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# Investigating the Effect of Direct Touch Method on Insulator Replacement in Candra Asri Feeder

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A R T I C L E I N F O

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A B S T R A C T

PLN UP3 East Bali in carrying out Fulcrum Insulator maintenance chooses to use Work In Direct Touch Voltage status. The purpose of using this method is to reduce the value of reliability indices in the form of System Averange Interruption Duration Index, System Averange Interruption Frequency Index, and Saving kWh which results in rupiah savings. The results showed that in 11 times the replacement work of the Fulcrum Insulator extinguishing method resulted in a SAIDI value of 0.105 minutes per customer, SAIFI of 0.104 times per customer. Meanwhile, if done with the Direct Touch method, PDKB gets a SAIDI and SAIFI value of 0. So if done with the Direct Touch Method, PDKB gets embedded 32,903.67 kWh and Rp. 42,248,314.85

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## INTRODUCTION

At this time, the electric power system plays a very important role in the lives of people and business actors because almost all activities carried out require electrical energy (Rahmaniar et al., 2022) Therefore, the reliability of the electric power system is very important to ensure the availability of adequate electrical energy for consumers(Rizky, 2020). Many factors affect the reliability of a medium-voltage air network. Insulators are insulating materials that function as direct insulation between conductors and support poles (Sampoern, 2020). A damaged insulator can cause interference so that electricity can be cut off due to leakage current flowing (Dewi, 2021).

Under these conditions, PT. PLN (Persero) UP3 East Bali uses a Direct Touch Work Under Voltage (PDKB) method ((Alam, 2021). This method is a method used for maintenance and handling of disturbances in medium-voltage networks that are carried out under tension. The implementation of these methods has a very high potential for danger (Nanda, 2021). Therefore, it is necessary to have careful planning and always prioritize safety, and work always in accordance with Standard Operating Procedures and Work Instructions so that work can be carried out properly without work accidents caused by human negligence, equipment used, or the work environment (Pancane, 2022)

## LITERATURE REVIEW

The results of a study conducted by brother Saputra, (2022), entitled "Analysis of the Effect of PDKB on the Maintenance Work of Pedestal Insulators in the 10 Gi Sayung 150/20 Kv Demak Feeder". In its analysis, it uses the PDKB method to replace fulcrum insulators to find the influence of PDKB in finding the value of SAIDI, SAIFI and Energy kWh and Rupiah saved (Manopo et al., 2020).

The results of research conducted by Rohadi, (2021), entitled "Implementation of Energy Management in Work in Medium Voltage Voltage (Pdkb-TM) Pt Pln (Persero) Up3 Kudus". Using the Net Present Value method to calculate economic feasibility and the Internal Rate of Return method to calculate the interest rate value of an investment, both methods are used to determine the economic feasibility of a 20 kV PDKB-TM investment in PT. This study produces an investment evaluation value with the NPV method resulting in a value of Rp10,313,000,000 where the NPV is greater than 0, meaning that the investment of work with PDKB is feasible, while in the IRR method the interest value is 44.34% greater than the reference bank interest used, which is 8%, meaning the investment is economically feasible.

The results of the research conducted by Juliasandi &; Alfi, (2019), this is to find out how much kWh is saved, rupiah saved due to work with the PDKB method, then to find out the comparison of the reliability value of SAIDI &SAIFI between work with the PDKB method and with outages, as well as to find out the potential losses and net profit obtained by PT. PLN (Persero) Distribution Central Java and D.I. Yogyakarta Purwokerto Area. After that, knowing the value of SAIDI &; SAIFI achieved by the existence of PDKB is 0.34068 hours / customer / year and 0.137 times / customer / year and the value of SAIDI &; SAIFI if maintenance work is not carried out by PDKB which is 0.7867 hours / customer

/ year and 0.279 times / customer / year. The total potential loss that can be experienced if it does not empower PDKB is IDR 1,470,507,887.

