Analysis Of Calculation Of Illumination Needs At Tadulako University Hospital

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ABSTRACT

Introduction: Lighting in the room varies, this is adjusted to the activities carried out in the room. Each room has its own lighting standards. The provision of electric power must meet sufficient capacity to serve the load. The construction of the Tadulako University College Hospital project cannot be separated from the need for electricity. In this building, electric power is used to meet lighting, air conditioning and medical needs. **Method**: This study uses a comparative analysis method to determine the suitability between the lighting calculation results and established standards, as well as a quantitative method in calculating lighting factors. **Results and Disscussion**: This study shows that the use of Downlight and LED Panel lamps at Tadulako University Hospital has met the standards of PERMENKES NO. 24 of 2016. Downlights are used in public spaces and corridors because they provide more focused and bright lighting, while LED Panels are used in special rooms for the comfort of patients and medical personnel. The trial showed that all rooms comply with the established lighting standards. **Conclusion**: This study concluded that the lighting system in Tadulako University Hospital using Downlight and LED Panel lamps has met the standards set by PERMENKES NO. 24 of 2016. LED Panel lamps are used in certain rooms to provide comfort for patients and medical personnel, while Downlight lamps are used in public rooms and corridors because the lighting is more focused and bright.

1. Introduction

The Tadulako University Higher Education Hospital (RSPT) Palu City was built in 2010 in the capital city of Central Sulawesi Province and is located in the campus area [1]. Based on UUD no. 20 of 2013 concerning Medical Education article 40 (1) the Faculty of Medicine and the Faculty of Dentistry can only collaborate with the Main Teaching Hospital, therefore the Tadulako University Higher Education Hospital was established [2].

After the earthquake disaster on September 28 2018 in Palu City, Central Sulawesi, it had an impact on the buildings and infrastructure supporting education at the University [3,4,5,6]. Therefore, in 2022, a Planning Team for the Tadulako University Hospital was formed with the aim of rebuilding the Tadulako University Hospital so that it can operate as it should for its original purpose, and this planning is supervised by the Ministry Of PUPR, the Ministry of Education and Culture, and the Ministry of Health.

The provision of electric power must meet sufficient capacity to serve the load. The construction of the Tadulako University College Hospital project cannot be separated from the need for electricity. In this building, electric power is used to meet lighting, air conditioning, and medical needs. Installation in a hospital building must be reliable and safe because it involves the safety of human

lives. So the availability of electric power is now a vital requirement for hospitals with various electronic equipment (medical and non-medical) to support work operations [7].

2. Research Method

There are several parameters that must be considered when you want to carry out illumination calculations, namely:

1. Illumination intensity (Lux)

Light Intensity/Illumination (E) is the light current that falls on the surface of an area per square meter, the units are Lux or Lumen/m².

2. Luminance Level (Lumen)

Luminance Level (Φ) is the total amount of light emitted by a light source in one second, the unit is Lumen (lm). To find out the lumen value of a lamp, you can look at the lamp boxes that are purchased in general.

3. Utility Factor (Coefficient of Utilization)

The utility factor can be determined using a lighting efficiency table by finding the correct room index (k) value using the formula in equation (1), as follows:

$$K = \frac{\text{Length x Width}}{\text{height of space x (Length + Width)}}$$

If the value (k) does not appear correctly in the existing table of lighting systems, efficiency, and depreciation, then the utility factor is obtained using an interpolation method such as equation (2), namely:

$$CU = kp_1 + \frac{k - k1}{k2 - k1}(kp_2 - kp_1)$$

Table 1. Lighting Efficiency System Table

		Faktor refleksi dari ceiling, dinding dan lantai									
	Plafond	80%	80%	70%	70%	70%	70%	50%	50%	30%	30%
	Dinding	50%	50%	50%	50%	50%	30%	30%	10%	30%	10%
	Lantai	30%	10%	30%	20%	10%	10%	10%	10%	10%	10%
INDEX		2	3	4	5	6	7	8	9	10	11
1	0.60	0.38	0.37	0.38	0.37	0.36	0.31	0.30	0.27	0.30	0.27
2	0.80	0.48	0.45	0.47	0.46	0.45	0.40	0.39	0.36	0.39	0.35
3	1.00	0.56	0.52	0.55	0.53	0.51	0.46	0.46	0.42	0.45	0.42
4	1.25	0.63	0.57	0.61	0.59	0.57	0.52	0.52	0.49	0.51	0.48
5	2.00	0.75	0.67	0.73	0.69	0.66	0.63	0.62	0.60	0.61	0.59
6	3.00	0.82	0.72	0.80	0.75	0.71	0.69	0.68	0.66	0.67	0.65
7	5.00	0.88	0.75	0.85	0.80	0.75	0.73	0.72	0.70	0.70	0.69

4. Light Loss Factor (LLF)

Light loss factor (LLF) The light loss factor is a comparison of the lighting level after a certain period of time when the lighting installation has been used with the lighting level at the time the new installation was used [8]. Usually, the depreciation coefficient is determined based on estimates. Light loss factors are divided into two, namely non-recoverable factors and recoverable factors. The non-recoverable consists of;

a. Luminaire Ambient Temperature (LAT), or the temperature near the luminaire. Temperatures above 250º Celsius in fluorescent lamps will lose 1% of light for every 10º Celsius increase in temperature [9]. If the lamp operates in a normal environment according to the factory design LAT = 1. The normal environment is a condition that is in accordance with the manufacturer's instructions to the lamp manufacturer.

b. Voltage Variation (VV), or variations in electrical voltage. It shows that if a 1% transformation in electric voltage will affect up to 3% of the lumens in an incandescent lamp if the lamp is operated at the appropriate voltage it will produce VV = 1.

c. Luminaire Surface Depreciation (LSD), or depreciation on the surface of the luminaire. Deterioration of the quality of the luminaire surface, such as covers that change color, reflectors that are scratched, and other things that will affect the quantity or quality of lighting in the room.

d. Ballast Factor (BF), or ballast factor. Where the ballast used in luminaires is sometimes different from what is stated in the technical data, this results in frequent errors or mistakes in calculations.

5. The Recoverable factor includes the following parts:

a. Luminaire Dirt Depreciation (LLD), is the depreciation of light caused by the accumulation of dirt in the luminaire. This is due to the influence of the luminaire, environmental conditions, and time for regular cleaning of the luminaire.

b. Room Surface Dirt Depreciation (RSDD), is light depreciation which occurs as a result of the accumulation of dirt on room surfaces. Lighting that often uses reflections will be more susceptible to causing a buildup of dirt, namely dust, and others.

c. Lamp Lumen Depreciation (LDD), is a factor that depends on the type of lamp and the time it is replaced.

d. Lamp Burnout (LBO), is the estimated number of lamps that have died before the previously planned replacement schedule. If the lights change completely, then LBO = 1, but if the lights only change when the lights are off, then LBO = 0.95.

So, it can be formulated to find LLF as equation (3).

LLF = (1.0) (RSDD x LLD x LBO x LDD)

If the level of contamination is unknown, the depression factor used is 0.8. (Muhaimin, 2001).

6. Number of Lights

After determining several parameters above, to find the number of lights, use the following equation (4):

$$N = \frac{E \times A}{\Phi \times CU \times LLF}$$

Information:

N = Number of armatures (light points)

E = Illumination intensity (Lux)

A = Area of the room (meters)

□ = Illumination level (lumen)

