JURNAL RISET REKAYASA ELEKTRO
Vol.6, No.2, Juni 2024, Hal. 121 ~ 132
P-ISSN: 2685 - 4341 E-ISSN: 2685 - 5313

Analysis of The Reliability Index of The Platuk Feeder Distribution System at PT. PLN ULP Kenjeran with Section Technique Method

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Article Information:
Dikirim, 3 Juli 2024
Diterima, 6 Desember 2024
Diterbitkan, 20 Desember 2024

Keywords:
CAIDI
Reliability
SAIDI
SAIFI
Section Technique Method

ABSTRACT
A high success rate is required to ensure the continuity of the supply of electricity, so that the distribution of electricity can maintain its availability continuously and have a reliable reliability value. Therefore, this study is intended to help evaluate the reliability of electric power distribution in plate feeders at PT. PLN ULP Kenjeran. The effect of failure on the system caused by equipment failure, as well as its impact on the load point will be evaluated using the section technique method. The results of the calculation show that the value of SAIFI is 2,699 times/year, SAIDI is 5.128 hours/year, and CAIDI is 1.9 hours/disturbance. Based on SPLN No. 68-2: 1986 concerning the reliability index, the value of SAIFI is 3.2 times/year, SAIDI is 21 hours/year, and CAIDI is 6.56 hours/disturbance, where the reliability index value can be categorized in accordance with SPLN standards and is considered reliable. Meanwhile, in the comparison of calculations between the section method and the method without sections, the reliability results were worse. Where the SAIFI value was 3.21112 times/disturbance (up 15.93%), the SAIDI value was 12.4056 hours/year (up 58.65%), and the CAIDI value was 3.9 hours/interruption (up 51.12%). Efforts to improve reliability by improving preventive maintenance and adding switching equipment such as LBS.

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1. INTRODUCTION

With the development of the modern world, the need for electrical energy consumption is increasingly high. Therefore, with the increasing need for electricity, reliable quality and quantity of electricity supply is needed. In terms of quantity, electricity supply must be available in adequate quantities and in terms of quality, electricity supply must have high reliability in distributing energy to customers [1][2][3]. A high success rate is needed to ensure continuity of electricity supply. This is done to ensure that electric power distribution remains available and has good reliability values [4]. The electricity distribution system to customers is divided into two, including the 20 kV medium voltage network or called primary distribution and the 380/220 Volt low voltage network or called secondary distribution. Distribution network configurations generally operate radially or in loops [5]. The system's ability to distribute electrical energy efficiently under various conditions and within a certain period of time is known as distribution system reliability. The success rate of system operations over a certain period of time can be used to determine the level of reliability of the distribution network. This can be analyzed by comparing it with previously established standards.

Disruptions in the 20 kV medium-voltage distribution network are common and significantly affect users. Recent data shows that these disruptions can be caused by several factors such as short circuits, overloads, and external disturbances like lightning or tree contact with power lines. The 20 kV distribution network, which primarily uses overhead lines, experiences disturbances up to 100 times per 100 km annually, especially in urban areas where tall buildings and trees often come into contact with power lines. In rural areas, lightning strikes are a frequent cause of disruptions. If left unresolved, these issues can damage equipment and result in power outages affecting customers. The impact on users is often measured using SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index), which track the duration and frequency of outages. Frequent and prolonged outages reduce system reliability, causing inconvenience to consumers and affecting business productivity that relies on stable electricity supply [x].

The SAIFI, SAIDI, and CAIDI reliability indices must be in accordance with the PLN Standart (SPLN) to determine the level of reliability of the electricity distribution system [6]. Failure is a condition that deviates from normal conditions. Disturbances occur due to failure of equipment or components to work according to their function [7]. Although interference cannot be completely eliminated, the possibility of interference can be reduced. The presence of additional load disturbances, additional voltage disturbances, and short circuit disturbances are factors that often cause problems in distribution systems [8]. A network system must be divided into small parts, namely sections and lines. To evaluate the calculation method using the section technique method. In using the section method, evaluation of the reliability index for electric power distribution is carried out by analyzing the impact of equipment failure on the system and looking at its impact on load points [9]. The higher the level of reliability in the electricity distribution system indicates the higher the success in maintaining the electricity supply to customers. In previous research, Samsurizal [10], Noufanda [11], and Said [12] discussed the reliability of distribution systems using various methods, where especially in research using the section technique method, better reliability results were obtained due to dividing the feeder into several sections. and the line is based on the LBS so that the analysis results obtained are more detailed where the failure of each section will be separated by the LBS as a switching device so that the disturbance that occurs will not affect other sections. However, in this research it is still not explained how LBS switching works using the section method and can affect the reliability results and there has been no comparison with calculations between the section and no section methods to see what percentage of differences in reliability results there are. Moreover, the absence of detailed calculations between the section and no section methods leaves a gap in understanding their comparative effectiveness.

