Design and Analysis of Electrical Installation System For Mahakam Agricultural Supermarket In Tebing Tinggi City, Indonesia

Erikson Tarigan
e-mail: eriksontarigan1988@gmail.com
Siti Anisah
e-mail: sitianisah@dosen.pancabudi.ac.id
Dino Erivianto
e-mail: dinoerivianto@dosen.pancabudi.ac.id

Universitas Pembangunan Panca Budi

Abstract

In designing an electrical installation, it is necessary to pay attention to safety, energy efficiency, and ease of maintenance. PUIL 2011 is a standard that is used as a reference in carrying out electrical installations in a building and SNI 6197:2020 which discusses energy conservation in lighting systems. In this study, an analysis of the design of electrical installations in buildings at the Mahakam agricultural supermarket located in Tebing Tinggi City, North Sumatra was conducted. This study was to determine the suitability of the installation with PUIL 2011 and SNI 6197:2020. From the calculations, it can be seen that the display room on the 2nd floor does not meet the standards of SNI 6197:2020 and also on the 3rd floor the hallway and kitchen area also do not meet the standards of SNI 6197:2020, therefore it is necessary to evaluate the design of lighting installations in these areas. The total active power in the building is 20,378 watts with a total current of 38.70 A. while the installed power from PLN is 33,000 VA after being multiplied by cosφ which is 26,400 watts. The safety devices used in this installation are MCB (Miniature Circuit Breaker) and MCCB (Molded Case Circuit Breaker) through the calculation of the safety current rating have met the PUIL 2011 standard, where the MCCB used on the MDP panel is 100 Ampere and the MCB used on the SDP panel is 40 Ampere.

Keywords: ***PUIL2011, SNI 6197:2020, Electrical Installation. Supermarket***

Introduction

Electrical installations are a crucial component of a building's electrical system, whether residential, office, industrial, or public facility. The quality of electrical installation design and implementation significantly impacts safety, comfort, and energy efficiency. Mistakes in planning and installation can lead to disruptions, energy waste, and even the risk of fire and accidents. When constructing an electrical installation, clear technical standards and guidelines are required to ensure safety and efficiency. In Indonesia, the standard used is the PUIL (General Requirements for Electrical Installations), which serves as a national reference for electrical installations. Every component of the installation must meet established technical requirements, both in terms of planning, implementation, and testing. In practice, many electrical installations are still found to be substandard, either due to limited knowledge, negligence, or cost-efficiency factors.

Mahakam Supermarket is a shopping center building for agricultural needs, where this supermarket sells various kinds of products related to agriculture such as fertilizers and pesticides. Mahakam Supermarket is located in the city of Tebing Tinggi, whose construction began in 2024 and was completed in 2025 and is planned to be operational in August 2025. To support shopping activities in the supermarket building, it is necessary to pay attention to the condition of its electrical installation. A good electrical installation for a supermarket must be designed with attention to safety, energy efficiency, ease of maintenance, and in accordance with the PUIL 2011 standards (General Requirements for Electrical Installations). Therefore, the author wants to conduct a study on the design of electrical installations in agricultural supermarkets in the city of Tebing Tinggi that pays attention to the suitability of the installation with the PUIL 2011 standards. In this design analysis, the author uses calculation and analysis methods as an approach in determining the components to be used in the installation. So that in the future the electrical components can run safely, reliably and efficiently.

Literature Review

2.1 Previous Researchers

Several previous studies have shown that compliance with PUIL (Indonesian Public Works and Housing) standards significantly impacts the safety and energy efficiency of buildings. Below are the journals used as references by the author. In his research, Mohammad Agrimansyah (2020) "Design of Electrical Installations in the Central Sulawesi Regional Police Headquarters Command Building in Wani Village" that the installation in his research is in accordance with PUIL 2011. The total power in this building is 80,000 watts, so the power required from PLN for the connection is 160 KVA. The conductors used in this installation use NYM and NYY type cables with varying sizes according to the CRC calculation (a method for detecting errors in data transmission) of the conductor that has been carried out

In his research, Riko Saputra (2024) "Evaluation of Electrical Installations according to PUIL standards at CV Multi Teknik Perkasa Palembang" that the total installed power is 18,448 wattsand the condition of the power used does not exceed capacity so that the electrical installation is safe to use.

