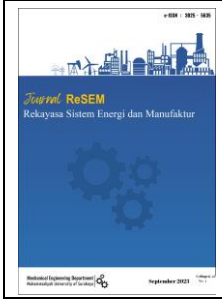

Jurnal ReSEM
Rekayasa Sistem Engineering dan Manufaktur

ISSN 3025-5635
Vol. 2 No. 2

POWER REQUIREMENT ANALYSIS FOR THE SURABAYA INTELLIGENCE TRANSPORT SYSTEM BUILDING *(SITS)*

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(Received: 30-03-2024; Reviewed: 15-06-2024; Accepted: 29-08-2024)

Abstract

Surabaya is the capital city of East Java province, which has a large area of ± 335.28 km^2, with a population of 2,972,801 (2022). Surabaya as a big city has public street lighting (PSL) from 2017 to 2023 amounting to 557,512 points. To facilitate the monitoring of PSL throughout the Surabaya area, the Surabaya Transportation Agency Government plans to build a PSL monitoring room which will be allocated in the Surabaya Intelligent Transport System (SITS) building which is located on the 2nd floor close to the ATCS monitoring room so that it is centralised. In achieving the plan, it is necessary to analyse the power requirements of the SITS building before and after the addition of PSL monitoring room by comparing the capacity of the existing generator. SITS building power before the addition of PSL monitoring room is 47.366 kW, while the power requirement after the addition of PSL monitoring room is 58.609 kW. Generator power of 110 kW is greater so it does not require additional generator capacity.

Keywords: PSL, Traffic Light, SITS

1. INTRODUCTION

The city of Surabaya is the capital of the province of East Java, which has a fairly large area of around ±335.28 km^2, with a population of 2,972,801 (2022). The city of Surabaya developing into a trade and services city requires the availability of ease and speed of access, especially in the field of facilities and infrastructure. As a city of trade and services, the activities of its citizens really need facilities and infrastructure to support these activities. One of the facilities that support community activities is Public Street Lighting (PSL). Data on the cumulative number of LED public street lighting in the city of Surabaya from 2017 to 2023 is 557,512 points.

Public street lighting (PSL) is a mandatory lighting installation on every road section. PSL can be installed on one side of the road or both sides of the road and can even be installed in the middle of the road sidewalk, according to the needs of the type of road and field conditions. The public street lighting in question is a complete unit consisting of a light source (lighting), elements, optics, reflector, refractor and diffuser (Rudini, P, and U, 2021).

To make it easier to monitor the PSL smart system, the Surabaya City Transportation Department Government plans to build a monitoring room for PSL which will be allocated in

the Surabaya Intelligent Transport System (SITS) building at Bratang Bus Station, Surabaya City, which is located on the 2nd floor close to the ATCS monitoring room so that it is centralized.

In building a PSL monitoring room, quite a lot of electrical power is needed because there are several electronic items to support PSL monitoring activities such as computers, servers, air conditioners, lights and so on. Because sometimes there are problems with PLN electricity, the Surabaya Intelligent Transport System (SITS) building has a generator as a temporary replacement for the power supply. The generator is very important if PLN goes out, otherwise the electricity will go out and operations will not run so that the main room such as the Control Room cannot monitor existing traffic conditions and is prone to causing accidents. However, will the existing generator power capacity be sufficient after the PSL monitoring room is built? Because the construction of the PSL monitoring room requires quite a lot of power if it is realized.

Therefore, this research was conducted to obtain information on the power requirements of the SITS building before and after the PJU monitoring room was built. So it can be analyzed whether or not it is necessary to increase generator capacity in the SITS building.