Previously, Hanif [13] evaluated the reliability of a 20 kV distribution system by comparing systems with sectional partitioning and those without (non-section). The results showed that the use of sectionalizing (the section method) significantly reduced the values of SAIDI and SAIFI. In the case study conducted, SAIDI decreased by 20-30% compared to the non-sectioned system. Furthermore, sectionalizing allows for the isolation of areas experiencing disturbances without affecting the entire network, thereby improving operational stability and efficiency. Sihombing [14] also researched sectionalizing and reconfiguration strategies in distribution systems to enhance reliability. Simulation results indicated that sectionalizing could reduce outage duration, with SAIDI dropping by up to 35% compared to systems without sections. Additionally, the average frequency of outages per customer also decreased by 15-20%. System reconfiguration with optimal placement of protective devices such as reclosers and fuses in each section is more effective in reducing reliability indices compared to non-section methods. Koba [15] conducted a comparative analysis between sectioned distribution systems and non-sectioned systems. The results showed that sectioned systems yielded a significant improvement in reliability. SAIDI in sectioned systems decreased by up to 30-40%, and SAIFI dropped by 25% compared to non-sectioned systems. Sectioned systems also enable faster responses in terms of disturbance detection and isolation, which directly improves the availability of electricity services.

Research related to the reliability analysis of electric distribution systems has rapidly developed, with various methods applied to enhance efficiency and minimize disruptions in the system. One commonly used method is the Section Technique, which has proven effective in identifying critical points in electric distribution systems. However, most previous studies have focused on general case studies or extensive distribution systems without giving specific attention to particular feeders in specific areas. Additionally, the application of this method rarely considers the unique operational and local environmental characteristics. On the other hand, historical reliability data is often not optimally utilized to develop more precise and locally relevant reliability improvement strategies. In the context of PT. PLN ULP Kenjeran, in-depth reliability analysis of the Platuk Feeder, which is one of the essential feeders in the area, remains limited. Therefore, there is a significant gap in research specifically examining the reliability of electric distribution feeders at this location using tailored methods.

This research offers a novel contribution by applying the Section Technique method specifically to the Platuk Feeder at PT. PLN ULP Kenjeran, providing a more in-depth reliability analysis focused on that feeder. Additionally, this study will consider the unique operational and environmental conditions of the area, thereby offering a more specific and relevant perspective for the Kenjeran region. Another novelty is the use of historical reliability data in greater detail, which has not been extensively applied in previous studies in this area, to predict system failures and formulate more accurate reliability improvement strategies. This research also offers an analysis that connects system reliability with economic impacts, thus not only generating technical solutions but also providing economic benefits for electricity distribution operations at PT. PLN ULP Kenjeran.This can be a recommendation in calculating a better reliability index in an effort to increase reliability. One of the feeders at PT. PLN ULP Kenjeran, which receives supplies from GI Kenjeran, is the Platuk feeder. The Platuk feeder is a feeder with the most diverse consumer loads, including industrial, home, public and commercial. Therefore, this research is intended to be able to produce calculations of the SAIFI, SAIDI, and CAIDI reliability indices using the section method and then the results will be compared with PLN Standards (SPLN) and also calculations without sections so that conclusions can be drawn in evaluating the effects of failure modes and response time on equipment so that it can increase feeder reliability.

2. RESEARCH METHODS

In this research activity, the course of the activity refers to planning in collecting, processing and analyzing data in a study. Survey and data collection at PT. PLN ULP Kenjeran, in 2024 starting from January to March. This research is intended to assist in analyzing the reliability index for the distribution of Platuk feeder power at PT. PLN ULP Kenjeran. It is hoped that this research will be able to help become a reference in efforts to increase the reliability of electricity distribution. he findings from this study will provide valuable insights into the current performance of the Platuk feeder. By identifying areas of improvement, PT. PLN ULP Kenjeran can implement targeted strategies to enhance service quality. Moreover, the research outcomes will contribute to the development of best practices in the management of electrical distribution systems.