In this research, Rahmad Hidayat Dongka (2024) "Design and Implementation of Electrical Installations in Simple Buildings According to PUIL Standards"The research results show that the recommended power requirement (VA) for KWH is 2200VA. MCB (Mini Circuit Breaker) with KHA of 10A and cable cross-sectional area of 2.5 mm2. The planned grounding system uses rod electrodes installed at 4 grounding points. Thus, it meets the reliability requirements of an electrical installation stipulated by the general regulations for electrical installations in PUIL.

2.2 Explanation of Electrical Installation

Electrical installation is the process of installing and adjusting electrical components in a building. Electrical installations generally consist of electrical power installations and lighting installations. Electrical power installation is the process of connecting a power source to electrical loads or equipment that require power, such as washing machines, refrigerators, air conditioners, fans, computers, and other loads. Lighting installation is the process of connecting a power source to a light or lighting point. Electrical installations consist of various components that transmit and control electrical energy. These components include cables, switches, sockets, Miniature Circuit Breakers (MCBs), MCB boxes, conduit pipes, and junction boxes. These components are explained as follows:

1. Cable

   A cable is an electrical conductor used to transmit electricity from one point to another. An electrical cable consists of two main components: a conductor (made of copper or aluminum) and an insulator or protective layer (made of thermoplastic).
2. Switch

   A switch is an electrical device that connects or disconnects the flow of electricity in a circuit. Switches are generally used to control lights, machines, or other electronic devices.
3. Electric socket

   A power outlet is an electrical component that connects electronic equipment to a power source. This component typically consists of one or more holes designed to accept a plug and channel electrical current to the device.
4. MCB

   MCB (Miniature Circuit Breaker) is an electrical component that functions as an automatic circuit breaker, thus protecting electrical installations from disturbances such as overloads or short circuits.
5. MCCB

   MCCB (Molded Case Circuit Breaker). This is an electrical component used to protect electrical systems from overloads and short circuits. MCCBs are designed for applications requiring greater current-breaking capacity than MCBs (Miniature Circuit Breakers), so they are often used in industrial and commercial electrical installations.
6. MDP Panel and SDP Panel

   MDP (Main Distribution Panel) and SDP (Sub Distribution Panel) are two types of electrical panels used in power distribution systems to divide and distribute electrical energy. The MDP panel functions as the main distribution center, receiving and dividing power from the main source, while the SDP panel distributes power further to various areas or more specific loads.
7. Electrical Pipe

   Electrical conduit is a tube or conduit used to protect and channel electrical cables in electrical installations, both inside and outside buildings. This conduit serves to protect the cables from physical damage, weather exposure, and other disturbances such as water, heat, or animals.
8. Junction box

   A junction box is a protective enclosure used to protect and contain electrical cable connections. This box serves to keep the cable connections safe from the environment and prevent accidental contact.

2.3 Lighting Installation

Good lighting installations must adhere to SNI 6197:2020, which discusses energy conservation in lighting systems. Good lighting in a room or area is determined by the lux level appropriate to the needs of the activities in that area. Lux is a unit for measuring the intensity of light received by a surface. Lux requirements vary depending on the type of room and the activities carried out within that room. SNI 6197:2020 contains standard lux values for rooms according to their respective functions. These standard values serve as a reference in determining the lux level.

A lamp is a device that produces light and is used as a lighting tool. Lighting using lamps is needed both indoors and outdoors for various activities, especially at night or in places with a lack of natural light. Commonly used types of lamps include TL (Tube Lamp), LED lamps, SL (Saving Lamp) lamps and incandescent lamps. In this study, three types of lamps were used, namely TL (Tube Lamp), SL (Saving Lamp) lamps and DL (Dwonlight) lamps, below is an explanation of the three lamps.

1. A TL (Tube Lamp) is a type of lamp that uses mercury and phosphor gas to produce light. Electricity flowing through the mercury gas produces ultraviolet radiation, which is then converted into light by a phosphor coating that coats the inside of the tube.
2. SL (Saving Lamp) lamps are a type of lamp designed to use less electrical energy compared to traditional incandescent lamps, while still providing the same level of lighting or are commonly called energy-saving lamps.
3. Downlights are lights that are installed on the ceiling or wall and direct light downwards, where the light is focused on a specific area.

