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Use of the Section Technique Method to Obtain Reliability Index Through SAIDI and SAIFI Values PT PLN (Persero) Tarakan

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Abstract_ *With the increasing demand for electrical energy in the city of Tarakan must be accompanied by increasing the quality of distribution to customers to provide the flow of electrical energy in a fairly reliable power. in this study aims to meet and analyze the reliability of the power distribution system based on SAIFI and SAIDI by using the section technique method. Distribution system reliability is one of the ways to improve the quality of electrical energy services to consumers. Section technique by breaking the system into several parts and then analyzing each part so that the results can be optimal and the section is divided into 10 sections of 10 feeders in Tarakan city. There are several system reliability indices as a reference in analyzing the SAIFI and SAIDI. As for the calculation results of the section technique method, the SAIFI value analyzed is 2.393765 times / year, it can be seen that it meets the specified standards. While the SAIDI value of 1.760446 hours / year appears to meet the standard.*

Keywords: *Section Technique; SAIFI; SAIDI.*

I. INTRODUCTION

Electricity has become an essential element in modern human life, serving as the backbone of all sectors—industrial, commercial, and domestic. As society advances in both technological complexity and economic scale, the demand for electrical energy continues to increase significantly. The reliability of power distribution systems must therefore evolve to ensure the consistent and efficient supply of electricity to end users [1].

In response to the growing demand and the complexity of load profiles, power utilities are increasingly required to maintain high system reliability. The rapid development of electrical loads, smart equipment, and energy-efficient devices has further emphasized the need for uninterrupted power supply. This reliability is commonly assessed using standardized indices, such as the System Average Interruption Duration Index (SAIDI) and the System Average Interruption Frequency Index (SAIFI), which represent the average outage duration and frequency experienced by customers over a given period [2], [3].

The evaluation of distribution system reliability can be enhanced through the application of the section technique. This method subdivides the distribution network into smaller, more manageable sections, allowing for a more detailed and accurate analysis of failure points, interruption duration, and service restoration. Numerous studies have successfully utilized this approach to identify network weaknesses and improve reliability performance [4], [5].

For instance, research conducted on the distribution network of PLN Bunyu demonstrated how the section technique can aid in optimizing reliability by localizing high-risk sections for preventive maintenance [5]. Similarly, evaluation studies in the Kotamobagu and Balikpapan areas confirmed the effectiveness of this method in providing actionable insights into network operation and planning [6], [7]. Moreover, a reliability analysis performed in Banda Aceh emphasized the importance of using such techniques to support strategic decision-making for long-term infrastructure development [8].

In addition to traditional network reliability concerns, the growing adoption of distributed energy resources such as rooftop solar photovoltaic (PV) systems has introduced new operational challenges. Therefore, it is critical to periodically reassess reliability metrics and adapt to evolving system conditions [9], [10].

Given this context, the present study focuses on evaluating the reliability of the power distribution system operated by PT PLN (Persero) Tarakan. By applying the section technique method, this research aims to calculate SAIDI and SAIFI values, identify critical segments within the distribution network, and provide recommendations for system enhancement. The results are expected to contribute toward improving power quality and service reliability in line with modern energy demands.

II. METHODS

This study employs a quantitative research approach, encompassing stages from problem identification to data collection, processing, and analysis. The primary objective is to test hypotheses regarding the Section Technique method for the SAIDI and SAIFI indices.

2.1. Section technique method

The section technique is a structured method for analyzing system reliability, specifically within distribution networks. This approach evaluates how equipment failures impact overall system operation by systematically identifying the effects or consequences of faults in individual equipment. Each potential equipment failure is assessed from all load points, using a bottom-up approach in which failures are considered independently over time [2].

In the section technique method, it is assumed that the failure of each equipment is not interconnected, each equipment can be analyzed separately. If equipment failures are interconnected, the calculation of system reliability is more complex. So to simplify the calculation by assuming that each failure is not interconnected. The reliability index calculated is the index at the load point and the system index both in section and as a whole [5],[6].

$$\lambda \text{ (Line 1)} = \text{component output number x air line length} \quad (1)$$

After getting the failure frequency value (λLP), the load point value (LP1) on the line can be calculated from the duration of the failure, while the duration of this failure is influenced by the repair time (repair time) regarding the component repair time, for the calculation below [5],[6].

$$\text{U (Line 1)} = \lambda \text{LP x equipment repair time} \quad (2)$$

2.2. SAIDI index

The SAIDI index represents the average outage duration per customer annually. It is calculated by dividing the total outage duration experienced by all customers over a specified period by the total number of customers served in one year. The SAIDI formula is defined as follows [4],[5],[6]:

$$\text{SAIDI} = \frac{\sum(ULP \times N\, i)}{\sum N} \quad (3)$$

Where SAIDI is the average outage duration of consumers per load point, ULP is the duration of failure per year, Ni is the number of consumers out at each distribution transformer, ∑N is the total number of consumers who go out.