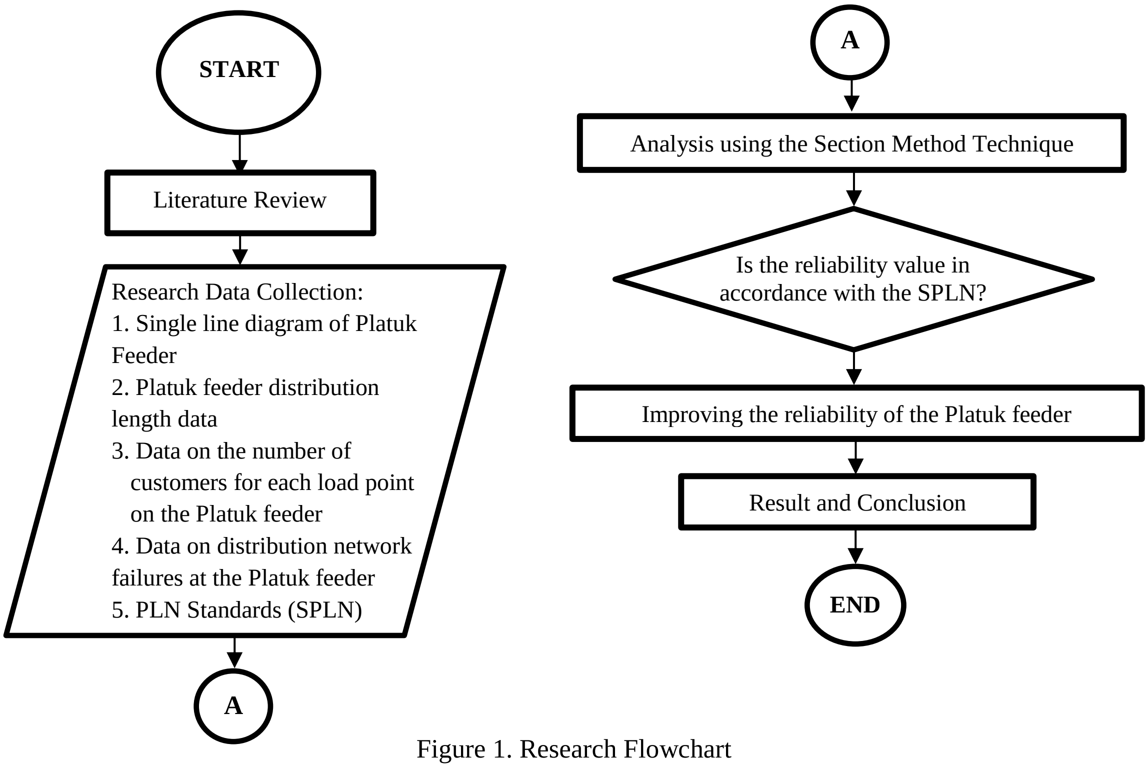

Figure 1. Research Flowchart

Figure 1 explains the course of the research mechanism, starting with a literature study by looking for references regarding the reliability of the distribution system and how the section technique method works. The data required from this research includes a diagram of one line of the Platuk feeder, customer data on the distribution transformer of the Platuk feeder, data on the length of the Platuk feeder line, data on disturbances in 2023, as well as network equipment parameters in accordance with the SPLN. Next, divide the one feeder line diagram into several sections and lines based on the LBS to carry out data analysis using the section technique method. And. Then carry out analysis and calculation of reliability values including SAIFI, SAIDI and CAIDI. After that, the reliability value obtained from the calculation is compared with the PLN Standard (SPLN) and will also be compared with the sectionless method calculation to obtain conclusions in order to increase feeder reliability.

2.1. Required Research Data

The following is data collected and identified from Platuk feeders at PT. PLN ULP Kenjeran:

1. Single line diagram of Platuk feeder
2. Total customers per distribution transformer
3. Length of Platuk feeder line
4. Recap of feeder failures in 2023
5. Parameter data for each network equipment according to PLN Standart (SPLN)

This data is needed in calculating failure rates to obtain reliability index values for the electricity distribution system in the form of SAIFI, SAIDI, and CAIDI.

2.2. Section Technique Method

At this stage, to determine the reliability index using the section technique method, calculations are needed to find the failure rate in the form of disturbance frequency and failure duration to obtain the reliability index value for the electricity distribution system in the form of SAIFI, SAIDI, and CAIDI. A cutting method known as Section Technique is used to assess the reliability index of electrical power distribution by looking at the impact of failures on the system caused by equipment failure and how it impacts the load points. The parameters calculated are the parameters λ and U at each load point in the distribution network [16]. The advantage of using this method is that by cutting the feeder network into small parts limited by load break switches (LBS), it will make it easier to analyze which areas of the network need repair, this will make it easier to calculate the reliability index because with simple analysis it can minimize errors. and the time needed is shorter [17].

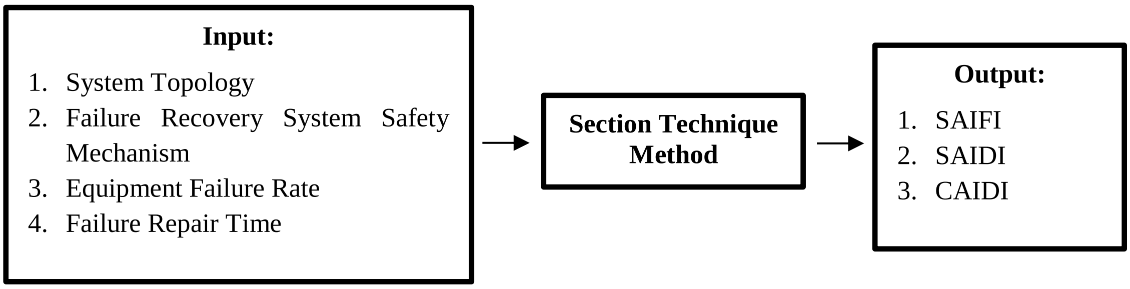

Figure 2. Section Technique Methods Diagram

2.3. Failure Rate (λ)

Failure rate is the number of failure values that occur within a certain time period. The failure frequency is represented by the symbol (λ) which shows the failure rate calculated in units of failure in 1 year. The failure value is addressed to the following equation:

$$\lambda = \frac{Total\ Failure}{Total\ Operating\ Time} \quad (1)$$

When calculating using this section method, the failure value is obtained by adding up the equipment failures at each load point on the network in the system with the response time. The following is the formula for finding the failure rate which is divided into 2 variables:

2.3.1. Failure Frequency

Failure frequency is the sum of the failure rates of all equipment in the distribution network that affects the load point.

$$\lambda\ LP = \sum_i \times \lambda\ i \quad (2)$$

Where,

λ i = failure rate of each equipment i

i = All equipment affected by loadpoint

2.3.2. Failure Duration

Failure duration is the number of results multiplied by the failure rate (λ) and repair time (r) on each piece of equipment that affects the load point.

$$U\ LP = \sum_i \lambda i\ \times ri \quad (3)$$

Where,

λi = failure rate of equipment (λ)i

ri = Respon Time of equipment i (Repair time / Switching time)

i = All equipment affected by loadpoint

2.4. Reliability Index Calculation

Overall, system reliability can be calculated and assessed based on the success rate of the system. Three values SAIFI, SAIDI, and CAIDI are used to evaluate the reliability value using the cutting section technique method. The reliability index formula is shown in the following equation:

2.4.1. SAIFI (System Average Interruption Frequency Index)

The SAIFI value index is obtained by adding up the average value of each customer's failures for one year. The SAIFI calculation is shown in the following equation:

$$SAIFI = \frac{Total\ Number\ of\ Outages}{Number\ of\ Customers} \quad (4)$$

$$SAIFI = \frac{\sum \lambda LP \times NLP}{\sum N} \quad (5)$$

Where,

λLP = Failure rate of *loadpoint*

NLP = Number of customers on loadpoint

N = Total customers

2.4.2. SAIDI (System Average Interruption Duration Index)

The SAIDI value index is obtained by adding up the average value of the duration of disruption from total customer failures for one year. The SAIDI calculation is shown in the following equation:

$$SAIDI = \frac{Total\ Duration\ of\ Outages}{Number\ of\ Customers} \quad (6)$$

$$SAIDI = \frac{\sum ULP \times NLP}{\sum N} \quad (7)$$

Where,

ULP = Duration of interruption per *load point* (*hours/years*)

NLP = Number of customers per *load point*

N = Total customers

2.4.3. CAIDI (Customer Average Interruption Duration Index)

The CAIDI value index is obtained by summing the average annual disturbances of consumers. The CAIDI formula is shown in the following equation:

$$CAIDI = \frac{\text{Customer Outages Duration}}{Total\ Number\ of\ Customer\ Disruptions} \quad (8)$$

$$CAIDI = \frac{SAIDI}{SAIFI}\ (Customer\ Usage\ Hours \times \text{Total Failures}) \quad (9)$$

3. RESULT DAN ANALYSIS

In this research, the reliability index will be calculated using the section technique method which will then be compared with the SPLN standard and the results of calculations without sections and provide suggestions for efforts to increase reliability.

3.1. Feeder Data Analysis using the Section Technique Method

This research will analyze using the section technique method to obtain the reliability index values for SAIFI, SAIDI, and CAIDI. The first step is to divide the platuk structure into four parts with 83 lines. The division of the 4 platuk feeder sections is based on the placement of the Load Break Switch (LBS). The calculation and analysis mechanism of this method uses failure modes in distribution network equipment such as CB, LBS, Transformer, and SUTM. Failure modes impact the load point, resulting in failure mode results for each part against the load point. The calculation results obtained will be used to calculate the total value of the failure rate and duration of the disturbance. Then, these results will be used to calculate the feeder reliability index value. However, the mechanism says that if an equipment failure occurs in one of the feeder sections, the switches will work together to open the switching, stopping the system temporarily. After 0.15 hours, the feeder will supply power again to the undisturbed part through a load transfer process with another nearby feeder or through the feeder itself.

3.2. Calculation Analysis Using the Section Technique Method

The type of network equipment, equipment failurate, overhead line length, and number of customers at each load point are needed to perform reliability analysis. The failure rate value (λ LP) for each load point is obtained by multiplying the failure rate of the equipment affected by the failure by the length of the line. These results are then summed to obtain the total failure rate of the equipment failure rates affecting that load point. In accordance with the formula in equation (2). For example, the failure rate for line 1 is obtained by:

$$\begin{aligned}\lambda\ (line\ 1)\ &= failure\ rate\ \text{equipment}\ \times \text{length of feeder line}\\ &=\ 0.2 \times 0.5\\ &= 0.1\ \text{failure/year}\end{aligned}$$