2. RESEARCH METHODOLOGY

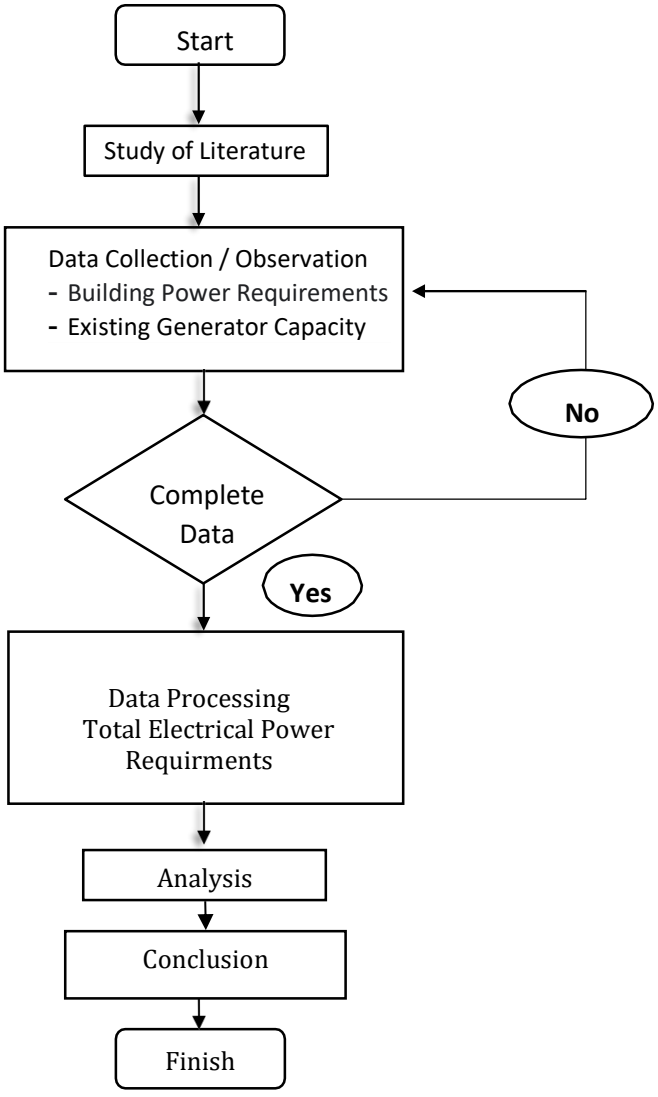

Figure 2. Flowchart Diagram

Data taken through direct observation is information about the electronic or power facilities installed in the Surabaya Intelligent Transport System (SITS) Bratang Bus Station building from the 1st to the 2nd floor and the surrounding electronic or power facilities as well as planning data for the construction of a PSL monitoring room.

Electrical power usage in a room or building has its own normal limits and has recommended usage standards before calculations are needed to analyze electrical power usage in a building. (Shafa, 2023)

The data collected is processed by calculating the installed power to determine the total installed power or installed load, calculating the air conditioning (AC) power requirements and calculating the lighting power requirements. Apart from that, researchers also collected information about existing generators and calculated generator capacity.

Generator capacity is measured in kilowatts (kW) and can be calculated by dividing the total power load by the power factor, and adding a predetermined safety margin, the generator formula can be seen as follows. (Naibaho, 2022)

Formula:

Power Capacity = installed load x demand factor x transformer safety factor (%)

3. RESULT AND DISCUSSION

SITS (Surabaya Intelligent Transport System) is one of the results of an intelligent program utilizing Information and Communication Technology designed by the Surabaya City Transportation Department in an effort to rank e-Government Improvement (PeGI). SITS is located at the Bratang Bus Station which is located at Jalan Raya Nginden, Baratajaya, Gubeng District, Surabaya City, East Java. This building has 2 floors, and each floor has a building area of 557.7 m2 plus the hallway and balcony on the 2nd floor, so the total building area is 1155.3 m^2.

Table 3.1 Area of SITS Building

Room	Dimension		
	Long (m)	Wide (m)	Area (m^2)
First floor			
Archive warehouse	3,60	5,00	18,0
Parking ticket room	7,20	5,00	36,0
Used goods warehouse	10,80	5,00	54,0
New goods warehouse	7,20	5,00	36,0
Supervisor room	3,60	5,00	18,0
Signs warehouse 1	21,60	7,00	151,2
Signs warehouse 1a	21,10	5,00	105,5
Lobby 1	7,20	5,00	36
Lobby 1a	21,60	2,00	43,2
Cooperative space	3,6	3	10,8
Toilet 1	3,6	5	18
Toilet 2	3,7	3,6	13,32
Toilet 2a	3,3	2,1	6,93
Toilet 3	3,6	3	10,8
2nd floor			
Head Office room	5,70	5,40	30,78
Meeting Room	10,80	5,00	54
CCTV *Workshop* room	3,60	5,40	19,44
Panel room	3,6	5,4	19,44
Utility Room	3,6	5	18
Waiting Room	3,6	5	18
IT room	3,50	3,25	11,375