The results of research conducted by Leksana, (2020), stated that the implementation of 20 kV medium-voltage overhead line maintenance work in a voltage state should not ignore the safety and security of line workers. The existence of safety and security guarantees starting from the initial preparation, the equipment used and the type of work to be used is a measure of success in preventing accidents that will occur in maintenance work of 20 kV medium voltage overhead lines under tension. PDKB is a team that in fact works without extinguishing electricity The benefits obtained if minimizing outages, suppressing the ratio of SAIDI and SAIF, kWh channels do not decrease, rupiah selling does not decrease. The results of the analysis show that the maintenance work of a 20 kV medium-voltage air line insulator in a voltage state can save electrical energy per semester in 2018 of 16,606.42 kWh.

## METHODOLOGY

This study uses quantitative methods where observation, substitution, testing, and calculation of the results of SAIDI, SAIFI, and Saving kWh data are saved without going out, at the replacement of the Tumpu Insulator in the Canda Asri feeder (Rahmaniar et al., 2022). Single Line Diagram of the Candra Asri feeder where the work to be analyzed is carried out. results of measuring how long the work time is (Swamardika et al., 2018). From the data that has been obtained from observations and data collection in the field, it will be processed to know the results of SAIDI, SAIFI and Saving kWh calculations using formulas based on references from books, journals, and the internet (Piasson, 2020).

From the observations, several stages will be poured
In a chart adopted from research (Widyastuti et al., 2021), the reliability of the electric power distribution system is a factor that is very concerned by PT. PLN Interference with cable channels can be caused by an inrush current when there is a load shift in the network and damage the cable jointing. Therefore, now the method of installing cubicle arresters in cable channels is carried out by PT PLN to reduce the intensity of these disturbances, so that system reliability values such as SAIDI and SAIFI parameters become better.

According to (Priyatno, 2023), for maintenance or replacement of the construction of the Double Circuit Fulcrum Insulator, it still has to shut down the electric power grid. The construction design of this equipment can be used for replacement/maintenance of Double Circuit Fulcrum Insulator construction. With this equipment, it will be very helpful in carrying out network maintenance work and can be implemented in PLN's operational units, so that the implementation of work becomes safer, faster, more efficient and can be avoided outages due to the maintenance.

This research will involve the use of special instruments focused on investigating the impact of the Direct Touch Method on insulator replacement in Candra Asri feeders (Mahadewi et al., 2019) The main instruments used include electrical system reliability monitoring devices, power measurement equipment, and fault frequency analyzers. In addition, thermal measurement instruments will be used to monitor temperature during the insulator replacement process

(Suryadi & Sofwan, 2021). All of these instruments will be used carefully and meticulously to obtain accurate and measurable data, in accordance with the scientific methodology applicable in this study (Putranto, 2019).

**RESEARCH RESULTS**

The results of the analysis in this study will be carried out carefully to ensure the accuracy and reliability of the data obtained in table 1. First, after the implementation of the Direct Touch Method in the replacement of the fulcrum insulator in the Candra Asri feeder, we will carry out continuous monitoring of critical parameters of the electrical system. This includes measuring voltage, current, and power at critical points in the feeder to evaluate changes that may occur post-replacement (Juliasandi &; Alfi, 2021).

Furthermore, the test steps will include data analysis of the frequency and duration of interruptions as well as system recovery time in situations that have the potential to cause instability (Eka et al., 2021). The Direct Touch method will be evaluated based on the increase or decrease in system reliability, which can be seen from the system's response to disruptions and its recovery capabilities. The use of thermal instruments will also be evaluated by checking the temperature of the insulator post-replacement to ensure there is no overheating or other thermal anomalies. These test steps will provide a comprehensive overview of the effect of the Direct Touch Method on system reliability in the Candra Asri feeder.

Table 1. Data on the Number of Customers and Expenses of P. Candra Asri October 2023

| No | Section | Number of Substations | Built-in Power | Beban Section | | Pelanggan Section |
|---|---|---|---|---|---|---|
| | | | | Installed | Channeled | |
| | | pcs | kVA | A | A | Plg |
| 1 | LBS Purnama-LBS Kecupin-Rec Pabean | 3 | 500 | 14 | 5 | 844 |
| 2 | Rec Pabean-LBS Pamesan-LBS Nata-LBS Guwang | 11 | 2020 | 58 | 20 | 3.408 |
| 3 | LBS Guwang-LBS Tebuana-LBS Celuk | 6 | 1350 | 39 | 13 | 2.278 |
| 4 | LBS Celuk-LBS Bendul-LBS Tegal Tamu | 20 | 3410 | 99 | 33 | 5.753 |
| | **Jumlah** | **40** | **7280** | **210** | **71** | **12.283** |
| | | **Average** | | | **18** | **3.071** |

## DISCUSSION

It should be understood that fulcrum insulators have a crucial role in maintaining system reliability and stability. The replacement of insulators with direct touch methods is expected to increase the efficiency of the process (Rahmaniar et al., 2022). As a first step, this study will identify the fulcrum insulator to be replaced, observe its existing condition, and evaluate the reliability of the system before replacement is carried out (Priyatno, 2023).