To calculate the value of equipment disruption duration (U LP), the value of each load point is obtained by multiplying the failure rate of the equipment being disrupted by the repair or transition time (where the equipment undergoes repair or only transitions during the disruption condition). These results are then added up to produce the total duration of equipment disruption affected by the loadpoint as in equation (3). For example, for LP 1 on line 1, it is obtained by:

$$\begin{aligned}U\ (line\ 1)\ &= failure\ rate\ \text{equipment}\ (\lambda\ ) \times repair\ time\ (ri)\\ &=\ 0.1\ x\ 3\\ &=\ 0.3\ hour/year\end{aligned}$$

It can be seen in Table 1 to Table 8 showing the results of the analysis of failure modes, failure rates and duration of disruption for each component of the Platuk feeder. The analysis highlights the most critical components that contribute to the overall failure rate. Based on the data presented, the transformer and circuit breaker appear to have the highest failure modes. These components also have the longest disruption durations, significantly impacting the reliability of the feeder. By addressing these key areas, improvements in feeder performance and system reliability can be achieved. Preventive maintenance and timely replacement of these components are crucial to reducing overall system downtime. Furthermore, advanced monitoring systems can help detect early signs of failure, enabling faster response times. Implementing these strategies will lead to a more efficient and reliable power distribution network. Additionally, training personnel to recognize and address potential issues can further enhance system reliability. Regular assessments of maintenance protocols can identify gaps and ensure that all components function optimally. Overall, a proactive approach to maintenance will not only minimize disruptions but also extend the lifespan of critical equipment.

a. Analysis Section 1

Table 1. Equipment Failure Index Section 1

Equipment Data		Impact System	
Number	Equipment	LP Repair Time	LP Transition Time
1	PMT	LP 1-LP20	-
2	LBS Pogot Lama	LP 1-LP20	-
3	LBS Pogot Seleb	LP 1-LP20	LP21-LP76
4-23	Transformer 1-20	LP 1-LP20	-
24-44	Line 1-22	LP 1-LP20	-

Table 2. Failure Rate (λ) and Duration of Failure (U) on LP Section 1

Loadpoint	Reliability Index on Loadpoint	
	λ (failure/year)	U (hour/year)
LP 1 – LP20	1.12	34
LP21 – LP76	1.11	3.39

b. Analysis Section 2

Table 3. Equipment Failure Index Section 2

Equipment Data		Impact System	
Number	Equipment	LP Repair Time	LP Transition Time
1	LBS Pogot Seleb	LP21-LP32	LP33-LP76
2	LBS Donomulyo	LP21-LP32	LP33-LP76
3	LBS Randu	LP21-LP32	LP33-LP76
4	LBS Sikar	LP21-LP32	LP33-LP76
5–16	Transformer 21–32	LP21-LP32	-
17–31	Line 23–37	LP21-LP32	LP1-LP20 dan LP 33-LP76

Table 4. Failure Rate (λ) and Duration of Failure (U) on LP Section 2

Loadpoint	Reliability Index on Loadpoint	
	λ (failure/year)	U (hour/year)
LP21 – LP32	0.437	1.46
LP1 – LP20 and LP33 – LP76	0.432	0.0648

c. Analysis Section 3

Table 5. Equipment Failure Index Section 3

Equipment Data		Impact System	
Number	Equipment	LP Repair Time	LP Transition Time
1	LBS Donomulyo	LP33-LP41	LP1-LP32
2	LBS X Kedinding	LP33-LP41	LP1-LP32
3–11	Trafo 33-41	LP33-LP41	-
12–21	Line 38-47	LP33-LP41	LP1-LP32 dan LP42-LP76

Table 6. Failure Rate (λ) and Duration of Failure (U) on LP Section 3

Loadpoint	Reliability Value on Loadpoint	
	λ (failure/year)	U (hour/year)
LP33 – LP41	0.321	1.04
LP1 – LP32 and LP42 – LP76	0.316	0.0474

d. Analysis Section 4

Table 7. Equipment Failure Index Section 4

Equipment Data		System Impact	
Number	Equipment	LP Repair Time	LP Transition Time
1	LBS Randu	LP42-LP76	LP1-LP41
2	LBS Platuk	LP42-LP76	LP1-LP41
3–37	Transformer 42-76	LP42-LP76	-
38–73	Line 48-83	LP42-LP76	LP1-LP41

Table 8. Failure Rate (λ) and Duration of Failure (U) on LP Section 4

Loadpoint	Reliability Value on Loadpoint	
	λ (failure/year)	U (hour/year)
LP42 – LP76	0.8492	2.6336
LP1 – LP41	0.8472	0.12708