Supervisor room	4,00	4,00	16
Toilet 1	5,4	3	16,2
Toilet 2	2,25	2,1	4,725
Prayer room	5,25	3,80	19,95
Pantry 1	3,8	1,5	5,7
Pantry 2	7,6	2,1	15,96
Pantry 3	2,85	1,5	4,275
CC Room	21,5	12,00	258
Server room	9,00	5,10	45,9
Back Hallway of *CC Room*	21,60	1,175	25,38
Front Balcony of *CC Room*	14,4	1	14,4
Total SITS Building Area (m^2)			1155,3

- Calculation analysis of the AC (Air Conditioner) Power required by the SITS Building

On the 1st floor of the SITS building, AC is only available in the coordinator's room, which from measurements is 11.81 feet long, 16.40 feet wide and 11.48 feet high. The room is on the ground floor so I = 10 and the longest wall faces south so E = 18, then the power requirement for AC (P.ac) can be calculated based on the equation:

$$(\text{BTU/hr}) = \frac{(L \; x \; W \; x \; H \; x \; I \; x \; E)}{60}$$

$$\text{P.ac} = \frac{(L \; x \; W \; x \; H \; x \; I \; x \; E)}{60} \text{ BTU/hr}$$

$$\text{P.ac} = \frac{(11{,}81 \; x \; 16{,}49 \; x \; 11{,}46 \; x \; 10 \; x \; 18)}{60} \text{ BTU/hr}$$

$$\text{P.ac} = 6.669 \text{ BTU/hr}$$

Based on AC capacity, the AC power requirement in the AC 3/4 PK coordinator room has a cooling power of ± 7,000 BTU/hr.

The results of calculating AC power requirements (BTU/hr) for each room as a whole that requires cooling power can be seen in table 3.2 as follows:

Table 3.2 AC Power Calculation for SITS Building

Room	Dimension			AC Power Calculation (P.ac)							
	L (ft)	W (ft)	H (ft)	I	E	P.ac dibutuhkan (BTU/hr)	P.ac dibutuhkan (PK)	P.ac eksisting (PK)	P.ac dibutuhkan (Watt)	P.ac eksisting (Watt)	Ket
First Floor											
Supervisor room	11,8	16,40	11,5	10	18	6.669	0,75	2,00	551,6	1.470,0	Lebih
2nd Floor											
Head Office room	18,7	17,7	11,5	18	18	20.528	2,50	2,00	1.838,8	1.470,0	Kurang
Rapat room	35,4	16,4	11,5	18	20	40.016	5,00	8,00	3.677,5	5.880,0	Lebih
CCTV *Workshop* room	11,8	17,7	11,5	18	18	12.965	2,00	2,00	1.471,0	1.470,0	Sesuai
IT room	11,5	10,7	11,5	18	18	7.586	1,00	2,00	735,5	1.470,0	Lebih
Supervisor room	13,1	13,1	11,5	18	18	10.671	1,50	2,00	1.103,3	1.470,0	Lebih
Prayer room	17,2	12,5	11,5	18	18	13.305	2,00	2,00	1.471,0	1.470,0	Sesuai
CC Room	70,5	39,4	11,5	18	20	191.188	21,50	6,00	15.813,3	4.410,0	Kurang
Server room	29,5	16,7	11,5	18	20	68.027	4,00	8,00	2.942,0	5.880,0	Lebih
Back Hallwayof *CC Room*	70,8	3,85	11,5	18	20	18.808	2,50	2,00	1.838,8	1.470,0	Kurang
Total Power of AC									31.442,6	26.460,0	

Keterangan :

