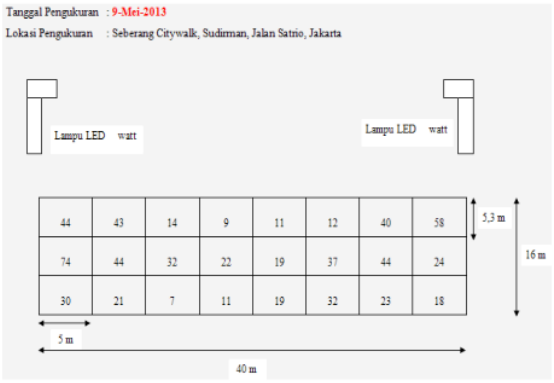

Figure 7. The result of the measurement of the LED lights on Zone 1, across the citywalk, Satrio street, South Jakarta

Table 4a. The calculation result of measured data on Satrio street, South Jakarta

	In front of Citywalk mall Zone 1	In front of Citywalk mall Zone 2	Across Citywalk mall Zone 1	Across Citywalk mall Zone 2
Street width (m)	10	10	16	16
Pole height (m)	11	11	11	11
Hangover length (m)	2	2	2	2
Pole distance (m)	40	40	40	40
LED light power (watt)	200	200	200	200
E_{max}	95	95	74	58
E_{min}	18	17	7	8
E_{avg}	41.71	42.5	28.67	30.29
Uniformity Ratio (gl)	0.19	0.18	0.09	0.14

The E_{avg} of the area in front of Citywalk mall zone 1 is a lot bigger than SNI standard because there is an effect of mall lighting. The gl value is within the SNI standard. The E_{avg} of the area in front of Citywalk mall zone 2 is a lot bigger than SNI standard because there is an effect of mall lighting. The gl value is within the SNI standard. The E_{avg} of the area across Citywalk mall zone 1 is a lot bigger than SNI standard. The gl value is a lot smaller than the SNI standard. The E_{avg} of the area across Citywalk mall zone 2 is a lot bigger than SNI standard. The gl value is within the SNI standard.

Table 4b. The calculation result of measured data on Satrio street, South Jakarta

	In front of Ciputra World I Zone 1	In front of Ciputra World I Zone 2	Across Ciputra World I Zone 1	Across Ciputra World I Zone 2
Street width (m)	10	10	10	10
Pole height (m)	11	11	11	11
Hangover length (m)	2	2	2	2
Pole distance (m)	45	52	50	50
LED light power (watt)	200	200	200	200
E_{max}	80	68	49	60
E_{min}	5	8	5	8
E_{avg}	28.07	29.7	18.27	18.63
Uniformity Ratio (gl)	0.06	0.27	0.10	0.13

The E_{avg} of the area in front of Ciputra World I building zone 1 is a lot bigger than SNI standard. The gl value is a lot

smaller than the SNI standard. The E_{avg} of the area in front of Ciputra World I building zone 2 is a lot bigger than SNI standard. The gl value is within the SNI standard. The E_{avg} of the area across Ciputra World I building zone 1 is a lot bigger than SNI standard. The gl value is a lot smaller than the SNI standard. The E_{avg} of the area across Ciputra World I building zone 2 is a lot bigger than SNI standard. The gl value is within the SNI standard.

IV. CONCLUSION AND RECOMMENDATION

Generally the LED light can be used as the street light although there are several things which need to be looked at, such as:

1. The illuminance right below the LED light (perpendicular direction) is bigger than the SNI standard value. It is decreasing sharply as it goes from the 10-15 meter to the middle point of the light pole. It reaches its minimum value on the middle point between the light pole and its value is still above 11 lux. Based on this result, we conclude that the LED light is not suitable to be implemented directly with the existing light pole and pole distance specification.
2. Lack of planning in arranging the light pole distance because the distance varies from 40 meter to 52 meter. The light pole distance should be the same to control the light distribution on the street surface.

Coordination between the department is needed in order to cut down the tree branches which obstruct the light from reaching the street surface. This research also doesn't discuss further about light pole design, light pole distance, the shape of light housing, and the most suitable type of LED light that can be used as street light. Therefore all these things can be the subjects of the next research. This reasearch also shows that there isn't serious effort from the involved department to design the standard street light. It is suggested that the standard street light will be used on the next street light application.

REFERENCES

[1] R. Boylestad dan L. Nashelsky, *Electronic Devices and Circuit Theory*, 10th ed., USA: Prentice Hall International Editions, 2008.

[2] P. Munzinger, H. Brocker, and A. Supriadi, *Substitution of Conventional Street Lights with LEDs*, Giz, Osram & Paklim, 2012.

[3] *giz* dan produsen lampu Osram, *Penggantian Penerangan Jalan Konvensional dengan LED*, Suatu pendekatan untuk aksi mitigasi RAD-GRK (NAMA), 2012.

[4] D. Chattopadhyay, P. C. Rakshit, B. Saha, N. N. Purkait dan Sutanto, *Dasar Elektronika*, Jakarta: Penerbit UI Press, 1989.

[5] SNI No. 7391, *Penerangan Jalan Umum,* Badan Standarisasi Nasional, 2008.

[6] CIE 115, *Lighting of Roads for Motor and Pedestrian Traffic*, 2nd ed., 2010.

[7] ANSI/IESNA RP-8-00, *American National Strandard Practice for Roadway Lighting*, 2005.

[8] ANSI / IESNA Rp-8-00, *American National Standard Practice for Roadway Lighting*, Ansi Aproval Date 6/27/00.

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