From the tables, the failure mode, failure frequency and duration of interruption in each feeder section, the SAIFI and SAIDI values, can be seen by calculating load point 1 in section 1. The SAIFI Load point 1 calculation is carried out using the formula in equation (5) by multiplying the number of consumers (N LP1) by (λ LP1), then the results obtained are divided by the total number of consumers in the Platuk feeder system. Meanwhile, the SAIDI Load point 1 calculation is carried out using the formula in equation (7) by multiplying the number of consumers (N LP1) by (U LP1), then the results obtained are divided by the total number of consumers in the Platuk feeder system. The following is an example of the calculation results on LP 1:

$$\text{SAIFI LP1} = \frac{\lambda \text{ x N LP1}}{\text{N total}} = \frac{1.12 \text{ x } 541}{14852} = 0.0407972 \text{ time/year}$$

$$\text{SAIDI LP1} = \frac{\text{U LP1 x N LP1}}{\text{N total}} = \frac{3.4 \text{ x } 541}{14852} = 0.12384864 \text{ hour/year}$$

The same formula is used to calculate LP2 through LP76. The total value of SAIFI and SAIDI obtained from section 1 is 1.11264409 times/year and 3.39440951 hours/year. By collecting reliability indices from the 4 sections of the Platuk feeder, the SAIFI and SAIDI values can be added up. The total value of the reliability index from section 1 to section 4 is shown in the following Table 9. This aggregation provides a comprehensive overview of the feeder's reliability performance. The SAIFI (System Average Interruption Frequency Index) reflects the average number of interruptions experienced by customers, while the SAIDI (System Average Interruption Duration Index) indicates the average duration of these interruptions. By analyzing these combined values, stakeholders can better understand the overall service quality of the Platuk feeder.
The following Table 9 illustrates these key reliability indices and highlights areas for potential improvement.

Table 9. Accumulated Reliability Value for each Section

SECTION	SAIFI	SAIDI
1	1.112	3.39
2	0.42264	0.243474
3	0.316667	0.179796
4	0.848148	1.315534
Result	2.699455	5.128804

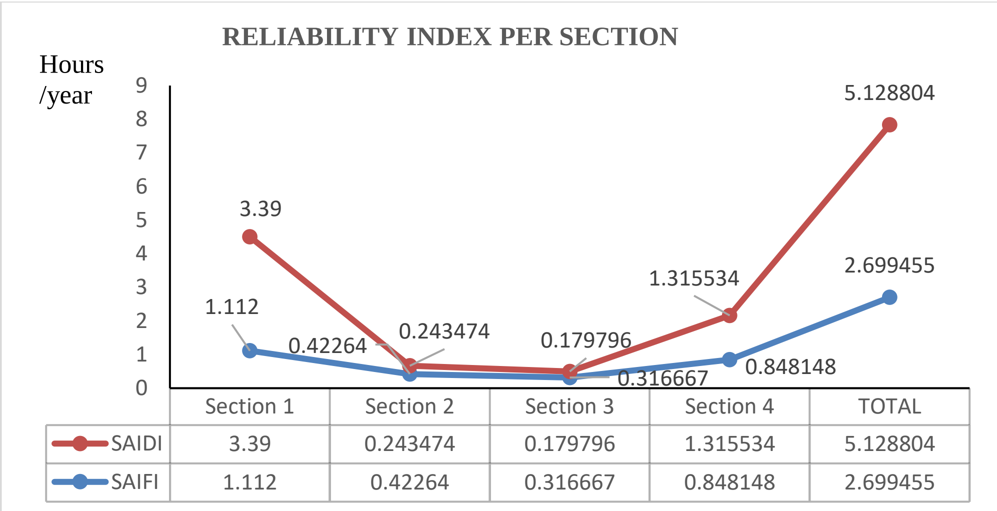

Figure 3. Reliability Index per Section

Based on Figure 3, the SAIFI and SAIDI values that experienced a spike were found in section 1, this is because this section has the longest channel compared to other sections so it is more susceptible to interference, besides that, the position at the base of the feeder makes section 1 the the most crucial because if there is a disturbance in section 1 it will affect the condition of all feeders while the other sections tend to have values that tend to be constant. This persection calculation produces a total SAIFI value of 2.699455 times/year and a SAIDI value of 5.128804 hours/year. The CAIDI value of 1.9 hours/disruption is obtained from calculating the division between the SAIDI value and the SAIFI value.

3.3. Comparison of Reliability Index Values for the Section Technique Method with SPLN 68-2:1986

It can be seen that the results of calculating the SAIFI, SAIDI, and CAIDI values using the section technique method are then compared with SPLN No. 68-2:1986, where the SAIFI value is 2.699455 times/year, the SAIDI value is 5.128804 hours/year, and the CAIDI value is 1.9 hours/disturbance which meets the SPLN standards so that the platuk feeder is in the reliable category.