I = Coefficient of location and insulator

E = Coefficient of longest wall direction

Based on table 3.2, the following things can be seen:

1. The AC power required by the SITS Building is 31,443 Watts while the existing AC power is 26,460 Watts.
2. The AC power required and the existing AC power in the CCTV workshop room and prayer room are appropriate and do not require the addition of an AC unit.
3. The existing AC power compared to the AC power needed in the coordinator room on the 1st and 2nd floors, the meeting room, IT room and server room have excess AC power so there is no need to add an AC unit.
4. The existing AC power compared to the AC power needed in the Head Office, CC Room and back hallway of the CC Room has a shortage of AC power so it is necessary to add an AC unit so as not to damage existing electronic equipment where the equipment works 24 hours.
5. Additional AC power required in the Head Office room is 1 0.5 PK AC unit, 7 2 PK AC units in the CC Room, and 1 1.5 PK AC unit and 1 0.5 PK AC unit in the back hallway of the CC Rooms.
6. In the server room, the existing AC power is deliberately installed at 2 times the AC power needed to keep the server equipment cool and safe if the AC unit is damaged.

- Calculation analysis of the lighting power required for the SITS building

Analysis of the calculation of lighting power required for the SITS Building based on the SNI-03-6575-2001 standard (procedures for designing lighting systems in buildings). Based on these standards, standardization of lighting requirements depends on the size and function of a room, therefore there is a determination of minimum lighting levels.

How to calculate the average lighting level (Average) based on equation below. So that on the 1st floor the calculation of the light power requirement in the Archives Warehouse based on table 3.1 shows that the area (A) = 18 m2 and average = 150 lux , then it can be calculated as follows:

$F_{total} = \frac{Erata-rata\ X\ A}{kp\ x\ kd}$ (lumen)

$F_{total} = \frac{(150\ lux) x\ (18\ m^2)}{(0{,}95) x\ (0{,}8)}$

F_{total} = 3.553 lumen

According to the SNI-03-6575-2001 standard of Ftotal = 3,553 lumens, we get the average lumen requirement needed in an Archives Warehouse is 3,553 lumens / 18 m2 = 197 lumens/m2.

In the archive warehouse, 2 DN016 SmartBright LED Downlights with 10 Watt power and 2000 lumens have been installed.

The Archives Warehouse has 2 lamps installed, so the total existing lumens (Fexisting) and the existing average lumen in the Archives Warehouse can be calculated as follows:

$F_{existing}$ = n x F1

$F_{existing}$ = (2) x (2000 lumens)

$F_{existing}$ = 4000 lumens

The existing average lumen in the Archives Warehouse is = $F_{existing}$ / Archive Warehouse
= 4000 lumens / 18 m2
= 222 lumens/m^2.

If we compare the number of existing lumens installed with the number of lumens required according to the SNI-03-6575-2001 standard, then we can know the condition of the lumens in a room.

From the Archives Warehouse we get:

$F_{existing} – F_{total}$ = (4000 - 3553) lumens = 447 lumens

The difference between $F_{existing}$ and F_{total} of 447 lumens is the excess light power in the Archives Warehouse.

The overall light power of the SITS building can be seen in table 3.3.

Based on table 3.3, the following things can be seen:

1. The SITS Building's existing lighting power is 3,933 Watts, while the required lighting power is 4,811 Watts, so there is a shortage of 879 Watts.
2. Lack of lighting in the sign warehouse room 1 is 9,842 lumens, the sign warehouse room 1a is 4,622 lumens, the toilet room 2a is 2,582 lumens, the coordinator room on the 2nd floor is 316 lumens, the prayer room is 1250 lumens, the pantry room 2 is 1250 lumens.
3. Other rooms meet SNI 2001 standards so they do not require additional lights.