2.3. SAIFI index

The SAIFI index measures the average frequency of service interruptions per customer annually. It is determined by dividing the total number of customer outages in a year by the total number of customers served by the system. The SAIFI formula is defined as follows [4],[5],[6]:

$$\text{SAIFI} = \frac{\sum \lambda LP \ X\ N\, i}{\sum N} \quad (4)$$

Where SAIFI is the average number of consumer outages per load point, λLP is the average failure index per year, Ni is the number of consumers out at each distribution transformer, ∑N is the total number of consumers who go out.

2.4. Reliability index standard parameters

The SAIDI and SAIFI standards set by PT PLN (Persero) are found in the standard book of the general electricity company regarding the level of electricity system guarantee better known as SPLN 68 2: 1986. The standards used to determine SAIDI and SAIFI have been written in SPLN 68 as in the table 1 below.

[Table 1 about here.]

The SAIDI and SAIFI standards set by the Institute of electrical and electronic engineers (IEEE). The standards used to determine SAIDI and SAIFI have been written as in table 2 below.

[Table 2 about here.]

III. RESULTS AND DISCUSSION

3.1. Calculation of overhead line faults

In the air duct fault data to achieve the equipment output number can be determined by dividing between the average number of network failures per year divided by the total length of the duct in each section to determine the channel output value, as can be seen in table 3 below.

[Table 3 about here.]

Based on the table 3 network disturbance data above, the output number value of the air duct can be calculated. In this case, 1 case is taken in the case of section 1 with a total channel length of 25.124 km. Steps in determining the air duct output number for each section, if an example is taken, namely section 1, the air duct output number in section 1 can be calculated as follows [5],[6]:

$$\lambda = \frac{average\ number\ of\ disturbances\ per\ year}{total\ length\ of\ section\ 1\ overhead\ line} \quad (5)$$

$$\lambda = \frac{1{,}750}{25{,}124}$$

λ = 0.06965 km/tahun

For calculations on other sections, it is done in the same way as above. So that the results of the calculation of the value of the air duct output number for each section can be seen in table 4 below.

[Table 4 about here.]

3.2. Distribution equipment fault calculation

[Table 5 about here.]

Based on Table 5 above, namely the average equipment interference for 1 year, it can be calculated the value of the output number that affects the failure of distribution equipment. Taken 1 case, namely the LBS, the value of the LBS equipment output number is obtained from the average number of equipment failures per year divided by the total number of equipment. Based on equation 5, an example calculation can be taken on LBS interference where for average equipment interference can be seen in table 5 equipment interference divided by the total number of LBS equipment.

$$\lambda 1 = \frac{average\ number\ of\ interruptions}{total\ transformer\ equipment} \quad (6)$$

$$\lambda 1 = \frac{31}{47}$$

λ1 = 0.65957 Unit/tahun

$$\lambda 2 = \frac{4}{338}$$

λ2 = 0,011834 Unit/tahun

To find the value of other equipment output numbers, you can use the same equation as above, so that the equipment output values can be seen in table 6 below.

[Table 6 about here.]

3.3. Section Technique Calculation

To evaluate the impact of equipment failures on the system, a comprehensive failure list is created based on collected data, including line lengths and the number of customers per load point. This list provides a basis for calculating the frequency and duration of failures at specific load points, such as load point 1. The frequency of disruptions at load point 1 (LP1) can then be calculated using Equation 1.

λ (Line 1) = 0,06965 x 0,158

λ (Line 1) = 0,011004 ganguan/tahun

After obtaining the failure frequency value (λLP), the load point value (LP1) on the line can be calculated from the duration of the failure, while the duration of this failure is influenced by the repair time regarding the component repair time, for calculation using equation 2.

U (Line 1) = 0,011004 x 1.527

U (Line 1) = 0,016803 Jam/tahun

SAIFI and SAIDI values at load point 1. The SAIFI value can be determined by transferring λ LP1 with LP1 consumers and dividing the value by the total number of consumers, while for the SAIDI value, namely multiplying the total ULP load point value by the number of consumers at the load point and then dividing by the total number of consumers supplied by PT PLN (Persero) Tarakan, for calculations using equations 3 and 4.

$$SAIFI = \frac{2{,}435575\ x\ 10}{4{,}735}$$

SAIFI = 0,00514377 gangguan/tahun

$$SAIDI = \frac{3{,}289755\ x\ 10}{4{,}735}$$

SAIDI = 0,00694774 jam/tahun

To determine the total value of SAIFI and SAIDI is as follows using the data in table 7 below:

[Table 7 about here.]

$$\text{SAIFI} = \frac{\text{Total nilai SAIFI}}{\text{jumlah bulan pertahun}}$$

$$\text{SAIFI} = \frac{28{,}725189}{12}$$

SAIFI = 2,397657 Gangguan/Tahun

$$\text{SAIDI} = \frac{\text{Total nilai SAIDI}}{\text{jumlah bulan pertahun}}$$

$$\text{SAIDI} = \frac{21{,}125363}{12}$$

SAIDI = 1,760446 Jam/Tahun

Based on Table 7 above, the total number of reliability index values at PT PLN (Persero) Tarakan, namely for SAIFI is 28.725189 disturbances / year, while SAIDI is 21.125363 hours / year. Comparison of the reliability index value of each section can be seen in the graph below.