Table 10. Comparison of Calculations with PLN Standart (SPLN)

Reliability Index	Section Technique Method	SPLN 68-2 : 1986	Result
SAIFI	2.699455 time/year	3.2 time/year	**Standar Compliant**
SAIDI	5.128804 hour/year	21 hour/year	**Standar Compliant**
CAIDI	1.9 hour/failure	6.56 hour/failure	**Standar Compliant**

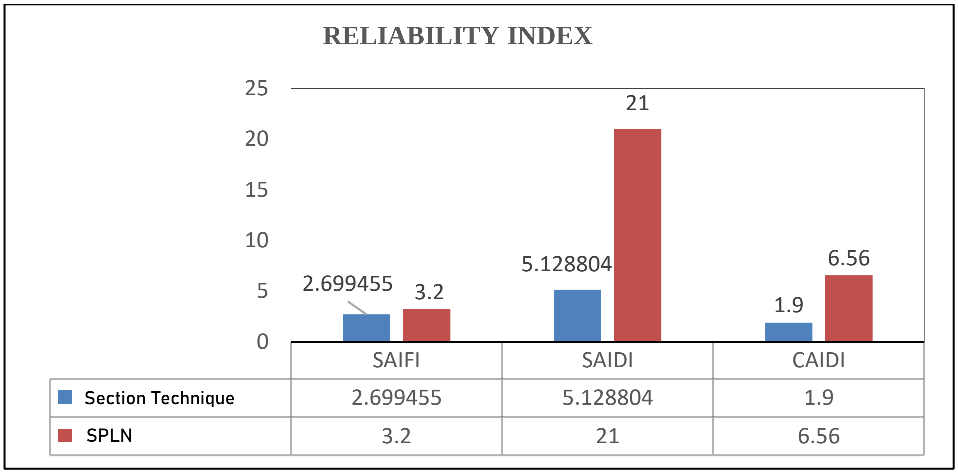

Figure 4. Comparison Calculation with SPLN

3.4. Comparison of Reliability Index Values for Section Techique and Without Section Technique

In calculations without sections on the trigger feeder, the failure mode, failure rate and failure duration are as follows:

Table 11. Feeder Equipment Failure Index

Equipment Data		Impact System	
Number	Equipment	LP Repair Time	LP Transition Time
1	PMT 1	LP1-LP76	-
2-5	LBS 1–4	LP1-LP76	-
6-81	Transformer 1–76	LP1-LP76	-
82-164	Line 1–83	LP1-LP76	-

Table 12. Failure Rate (λ) and Duration of Failure (U) on Feeder Loadpoint

Loadpoint	Reliability Value	
	λ (failure/year)	U (hour/year)
LP1 – LP76	3.2112	12.4056

Table 13. Comparison of Reliability Value Calculation Results for Section Technique and Without Section

Index	With Section Technique	Without Section Technique	Result
SAIFI	2.699455 time/year	3.21112 time/year	0,511665 (15,93%)
SAIDI	5.128804 hour/year	12.4056 hour/year	7,276796 (58,65%)
CAIDI	1.9 hour/failure	3.9 hour/failure	2 (51,12%)

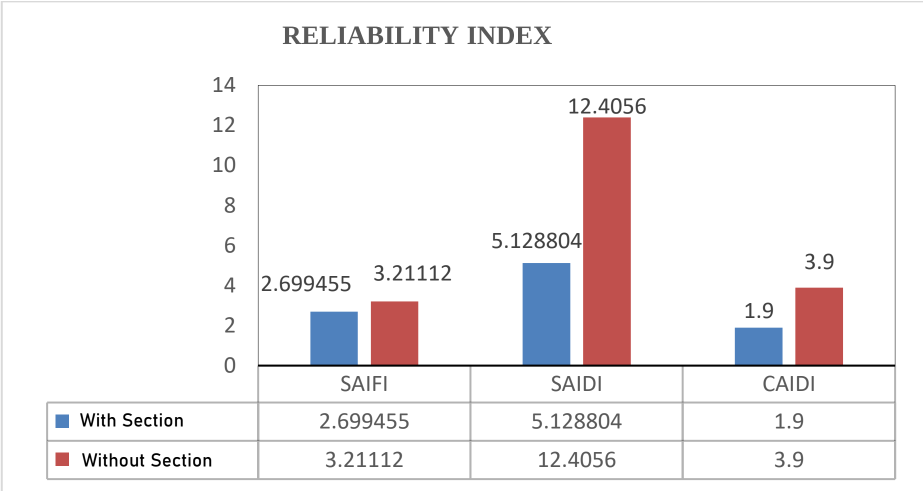

Figure 5. Comparison Diagram for Calculation of Sections and Without Sections

From Table 13, the SAIFI and SAIDI values can be calculated using the method without sections. The CAIDI value is obtained by dividing the SAIDI value by SAIFI. Then the results can be compared in the calculation between the section technique method and the method without sections. The results of the comparison of calculations between the section technique and without the section technique showed that the reliability value was getting worse. This can be seen where in the section technique method the SAIFI value calculation was obtained from 2.699455 times/year, increasing by 15.93% to 3.21112 times/year using the method without sections, and in the SAIDI value using the section technique method, it was found to be 5.128804 hours/year, increasing by 58.65 % becomes 12,4056 hours/year with the method without sections, so that the CAIDI value using the section technique method is found to be 1.9 hours/interference, an increase of 51.12% to 3.9 hours/interference with the method without sections. This proves that the results of the reliability evaluation using the section technique obtained better reliability results than without sections.