To determine the lux value in a room, the following equation can be used.

$$E=\frac{F\ x\ n\ x\ kd\ x\ kp}{A} \tag{1}$$

Where:

F = luminous flux emitted by the lamp (lumens)

n = number of lights

A = Area of the room

kd = depreciation coefficient (new building 0.8)

kp = coefficient of use (new building 0.9)

2.4 Current Carrying Capacity

Current carrying capacity (CPAC) is the maximum capacity of an electrical current that can be carried by a cable or electrical conductor without causing damage or a dangerous temperature rise. The CPAC value can be influenced by several factors, including the cable's cross-sectional area, insulation material, and environmental conditions. To determine the cross-sectional area of a conductor, the nominal current flowing through the conductor must first be determined. The equation is as follows.

For single-phase alternating current:

$$I = \frac{P}{V\ x\ Cos\ \varphi} \tag{2}$$

For three-phase alternating current:

$$I = \frac{P}{\sqrt{3}\ x\ V\ Cos\varphi} \tag{3}$$

Where:

I = Nominal current (A)

P = Active power (W)

V = Voltage (V)

Cosφ = Power factor

The current-carrying capacity used in selecting a conductor is 1.25 times the nominal current passing through the conductor. The KHA value obtained is then adjusted according to the Current-Carrying Strength table.

Table 1. Current Carrying Capacity

No	Cable Cross Section (mm^2)	Current Carrying Strength (A)
1	0.75	12
2	1	15
3	1.5	18
4	2.5	20
5	4	34

2.5 Safety Current Rating

Electrical safety is an electrical component used to protect electrical installation systems from excessive current or dangerous short circuits. There are various types of electrical safety commonly used, including MCB (Miniature Circuit Breaker), Fuse, ELCB (Earth Leakage Circuit Breaker). MCB (Miniature Circuit Breaker) works on the principle of detecting excessive current or short circuits in electrical installations. When the current flowing exceeds the specified limit (the nominal current of the MCB), the MCB will automatically cut off the electricity flow, thus preventing damage to the installation and electrical equipment. To calculate the safety current rating in an installation is to calculate the total power in the electrical circuit then from the total power can be calculated from the current, then the total current value is added by 25% to 30% of the calculated result as a safety factor.

Results And Discussion

4.1 Electrical Wiring Diagram

A building's electrical wiring diagram is a schematic that explains the relationship between components in detail. This diagram displays the relationship between each component in an electrical installation. Single-line diagrams are used to determine the power consumption. This diagram is more like a table, making it easy to understand and use in planning the construction of SDP/MDP panels.

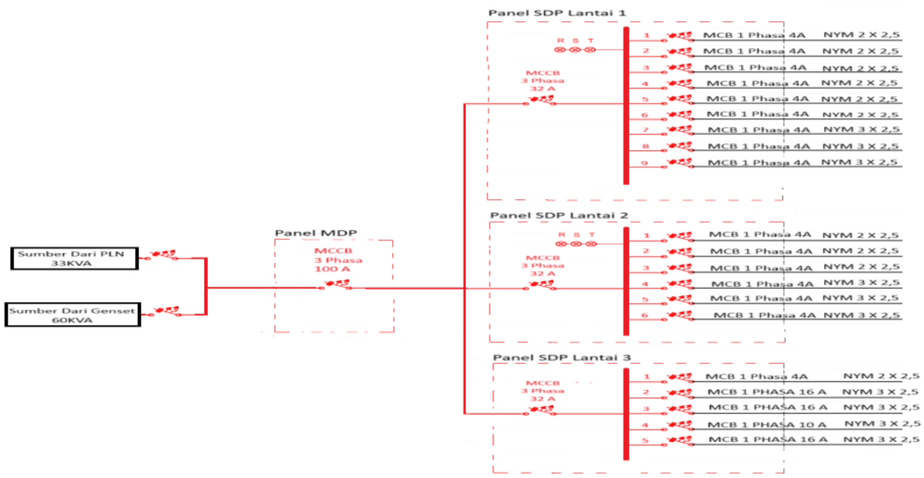

Figure 1. Single Line Diagram

4.2 Lighting Intensity Calculation (Lux)

Calculating the lux of a lamp is important to ensure optimal lighting levels and suit the **needs of the room or area being illuminated. From the results of the observation, it is known** that in lighting installations there are three types of lamps used, namely:

a. Toshiba brand TL (Tube Lamp) lamp with 18 watt power, 1800 lumens.
b. Philips brand SL (Service Lamp) lamp with 20 watt power, 2000 lumens.
c. Philips brand DL (Down Light) lamp with 17 Watt power, lumens 1300

The lumen value is obtained by consulting the catalog for each lamp product. A lumen is a unit of measurement for luminous flux, which measures the total amount of visible light emitted by a light source, where the light source in this case is a lamp. Using equation 1, we can determine the lux of the lighting in a room. The calculation results will then be compared with the SNI 6197:2020 standard. It should be noted that SNI 6197:2020 is the Indonesian National Standard that regulates energy conservation in lighting systems. This standard establishes technical requirements and design criteria for lighting systems to achieve optimal energy efficiency in buildings, including aspects of design, equipment selection, operation, and maintenance. The calculations that have been carried out are shown in the following table.

Table 2. Lux Calculation for Floor 1

No	Room Name	Room area (m^2)	Types of Lamps	Lamp Power (watts)	Number of Lights	Lux Value Calculation	Lux Value Standard
1	Front Porch	35	TL	18	12	444.32	40
2	R. Security	6	SL	20	2	480	100
3	R.Display	500	TL	18	136	352.51	300
4	Goods Room	500	TL	18	104	269.56	300
5	Toilet 1	4	SL	20	1	360	200
6	Toilet 2	4	SL	20	1	360	200

After the calculation is carried out, the calculated Lux value is compared with the standard minimum lighting level value contained in SNI 6197:2020, dIt can be seen that the lux value on the 1st floor meets the SNI 6197:2020 standard.

Table 3. Lux Calculation for Floor 2

No	Room Name	Room area (m^2)	Types of Lamps	Lamp Power (watts)	Number of lights	Lux Value Calculation	Lux Value Standard
1	R. Display	500	TL	18	90	233	300
2	R.Goods	500	TL	18	20	51.84	50
3	R. Prayer Room	6	SL	20	1	240	200

On the 2nd floor, it can be seen in Table 3 that the display room does not meet the SNI 6197:2020 standard, therefore it is necessary to redesign the lighting requirements according to the specified standards.

Table 4. Lux calculation for the 3rd Floor

No	Room Name	Room area (m^2)	Types of Lamps	Lamp Power (watts)	Number of Lights	Lux Value Calculation	Lux Value Standard
1	R.Wait	20	DL	17	2	93.6	200
2	hallway	8	DL	17	2	234	100
3	R. kitchen	8	DL	17	2	234	300
4	Toilet	4	DL	17	1	234	200
5	R. Meeting	30	DL	17	8	249	250
6	R. Admin	24	DL	17	10	390	200
7	R. Archives	9	DL	17	2	208	150

On the 3rd floor, it can be seen in Table 4 that the hallway and kitchen area do not meet the standard lux value requirements, therefore it is necessary to redesign the lighting requirements according to the SNI 6197:2020 standard.

4.3 Total Installed Power Calculation

Comparing the total installed power to the rated power is a crucial step in ensuring the safety and reliability of an electrical installation. Total installed power refers to the total power of all electrical equipment connected to the installation. In this case, installed power does not refer to the power actually used at any given time, but rather to the estimated maximum power that the equipment can supply or consume.