Furthermore, the analysis will focus on the implementation of the direct touch method in insulator replacement (I. Saputra et al., 2023). This process will be examined in detail, covering technical aspects, implementation time, and impact on system power flow. Temperature data during the replacement process will also be measured to evaluate potential thermal changes that could affect the performance of the new insulator (Swamardika et al., 2019).

Table 2. PDKB Job Data

| No | Types of Jobs | Burden/Section (A) | Number of Customers Outage | Total Number of Customers | Standar Waktu PDKB (jam) | Average Rupiah per kWh | Voltage (kV) |
|---|---|---|---|---|---|---|---|
| Agustus (LBS Guwang-LBS Tebuana-LBS Celuk) | | | | | | | |
| 1 | Fulcrum Insulator Replacement | 13 | 2.278 | 460.302 | 1,5 | 1.284 | 20 |
| 2 | Fulcrum Insulator Replacement | 13 | 2.278 | 460.302 | 1,5 | 1.284 | 20 |
| 3 | Fulcrum Insulator Replacement | 13 | 2.278 | 460.302 | 1,5 | 1.284 | 20 |
| September (LBS Purnama-LBS Kecupin- Rec Pabean) | | | | | | | |
| 1 | Fulcrum Insulator Replacement | 5 | 844 | 460.302 | 1,5 | 1.284 | 20 |
| 2 | Fulcrum Insulator Replacement | 5 | 844 | 460.302 | 1,5 | 1.284 | 20 |
| Oktober (Rec Pabean-LBS Pamesan-LBS Nata-LBS Guwang) | | | | | | | |
| 1 | Penggantian Isolator Tumpu | 20 | 3.408 | 460.302 | 1,5 | 1.284 | 20 |
| 2 | Fulcrum Insulator Replacement | 20 | 3.408 | 460.302 | 1,5 | 1.284 | 20 |
| November (LBS Celuk-LBS Bendul-LBS Tegal Tamu) | | | | | | | |
| 1 | Fulcrum Insulator Replacement | 33 | 5.753 | 460.302 | 1,5 | 1.284 | 20 |
| 2 | Fulcrum Insulator Replacement | 33 | 5.753 | 460.302 | 1,5 | 1.284 | 20 |
| 3 | Fulcrum Insulator Replacement | 33 | 5.753 | 460.302 | 1,5 | 1.284 | 20 |
| 4 | Fulcrum Insulator Replacement | 33 | 5.753 | 460.302 | 1,5 | 1.284 | 20 |

**Data Hasil Pekerjaan Penggantian Isolator Tumpu Metode PDKB**
**Perhitungan SAIDI (System Average Intteruption Duration Index) August-November 2023**

The result of SAIDI's calculation that was saved was the difference in SAIDI values from two work methods in the maintenance of the replacement of the Fulcrum Insulator in the Candra Asri Feeder, namely between the Direct Touch PDKB method compared to the extinguishing method (Swamardika et al., 2019).

$$\textbf{SAIDI} = \frac{\sum(\textbf{long customer outages x number of outages})}{\textbf{TOTAL NUMBER OF CUSTOMERS SERVED}}$$

The results of SAIDI in the Direct Touch PDKB method can be ascertained to be 0 because it is done without blackouts. So the calculation of the value of SAIDI using the blackout method can be seen in Table 3.