The difference in calculating reliability values when using the Section Technique method and without Sections lies in the way the distribution network is divided into several parts to make it easier to analyze. By dividing the network into several small sections based on LBS, dividing the network sections into several lines using the Section Technique method, this makes it possible to find out more quickly which areas of the network need maintenance. Meanwhile, without using the Section Technique method, the reliability index calculation is carried out directly on the distribution system as a single unit, without dividing the network into smaller parts. So, from the results of the calculation data with sections and without sections, it can be concluded that by using a section technique where failures can be analyzed in small sections to find out the location of the failure position so that repairs can be prioritized, so that the system will be able to experience more optimal switching times with the help of LBS, so that by implementing equipment switching, the effect of a disturbance can minimize the blackout area so that sections that are not disturbed do not need to experience repair time. This can reduce the number of failure frequencies and failure duration to reduce the SAIFI, SAIDI, and CAIDI.

In this research, the analysis of the reliability index of the Platuk Feeder distribution system at PT. PLN ULP Kenjeran using the section technique method provides in-depth insights into the system's performance. The results obtained show a significant difference between the SAIFI and SAIDI indices when compared to conventional methods that do not consider section divisions. The use of the section technique method allows for more accurate identification of the frequency and duration of outages in each section, reflecting the variability of performance across different segments of the network. These findings highlight that some sections have higher reliability levels, while others indicate potential areas for necessary improvements. Thus, the application of the section technique not only enhances accuracy in reliability measurement but also provides a solid foundation for decision-making related to maintenance and improvement of distribution infrastructure. This analysis is expected to contribute to the development of more effective disruption management strategies to enhance the reliability of electricity supply for customers in the Kenjeran area.

3.5. Analysis of Efforts to Improve Feeder Reliability

Determining the reliability index on feeders in the electricity distribution network can be done using two main approaches, namely the section method and without the section method. The section method involves dividing the feeder into several segments or sections. Reliability is calculated for each segment based on fault data and recovery time. For example, a feeder can be divided into segments such as transformer, main line, and branch line, and the overall reliability is calculated by multiplying the reliability of each segment if they are considered connected in series. This method helps identify the segments most vulnerable to disruption and allows more specific improvements. On the other hand, determining the reliability index without the section method does not involve dividing the feeder into smaller segments. Instead, reliability is calculated overall for the feeder using several indices such as SAIDI (System Average Interruption Duration Index), which measures the average duration of interruptions per customer in one year, and SAIFI (System Average Interruption Frequency Index), which measures the average Frequency of interruptions per customer in one year [18],[19].

In addition, MTBF (Mean Time Between Failures) is used to measure the average time between two consecutive failures on a feeder, while MTTR (Mean Time to Repair) measures the average time required to repair a feeder after a failure occurs. This approach provides a general overview of feeder reliability performance without requiring segmentation, making it easier to apply on a wider scale. Both methods are important for the management and maintenance of electricity distribution networks, with the choice of method depending on the analysis objectives and data availability. Reducing fault frequency and fault time are two ways to increase trigger feeder reliability [20],[21]. Reducing the frequency of disturbances can be done by increasing preventive maintenance and using LBS or fuses to minimize fault areas. As a result, the smaller the λ value, the failure will decrease and the frequency of failure will also decrease. In addition, LBS can reduce the time to failure of equipment repairs. Where the failure rate decreases, the frequency of failure will also decrease. Meanwhile, duration can reduce repair time for equipment that has failed by adding LBS. When a disturbance occurs in a certain section so that it is necessary to disconnect the electricity network in that section, the disturbance can only occur in the section experiencing the disturbance so that the disturbance will not spread to other sections. With LBS operating, it carries out switching so that other sections will only experience switching times and the blackout area can be minimized [22]-[24].

4. CONSLUSION

The results of the evaluation of the reliability calculation of the platuk feeder at PT. PLN ULP Kenjeran using the section technique method obtained a SAIFI value of 2.699455 times/year, a SAIDI value of 5.128804 hours/year, and a CAIDI value of 1.9 hours/interference, including in the reliable and standard (SPLN) category because the SAIFI value is below 3.2 times/year, the SAIDI value is below 21 hours/year, and the CAIDI value is below 6.56 hours/interruption. The results of the evaluation carried out to obtain comparison results of the reliability index values resulting from calculations between the use of the section technique and without section methods show that the reliability values have worsened. Where the previous SAIFI value of 2.699455 times/year rose 15.93% to 3.21112 times/year, the SAIDI value of 5.128804 hours/year rose 58.65% to 12.4056 hours/year, and the CAIDI value of 1.9 hours/interference rose 51 .12% to 3.9 hours/interruption. Efforts to increase the reliability of the Platuk feeder to reduce the frequency of failures and duration of failures are by increasing routine maintenance (preventive maintenance) and adding switching equipment, such as LBS to separate sections that experience problems so that they do not impact other sections in order to minimize blackout areas so that in sections that undisturbed no need to experience repair time.

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