Table 5. TotalUsed Power Load on Floor 1

Group	Cable size (mm)	Phase	MCB Size (A)	Power load			Power (watts)
				SL Lamp (20 watts)	TL lamps(2 x 18 watts)	Electric socket	
1	NYM 2 x 2.5	R	4	-	720	-	720
2	NYM 2 x 2.5	S	4	-	720	-	720
3	NYM 2 x 2.5	T	4	-	720	-	720
4	NYM 2 x 2.5	R	4	-	720	-	720

Group	Cable size (mm)	Phase	MCB Size (A)	Power load			Power (watts)
				SL Lamp (20 watts)	TL lamps(2 x 18 watts)	Electric socket	
5	NYM 2 x 2.5	S	4	-	720	-	720
6	NYM 2 x 2.5	T	4	100	900	-	1000
7	NYM 3 x 2.5	R	4	-	-	750	750
8	NYM 3 x 2.5	S	4	-	-	525	525
9	NYM 3x 2.5	T	4	-	-	1000	1000
Total installed power (watts) on the 1st floor							**6,875**

On the 1st floor, the MCCB value used on the SDP panel is a three-phase 32 Ampere MCCB. Table 5 shows that the total power load used on the 1st floor is 6,875 watts. After adding up the loads for each phase, namely the R phase, S phase, and T phase, the total power on the R phase is 2,190 watts, the S phase is 1,965 watts, and the T phase is 2,720 watts. From the data, it can be seen that the distribution of loads on each phase is not balanced.

Table 5. Total Power Load Used on Floor 2

Group	Cable size (mm)	Phase	MCB Size (A)	Power load			Power (Watts)
				SL lamp (20 watts)	TLlamps (2 x 18)	Electric socket	
1	NYM 2x 2.5	R	4	20	612	-	632
2	NYM 2x 2.5	S	4	-	720	-	720
3	NYM 2x 2.5	T	4	-	720	-	720
4	NYM 3x 2.5	R	4	-	-	750	750
5	NYM 3x 2.5	S	4	-	-	525	525
6	NYM 3x 2.5	T	4	-	-	1000	1000
Total installed power (watts) on the 2nd floor							**4,347**

On the 2nd floor, the MCCB value used on the SDP panel is a three-phase 32 Ampere MCCB. Table 6 shows that the total power load used on the 2nd floor is 4,347 watts. After adding up the loads for each phase, namely the R phase, S phase, and T phase, the total power on the R phase is 1,382 watts, the S phase is 1,245 watts, and the T phase is 1,720 watts. Based on Table 6, it can be seen that the power values on each phase are not that different in power on each phase. The load balance on each R, S, and T phase needs to be considered to prevent excessive load on one phase which results in a trip on the MCCB due to an unbalanced load.

Table 6. Total Power Load Used on the 3rd Floor

Group	Cable size (mm)	Phase	MCB Size (A)	Burden		Power (Watts)
				Downlight lamp (17 watts)	Electric socket	
1	NYM 2x 2.5	R	4	476	-	476
2	NYM 3x2.5	S	16	-	2,250	2,250
3	NYM 3x 2.5	T	16	-	2,250	2,250
4	NYM 3x 2.5	R	10	-	1,980	1,980
5	NYM 3x 2.5	S	10	-	1,320	1,320
6	NYM 3x 2.5	T	6	-	880	880
Total installed power (watts) on the 3rd floor						**9,156**

On the 3rd floor, the MCCB value used on the SDP panel is a three-phase 32 Ampere MCCB. Table 7 shows that the total power load used on the 3rd floor is 9,156 watts. After adding up the load of each phase, namely the R phase, S phase, and T phase, it is known that the total power on the R phase is 2,456 watts, the S phase is 4,450 watts and the T phase is 2,250 watts. Table 7 shows a very different imbalance between the phases where the S phase has a very large load from the R phase and T phase loads. Through this data, it is recommended to rearrange the load distribution on the 3rd floor so that the load on each phase is evenly distributed. From the load data installed on the 1st, 2nd and 3rd floors, we can calculate the total load capacity used in the Mahakam supermarket building.

Overall power = Floor 1 Power + Floor 2 Power + Floor 3 Power

= 6,875 watts + 4,347 watts + 9,156 watts

= 20,378 watts

According to data obtained by researchers, the power supplied by PLN to the Mahakam Supermarket building is 33,000 VA. VA is typically used for alternating current (AC). To convert VA to watts, additional information is required, namely the power factor (cos phi). With a power factor of 0.8, the actual power value from PLN is: Actual power from PLN = 33,000 VA x 0.8 = 26,400 watts. So we can see that the load power used in the Mahakam Supermarket building is still below the installed power from PLN, where the total building power used is 20,378 and the installed power from PLN is 26,400 watts.