Table 3.3 SITS Building Light Power

Room	Light Power Calculation (F)											
	Kp	Kd	E (Lux)	A (m^2)	Ftotal (lumen)	F1 (lumen)	n eksisting (buah)	F eksisting (lumen)	Ftotal (Watt)	F eksisting (Watt)	F eksisting - Ftotal (lumen)	Ket
First Floor												
Archive warehouse	0,95	0,8	150	18,0	3.553	2.000	2	4.000	47	40	447	
Parking ticket room	0,95	0,8	150	36	7.105	3.800	2	7.600	95	80	495	
Used goods warehouse	0,95	0,8	150	54	10.658	3.800	3	11.400	142	120	742	
New goods warehouse	0,95	0,8	150	36	7.105	3.800	2	7.600	95	80	495	
Supervisor room	0,95	0,8	300	18	7.105	3.800	2	7.600	95	80	495	
Signs warehouse 1	0,95	0,8	150	151	29.842	2.000	10	20.000	398	100	-9842	Less
Signs warehouse 1a	0,95	0,8	150	105,5	20.822	2.700	6	16.200	278	168	-4622	Less
Lobby 1	0,95	0,8	150	36	7.105	2.000	8	16.000	95	160	8895	
Lobby 1a	0,95	0,8	150	43	8.526	2.700	6	16.200	114	168	7674	
Cooperative space	0,95	0,8	300	11	4.263	2.000	2	4.000	57	40	-263	
Toilet 1	0,95	0,8	250	18	5.921	900	8	7.200	79	80	1279	
Toilet 2	0,95	0,8	250	13	4.382	900	2	1.800	58	20	-2582	Less
Toilet 2a	0,95	0,8	250	6,9	2.280	900	2	1.800	30	20	-480	
Toilet 3	0,95	0,8	250	11	3.553	900	7	6.300	47	70	2747	
2nd Floor												
Head Office Room	0,95	0,8	350	31	14.175	2.000	8	16.000	189	160	1825	
Meeting room	0,95	0,8	300	54	21.316	2.000	12	24.000	284	240	2684	
CCTV Workshop Room	0,95	0,8	350	19	8.953	2.000	5	10.000	119	100	1047	
Panel room	0,95	0,8	300	19	7.674	2.000	4	8.000	102	80	326	
Utility room	0,95	0,8	300	18	7.105	2.000	4	8.000	95	80	895	
Waiting room	0,95	0,8	300	18	7.105	2.000	4	8.000	95	80	895	
IT room	0,95	0,8	350	11	5.238	2.000	3	6.000	70	60	762	
Supervisor room	0,95	0,8	300	16	6.316	2.000	3	6.000	84	60	-316	Less
Toilet 1	0,95	0,8	250	16	5.329	900	6	5.400	71	60	71	
Toilet 2	0,95	0,8	250	4,73	1.554	900	2	1.800	21	20	246	
Prayer room	0,95	0,8	200	20	5.250	2.000	2	4.000	70	40	-1250	Less
Pantry 1	0,95	0,8	250	5,7	1.875	2.000	1	2.000	25	20	125	
Pantry 2	0,95	0,8	250	16	5.250	2.000	2	4.000	70	40	-1250	Less
Pantry 3	0,95	0,8	250	4,3	1.406	2.000	1	2.000	19	20	594	
CC Room	0,95	0,8	350	258	118.816	2.000	29	58.000	1.584	580	7584	
CC Room 1a						3.800	18	68.400		720		
Server Room	0,95	0,8	300	46	18.118	2.000	10	20.000	242	267	1.882	
Back Hallway of CC Room	0,95	0,8	60	25	2.004	1.020	5	5.100	27	50	3096	
Front Balcony of CC Room	0,95	0,8	60	14	1.137	1.020	3	3.060	15	30	1923	
Total Power									4.811	3.933		

- Building Power Calculation Before Adding PSL Monitoring Room
  The SITS building power calculation is the total of the following things:
  1. SITS building's existing AC power.
  2. Existing light power of the SITS building.

3. Power of other electronic equipment in the building and power around the SITS building

Around the SITS building there are buildings such as the Bratang Bus Station staff building, PSL staff building and prayer room, Kios area, Generator Room, Organda Room, and Land Development Bratang Bus Station which has a total power of 9,316 Watts.