Table 3. SAIDI August-November 2023 (Researcher, 2023)

| month | Comparison Results of SAIDI Value Calculation | |
|---|---|---|
| | PDKB | Blackout |
| **August** | 0 | 0,022 |
| **September** | 0 | 0,005 |
| **October** | 0 | 0,022 |
| **November** | 0 | 0,056 |
| **Total** | 0 | 0,105 |

**SAIFI (System Average Interruption Frequency Index) Calculation for August-November 2023**

The result of the SAIFI calculation that was saved was the difference in the value of SAIDI from two work methods in the maintenance of the replacement of the Fulcrum Insulator at the Candra Asri Feeder, namely between the Direct Touch PDKB method compared to the extinguishing method (Kruithof et al., 2020).

$$\textbf{SAIFI} = \frac{\sum(\textbf{OUTAGE FREQUENCY x NUMBER OF CUSTOMERS DECLINED})}{\textbf{TOTAL NUMBER OF CUSTOMERS SERVED}}$$

The results of SAIDI on the Direct Touch PDKB method can be ascertained to be 0 because it is done without blackouts (Gonzalez, 2019). So the calculation of the value of SAIDI using the blackout method can be seen in Table 4.

Table 4. SAIFI August-November 2023 (Researcher, 2023)

| Moon | Comparison Results of Value Calculation SAIFI | |
|---|---|---|
| | PDKB | Blackout |
| **August** | 0 | 0,015 |
| **September** | 0 | 0,037 |
| **October** | 0 | 0.015 |
| **November** | 0 | 0,037 |
| **Total** | 0 | 0.104 |

**The calculation of Saved kWh** can be seen in Table 5.

Table 5. kWh Data Saved in August-November 2023 (Researcher, 2023)

| No | Bulan | kWh Terselamatkan |
|---|---|---|
| **1** | Agustus | 5.167,42 |
| **2** | September | 883,32 |
| **3** | Oktober | 3.533,28 |
| **4** | November | 23.319,65 |
| | **Total** | 32.903,67 |

**Calculation of Saved Rupiah**

To calculate the value of the saved Rupiah, you can use cumulative data saving kWh from each August to November (LaCommare &; Eto, 2006). The kWh price used is the average price of UP3 East Bali total customers based on TULL III-09. (See Table 6)

Table 6. Rupiah Data Saved for August-November 2023 (Researcher, 2023)

| No | Month | Rupiah Saved |
|---|---|---|
| **1** | Agustus | 6.634.969,85 |
| **2** | September | 1.134.182,88 |
| **3** | Oktober | 4.536.731,52 |
| **4** | November | 29.942.430,60 |
| | **Total** | 42.248.314,85 |

Table 7. Results of PDKB Rescue on Fulcrum Isolator Replacement Work (Researcher, 2023)

| No | Month | SAIDI PDKB (Minutes/Subscribers) | SAIFI PDKB (Times/Customer) | kWh Saved | Rupiah Saved |
|---|---|---|---|---|---|
| **1** | August | 0,022 | 0,015 | 5.167,42 | 6634969,85 |
| **2** | September | 0,005 | 0,037 | 883,32 | 1134182,88 |
| **3** | October | 0,022 | 0,015 | 3.533,28 | 4536731,52 |
| **4** | November | 0,056 | 0,037 | 23.319,65 | 29942430,6 |
| | **Total** | 0,105 | 0,104 | 32.903,67 | 42.248.314,85 |

In Table 7 above, it can be seen that if the work to replace the Fulcrum Insulator is carried out by the power outage method, not by PDKB, PLN can certainly lose money because it has to lose electrical energy, which when converted into rupiah becomes Rp. 42,284,314.85. In addition, PLN will also feel other losses such as decreasing the level of distribution network reliability and of course will have an impact on customer satisfaction with PLN if the work is carried out with the blackout method.

## CONCLUSIONS AND RECOMMENDATIONS

The direct touch method in replacing the fulcrum insulator on the Candra Asri feeder can be considered an effective approach and has the potential to be applied in similar scenarios in the electricity sector. This research makes an important contribution to the understanding of innovative insulator replacement technologies that can have a positive impact on the reliability of electric power systems.

Based on the findings in this study, it is recommended that the direct touch method in the replacement of fulcrum insulators can be widely adopted in the management of similar feeder systems. It is necessary to conduct regular monitoring of the reliability of the system after the implementation of this method to ensure consistency of results. In addition, further research can be done to explore it, focusing on larger scales and variations in operational conditions. It is hoped that the application of this method can be the foundation for improving the reliability of the overall electricity distribution system, creating a more reliable and efficient electricity network.

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