CU= Utility Factor

LLF = Light loss factor

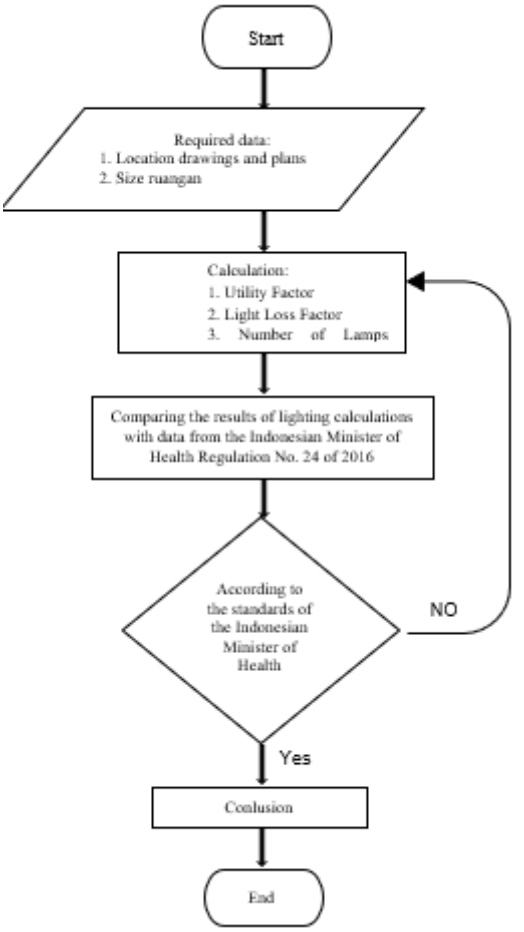

Fig 1. Flowcart Research

3. Results and Discussion

3.1 Research result

After collecting the necessary data, an analysis of the calculation of lighting requirements at Tadulako University Hospital is then carried out so that it is in accordance with the Republic of Indonesia Minister of Health Regulation NO.24 of 2016.

1. The lights used

Downlights (1800 lm & 1400 lm). Downlights are used in public rooms and corridors because these lamps have more focused and bright lighting so they are very suitable for use in corridors.

Excess :

- More focused and brighter lighting
- Installation and maintenance of the lights is not difficult

- Prices are relatively cheap

Lack :

- In hot conditions it can reduce the life of the lamp

Led Panel (3600 lm). Led Panels are used in special rooms so that patients feel comfortable and also medical personnel can work more comfortably because this type of LED panel light has the advantage of being comfortable for the eyesight (does not create glare)

Excess :

- Lifespan and Durability
- Environmentally friendly
- More comfortable for eyesight

Lack :

- Cost
- Size

Calculation Example:

1. VIP class treatment room

Utility Factor (CU):

P = 6.35 m

L = 5.35 m

H = 2.40 m

Question : Space Index (k) =?

Utility factor (CU) =?

Solution: $k = \frac{\text{P x L}}{\text{H x (P+L)}}$

$$k = \frac{6{,}35 \text{ x } 5{,}35}{2{,}40 \text{ x } (6{,}35+5{,}35)}$$

k = 1.21

So when the space index value has been obtained, the author can determine the CU value using the Lighting Efficiency table as in table 2.1 and obtain the CU value, namely = 0.56

Number of Lamps / Armature:

E = 200 lux

A = 33.97 m

Φ= 3,600 lm

CU = 0.56

LLF = 1

Question : N =?

Solution: $N = \frac{\text{E x A}}{\Phi \; x \; CU \; x \; LLF}$

$$N = \frac{200 \text{ x } 33{,}97}{3600 \; x \; 0{,}56 \; x \; 1}$$

$$N = \frac{6.794}{2.016}$$

N = 3.37

When we get the value of N, we round it to the nearest number, like the calculation above which gets the number 3.37, so we round it to 3, then the value of N is 3.

2. Polyclinic Room:

Utility Factor (CU):

P = 4.35 m

L = 2.85 m

H = 3 m

Question: Space Index (k) =?

Utility factor (CU) =?

Solution: $k = \frac{\text{P x L}}{\text{H x (P+L)}}$

$$k = \frac{4{,}35 \text{ x } 2{,}85}{3 \text{ x } (4{,}35+2{,}85)}$$

k = 0.57

Because the k value is not found in the lighting efficiency table, the utility factor can be determined using an interpolation method such as equation (2), namely:

$$CU = kp_1 + \frac{k - k1}{k2 - k1}(kp_2 - kp_1)$$

$$CU = 0{,}36 + \frac{0{,}57 - 0{,}60}{0{,}80 - 0{,}60}(0{,}45 - 0{,}36)$$

$$CU = 0{,}36 + \frac{-0{,}03}{0{,}20}(0{,}9)$$

$$CU = 0{,}36 + -0{,}15\ x\ 0{,}9)$$

$CU = 0{,}3465$ dibulatkan menjadi 0,35

Number of Lamps / Armature:

: E = 200 lux

A = 12.40 m

Φ = 3,600 lm

CU = 0.35

LLF = 1

Question: N =?