4.4 Safety Current Rating Calculation

The purpose of determining the safety current rating is to protect electrical installations and equipment from damage caused by excessive current or faults. In this installation, the safety current used is an MCB (Miniature Circuit Breaker). To calculate the safety current rating, we must calculate the total power to be protected. In this calculation, we will calculate the safety current rating and compare it to the MCB installed in the installation. The following is data obtained in the field.

Table 7. MCCB Size Data

No	MCCB Location	Installed MCCB size
1	MCCB in MDP panel	100 A
2	MCCB on the SDP panel on the 1st floor	40 A
3	MCCB on the SDP panel on the 2nd floor	40 A
4	MCCB on the SDP panel on the 3rd floor	40 A

The calculation can be seen below.

1. MDP Panel

It is known: Total Power =20,378 watts

Voltage =380 volt

So, I= $\frac{P}{V\ x\ Cos\ \varphi}$

$= = = 38.70\ A \frac{20378}{\sqrt{3}\ x\ 380\ x\ 0,8} \frac{20378}{526,54}$

From the total current we have to add 30% as a safety factor.

Then, I = I total + 30% = 38.70 A + 30% = 50.31 A

2. SDP PanelFloor 1

It is known: Total Power = 6,875watt

Voltage = 380 volt

So, I= $\frac{P}{V\ x\ Cos\ \varphi}$

$= = = 13.05\ A \frac{20378}{\sqrt{3}\ x\ 380\ x\ 0,8} \frac{6875}{526,54}$

FromOur total current must add 30% as a safety factor.

Then, I = I total + 30% = 13.05 A + 30% = 16.96 A

3. SDP Panel2nd Floor

It is known: Total Power = 4.347watt

Voltage = 380 volt

So, I= $\frac{P}{V\ x\ Cos\ \varphi}$

$= = = 8.25\ A \frac{20378}{\sqrt{3}\ x\ 380\ x\ 0,8} \frac{4347}{526,54}$

FromOur total current must add 30% as a safety factor.

Then, I = I total + 30% = 8.25 A + 30% = 10.72 A

4. SDP Panel, 3rd Floor

It is known: Total Power =9,156 watts

Voltage = 380 volt

So, I= $\frac{P}{V\ x\ Cos\ \varphi}$

$= = = 17.3\ A \frac{9156}{\sqrt{3}\ x\ 380\ x\ 0,8} \frac{9156}{526,54}$

FromOur total current must add 30% as a safety factor.

Then, I = I total + 30% = 17.3 A + 30% = 22.49A

4.5 Calculation of Current Carrying Ability

It's crucial to know the KHA to ensure the safety and reliability of electrical installations. If a cable's KHA doesn't meet requirements, it can overheat, damage its insulation, and even cause a fire. The KHA value can be determined by first calculating the nominal current and then comparing it with the provisions for the cable cross-sectional area according to the KHA in PUIL2011.

Table 8. Calculation of Cable Cross-Section Area

No	Cable Position	Nominal Current Calculation	Size of the installed cable cross-sectional area	Recommended cable cross-sectional area size (PUIL 2011)
1	MDP Panel to SDP Panel	38.70 A	$10m^2$	$6\ m^2$
2	SDP L.1 Panel to Load	13.05 A	$2.5m^2$	$1.5m^2$
3	SDP L.2 Panel to Load	8.25 A	$2.5m^2$	$0.75m^2$
4	SDP L.3 Panel to Load	22.49 A	$2.5m^2$	$2.5m^2$

From the tableWe can see that the use of cable sizes or cable cross-sectional areas is in accordance with PUIL 2011.