The power of other electronic equipment in the SITS building on the 1st floor is in the form of 5 CCTV points with a power of 30 Watts, while on the 2nd floor there is other electronic equipment in the form of 8 CCTV points spread across the 2nd floor, 4 all in one PC units in the CC Room and 1 unit in the Head Office room, 42 55 Inch Monitors in the CC Room, 6 server units in the server room, 1 Sony Projector unit in the meeting room, 5 Inject Printer units in the CC Room and 1 unit in the Head Office room, and in the The Head Office has 4 CL (Countinous LEDs).

In total, other electronic equipment in the SITS building is counted and It was found that the power of other equipment in the SITS building was 7,657 Watts.

The power of the SITS building before the addition of the PJU monitoring room can be calculated as follows:

SITS Building Power Before Addition of PSL Monitoring Room = (26,460)+(3,933)+(7,657)+(9,316) Watts
= 47,366 Watts
= 47.366 kW

- SITS Building Power Calculation After Adding PSL Monitoring Room

The SITS building power calculation after adding the PJU monitoring room is carried out by adding the power in accordance with the SNI-03-6575-2001 standard as follows:

1. AC power required for the SITS building.
2. Light power required by the SITS building.
3. Power of other electronic equipment in the building and power around the SITS building.
4. Other electronic equipment plans for the PSL monitoring room

The power in the PJU monitoring room is in the area inside the CC Room so that if the AC power and lighting power in the CC Room have been adjusted to SNI-03-6575-2001 standards, then the power of the SITS building after adding the PSL monitoring room will only be added to other electronic equipment in the PSL monitoring room.

The power of the SITS building after the addition of the PJU monitoring room is as follows:

SITS building power after adding PSL monitor room = (31,443) + (4,811) + (7,657) + (9,316) + (5,382) Watts
= 58,609 Watts
= 58.609 kW

- Analysis of Generator in the SITS Building

Monitoring in the control room plays a role in traffic management such as managing congestion by providing information to officers in the field to divert roads to other roads with low volume, monitoring traffic violations and calculating the number of vehicle volumes. Apart from that, it provides information on the status of the traffic controller device, storing traffic videos at road intersections. Therefore, the control room should not experience power outages because it works 24 hours a day which will

affect traffic performance. Because focus is needed for maximum performance, a generator is needed that doesn't make a lot of noise so it doesn't interfere with performance.

The generator used is a Perkins Diesel Generator 137 kVa Silent Type Model WPS137. With a prime generator capacity of 137/110 kVa/kW. The fuel consumption rate according to the technical specifications used is 22.9 liters of diesel per hour.

The installed load on the SITS building after the addition of the PSL monitoring room is 58,608 kW and the prime generator capacity is 137 kVa, with a power factor = 0.8 can be seen in the technical specifications on the alternator name plate.

So we can calculate the generator power in the SITS building as follows:

Genset Power = Power factor x Prime Genset Capacity
= (0.8) x (137) kW
= 110 kW

If we compare the installed load on the SITS building after the addition of the PSL monitoring room which is 58,608 kW with the SITS building generator power of 110 kW, then the generator power is greater than the installed load so there is no need to increase the generator capacity.

Figure 3.1 Altenator Specifications for SITS Building

4. CONCLUSION

From the research that has been carried out, it can be concluded as follows:

1. The SITS building's existing AC power is 26,460 kW, while the AC power required is 31,4426 kW.
2. The existing lighting power of the SITS building is 3,933 kW, while the required lighting power is 4,811 kW.
3. The power of the SITS building before the addition of the PSL monitoring room was 47,366 kW, while the power requirement after the addition of the PJU monitoring room was 58,609 kW.
4. The power of the SITS building after adding the PSL monitoring room is 58,609 kW, while the generator power is 110 kW.

After completing this research, in preparing this final assignment the author included several suggestions that might be constructive. The suggestions given by the author are as follows:

1. Evaluate the power requirements needed in the building before new construction is carried out so that the generator capacity matches the installed power.
2. Evaluate the needs for lighting power and AC power needed in the room which have not been met.
3. Pay attention to the condition of the generator being used and regularly carry out generator maintenance, so that there are no interruptions when carrying out emergency back-up of electrical power and problems with electricity distribution when PLN power goes out.

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