[Figure 1 about here.]

Based on the graph above, it can be seen that the SAIFI reliability index has increased significantly in Section 4. Because this section has the largest number of customers compared to other sections, while SAIDI has decreased.

IV. CONCLUSION

Based on the results obtained in the reliability index table, it can be seen that the highest frequency of interference is in section 4, namely SAIFI is 3.465778 times / year and SAIDI is 3.837799 hours / year, this happens because in this section the longest air duct feeder. As for the duration of the smallest disturbance in section 8, SAIFI is 2.632703 times / year and SAIDI is 1.248680 hours / year. Meet the standards of PT PLN (Persero) Tarakan. The reliability of the electricity distribution system at PT PLN (Persero) Tarakan can be influenced by the number of customers, the length of the air duct and the number of blackouts that occur.

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Table 1. Reliability index standards SPLN 68

Reliability index standard	Grade standard	
	SAIFI (disturbance/year)	SAIDI (hours/year)
SPLN 68-2 : 1986	2,88	15,36

Table 2. IEEE reliability index standards

Reliability index standard	Grade standard	
	SAIFI (disturbance/year)	SAIDI (hours/year)
IEEE	2,30	1,45

Table 3. Air duct fault data

Month	Number of interruptions	Length of outage	Length of outage
January	28	26:29:00	2,648,333
February	19	7:10:00	716,667
March	18	10:33:00	10,55
April	14	15:01:00	1,501,667
May	10	7:09:00	7,015
June	21	9:04:00	906,667
July	13	8:41:00	868,333
August	8	4:58:00	496,667
September	7	1:33:00	01,55
Oktober	13	4:45:00	4,075
November	21	9:23:00	938,333
Desember	19	5:11:00	518,333

Table 4. Calculation of air duct failure rate index of each section

Section	Average disturbance (times/year)	Channel length (Km)	λ (Km)	R (hours)	Swiching time (hours)
1	1,750	25,124	0,06965	1,527	0,15
2	1,750	39,876	0,04388	1,527	0,15
3	1,750	26,897	0,06506	1,527	0,15
4	1,750	91,734	0,01907	1,527	0,15
5	1,750	60,996	0,02869	1,527	0,15
6	1,750	29,533	0,05925	1,527	0,15
7	1,750	55,317	0,03163	1,527	0,15
8	1,750	31,379	0,05576	1,527	0,15
9	1,750	27,497	0,06343	1,527	0,15
10	1,750	30,153	0,05803	1,527	0,15

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Table 5. Average distribution equipment fault data

No	Distribution Equipment	Number of failures (Times/year)
1	LBS	31
2	Trafo	4
3	Fuse cut out	-
4	CB	-

Table 6. Distribution equipment failure index data

No	Distribution Equipment	Number of failures (Times/year)
1	LBS	0,65957
2	Trafo	0,011834
3	Fuse cut out	-
4	CB	-

Table 7. Reliability index of the analyzed distribution network

No. Section	System reliability index	
	SAIFI	SAIDI
1	3,204998	1,712106
2	2,684976	1,474296
3	2,806029	2,308729
4	3,465778	3,837799
5	2,491852	2,274859
6	2,533363	2,592481
7	3,147797	2,195167
8	2,632703	1,248680
9	2,977400	1,697072
10	2,716206	1,571743
Total	**28,725189**	**21,125363**

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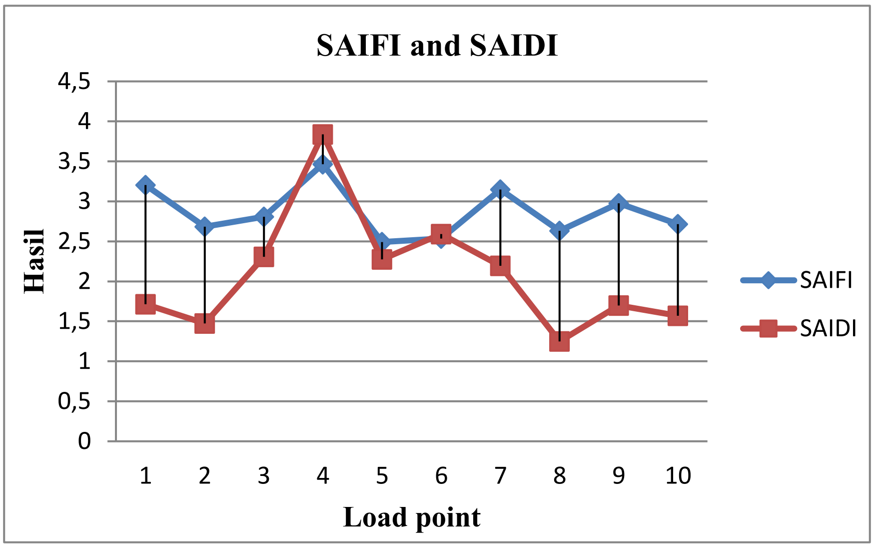

Figure 1. Comparison chart of SAIFI and SAIDI for each section.