Conclusion

From the results of the research on the Analysis of Electrical Installation Design at Mahakam Agricultural Supermarket in Tebing Tinggi City, the following conclusions can be obtained:

a. The entire electrical installation system receives a 3-phase electricity supply from PLN, and as a backup power source uses a generator with a capacity of 60 KVA.
b. The total active power in the building is 20,378 watts with a total current of 38.70 A. while the installed power from PLN is 33,000 VA after being multiplied by cos, which is 26,400 watts.φ
c. The RAB for this installation design that the author obtained was Rp. 328,760,000,-
d. There are still lighting installations that do not meet the SNI 6197:2020 standard, so they need to be readjusted.
e. The cables used in electrical installations in buildings use NYM and NYYHY type cables.
f. The safety device used in this installation is MCB (Miniature Circuit Breaker).(Yusuf & Kali, 2020)Breaker) and MCCB (Molded Case Circuit Breaker) through the calculation of the safety current rating have met the PUIL 2011 standards
g. Through calculations, it is also known that the cable cross-sectional area after being compared with the 2011 PUIL provisions meets the standards.

References

[1] Agrimansyah, M. (2020). Electrical Installation Design at the Central Sulawesi Regional Police's Air and Water Police Directorate Command Headquarters Building, Wina Village. Foristek Scientific Journal, Vol. 10 Number 2.

[2] Alip, M., Rauf, R., & Ridal, Y. (2024). Electrical System Design Review of Stikes Alifah Padang. Journal of Civil Engineering (Electro Civil Engineering), Vol 5, No. 2, Pages 12-22.
[3] Anisah, S., Fitri, R., & Rahmaniar. (2021). Analysis of the Use of Environmentally Friendly Technology-Based Lighting Systems in Residential Homes. Seminar of Social Sciences Engineering & Humanities.
[4] Anisah, S., Rahmaniar, & Indayani, P. (2019). Implementation of resistive and inductiveloads for error testing on single-phase kWh meters. JESCE, Vol 3, No 1 , Pages 30-41.
[5] Dwilesmana, A., & Cahyono, BD (nd). Analysis of Electrical Installation Systems in Multi-Story Buildings at PT. Multi Group.
[6] Fauzan, MZ, & rusdiyanto, d. (2022). Evaluation and Redesign of Electrical Installations of the Management Building and Classrooms at SMAN 6 Garut. Journal of Electrical Engineering Studies, Vol. 6, No. 2.
[7] Ginting, E., Fahreza, M., & Dalimunthe, ME (2024). Electrical Analysis at the Kualanamu Central Service Laboratory. Power Electronics: Jurnal Orang Elektro, Vol. 13, No. 1.
[8] Idris, M., Tharo, Z., & Siagian, P. (2025). Analysis of Prepaid kWh Meter Rejuvenation on Electric Power System Reliability. National Journal of Computer Technology, Vol. 5, No. 3.
[9] Olanda, B., & Susilo, D. (2021). Design and Drafting of Simple Household-Scale Electrical Installations. ELECTRA Journal: Electrical Engineering Articles, Vol. 1, No. 2.
[10] Rahmaniar, & Anisah, S. (2021). Improving Understanding of PUIL 2000 and Illumination Calculations at the Deli Serdang Museum. Abdidas Journal, Vol. 2, no. 3, pp. 646-651.
[11] Saifudin, MA (2018). Analysis of Installed Electrical Power Requirements in the West Halmahera Regent's Office Building. PROTEK Journal, vol 05, No. 1.
[12] Saputra, R., Al Amin, M., & Irwansi, R. (2024). Evaluation of Electrical Installations According to PUIL Standards at CV Multi Teknik. URANUS: Scientific Journal of Electrical Engineering, Science and Informatics, Vol 2, No. 3, Pages 239-245.
[13] Suharto. (2016). Analysis of Electrical Energy Savings at Dr. Soedarso Regional General Hospital, Pontianak, Reviewed from Installation Design. Elkha Journal, Vol. 8, No. 1.
[14] Taryana, t., & Kuntadi, C. (2023). Factors Affecting the Reliability of Electrical Installations. JMPIS, Vol. 4, No. 1.
[15] Tharo, Z., Tarigan, AD, & Pulungan, R. (2018). The Effect of Unbalanced Load Usage on Electrical Equipment Lifespan. RELE (Electrical and Energy Engineering), Vol. 1, No. 1.
[16] Yusuf, & Kali, A. (2020). Electrical Installation Design of the Population and Family Planning Control Office (P2KB) Building, Central Sulawesi Province. Jurnal Ilmiah Foristek, Vol. 10, No. 2.