Solution: $\text{N} = \frac{\text{E x A}}{\Phi\ x\ CU\ x\ LLF}$

$$\text{N} = \frac{200 \text{ x } 12{,}40}{3600\ x\ 0{,}35\ x\ 1}$$

$$\text{N} = \frac{2.480}{1.260}$$

N = 1.96

When we get the value N, we round it to the nearest number, like the calculation above which gets the number 1.96, so we round it to 2, then the value of N is 2.

3. Consultation Room:

Utility Factor (CU):

P = 2.90 m
L = 2.88 m
H = 3 m

Question: Space Index (k) =?

Utility factor (CU) =?

Solution: $k = \frac{\text{P x L}}{\text{H x (P+L)}}$

$$k = \frac{2{,}90 \text{ x } 2{,}88}{3 \text{ x } (2{,}90+2{,}88)}$$

k = 0.48

Because the k value is not found in the lighting efficiency table, the utility factor can be determined using an interpolation method such as equation (2), namely:

$$CU = kp_1 + \frac{k - k1}{k2 - k1}(kp_2 - kp_1)$$

$$CU = 0{,}36 + \frac{0{,}48 - 0{,}60}{0{,}80 - 0{,}60}(0{,}45 - 0{,}36)$$

$$CU = 0{,}36 + \frac{-0{,}12}{0{,}20}(0{,}9)$$

$$CU = 0{,}36 + -0{,}6\ x\ 0{,}9)$$

$$CU = 0{,}306 \text{ dibulatkan menjadi } 0{,}31$$

Number of Lamps / Armature:

E = 200 lux
A = 8.35 m
Φ= 3,600 lm
CU = 0.31
LLF = 1

Question : N =?

Solution:

$$\text{N} = \frac{\text{E x A}}{\Phi\ x\ CU\ x\ LLF}$$

$$\text{N} = \frac{200 \text{ x } 8{,}35}{3600\ x\ 0{,}31\ x\ 1}$$

$$\text{N} = \frac{1.670}{1.116}$$

N = 1.49

When we get the value N, we round it to the nearest number, like the calculation above which gets the number 1.49, so we round it to 1, then the value of N is 1.

3.2 The calculation results

Table 2. Calculation Results for Building A Floor 1

	Room	Length (m)	Width (m)	Area (m^2)	Height (m)	Room Index
1	Waiting Room	2.9	2.88	8.35	3.0	0.38
2	Consultation Room	4.35	2.85	12.4	3.0	0.57
3	Poli Room	14.35	1.85	26.55	2.4	0.68
4	Lab Room	17.27	8.45	145.93	3.0	1.89
5	ER Room	6.85	3.65	25.0	3.0	0.79
6	Delivery Room	15.85	14.85	235.37	2.4	3.19
7	ICU	15.85	3.7	11.61	2.4	0.65
8	Class I Room	2.85	1.65	4.7	3.0	0.94
9	Admin Room	4.85	3.35	16.26	3.0	0.25
10	Decontamination Room	3.4	3.65	14.05	3.0	0.38
11	Isolation Room	3.85	3.85	14.05	3.0	0.62

4. Conclusion

From the research results, the following conclusions were obtained: The lights used in this calculation use Downlight and LED panel-type lights. Led panel lights are used only in certain rooms, while Downlights are used in general rooms and corridors. The calculation results show that all rooms are in accordance with the standards of PERMENKES NO. 24 of 2016 and use a maintenance factor of 1. Lamp lumens are determined by the type and wattage of the lamp you want to use.

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