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Analysis of the Electric Power Distribution System Service Reliability Index at PLN Lancang Garam

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Abstract— The level of electrical energy demand in an area reflects the welfare of that community. The greater the use of electrical energy, the higher the community's standard of living, followed by the public's critical attitude towards everything that happens and influences lives, including electricity services. Generally, a network's reliability level can be seen from the size of the SAIDI and SAIFI values on the PLN (state electricity company) side. The calculation and reliability analysis results of the Lhokseumawe ULP above show that the total SAIFI index value is 2.68 times/year. The SAIFI Rayon Lhokseumawe reliability index is categorized as reliable because its value does not exceed the standard set by PLN in SPLN 68-2 of 1986, namely 3.2 times/year. The total value of the SAIDI index is 45.30 hours/year. The Lhokseumawe Rayon SAIDI reliability index is categorized as unreliable because its value exceeds the standard set by PLN in SPLN 68-2 of 1986, namely 21 hours/year. There are certainly differences in infrastructure, electrical equipment, and number of customers in 1986 compared to current years; this has a different influence on electricity reliability values such as SAIDI and SAIFI.

Keywords: Reliability index, SAIFI, SAIDI.

I. INTRODUCTION

Indonesian society is increasingly critical in responding to problems related to electricity and the enactment of Law No. 8 of 1999 concerning customer service (Firdaus et al., 2022), as well as the results of the Presidential Decree of the Republic of Indonesia No. 89 in 2002 concerning the nominal sale of electricity in 2003 (Laksono Aji & Anis Mashdurohatun, 2021). The regulation relates to the parameters of the level of service in the electric power system, especially regarding the duration and the number of disruptions, and not the task of recording kWh not being fulfilled. PT. PLN (state electricity company) is authorized to cut electricity bills made on the following month's bill (Siregar, 2018).

PLN must provide services for problems experienced by customers before making bill deductions (Ginting et al., 2020). Several indicators/indices related to service level parameters are set. The reliability indicators set are the duration of the outage or the System Average Interruption Duration Index (SAIDI), which includes data on units of hours, customers, months, and the outage duration for customers (Kornatka & Popławski, 2021; Marcelino et al., 2022; Venturini et al., 2022). The next indicator is the System Average Interruption Frequency Index (SAIFI), which includes data on units of time, customers, and years of customer interruptions (Cabral et al., 2018; Karpov & Akimov, 2018; Mihai & Helerea, 2019). The distribution system's reliability is measured by the ability to provide electricity services from the generator to the consumer (Escalera et al., 2018; Peyghami et al., 2020; Sallam & Malik, 2019; Shaukat et al., 2018). The intensity of the system disruption measures the reliability parameters, the duration of the problem that occurs, and the duration of time needed to resolve the problem (Sallam & Malik, 2019; Short, 2017).

The quality of PLN's service in distributing electricity significantly affects the smoothness of all activities in the community (Purwatiningsih et al., 2021). Electricity has become the primary source of electricity in all community activities, homes, schools, and offices (Riva et al., 2018). Therefore, it is essential to know the problems with distribution services from source to consumer. From an electrical perspective, reliability is the ability of a component to fulfill its duties under predetermined conditions and durations (Heylen et al., 2018). The reliability parameters of a distribution system can be determined by analyzing the average time of disruption experienced by customers, which is called the SAIFI-SAIDI method (Husna et al., 2018; Sihombing, 2022). This reliability measurement analysis data affects the

distribution system. If the distribution is high, it can help customers and suppliers. Indirectly affects the production and economic activities of the community (Muhtar et al., 2021; Tegar, 2019).

Based on these problems, the author is interested in conducting research at PT. PLN (Persero) ULP (customer service unit) Lancang Garam, Lhokseumawe City, regarding the 20 KV Electric Power Distribution System Service Reliability Index Based on the SAIDI and SAIFI Methods at PT. PLN (Persero) ULP Lancang Garam, Lhokseumawe City. The results of this study can be used to consider and evaluate the service reliability of the 20 kV electric power distribution system at PT. PLN (Persero) ULP Lancang Garam, Lhokseumawe City, to minimize the occurrence of high service reliability indexes in the distribution system.

ULP (Customer Service Unit) under UP3 (Customer Service Implementation Unit) helps manage customer service and electricity distribution network services closer to a smaller area scope (Rimbani et al., 2024).

Lhoksemawe City has 11 ULP Units, under UP3 Lhoksemawe, namely:

1. ULP Panton Labu
2. ULP Lhoksukon
3. ULP Geudong
4. ULP Lhokseumawe City (Lancang Garam)
5. ULP Krueng Geukuh
6. ULP Gandapura
7. ULP Matang Geulumpang Dua
8. ULP Bireuen
9. ULP Samalanga
10. ULP Takengon
11. ULP Janarata

Here, the author raises the problems in the ULP Lancang Garam, Lhoksemawe City. ULP (Customer Service Unit) under UP3 helps manage customer service and Distribution Electricity Network services closer to the scope of small areas. UP3: Customer Service Implementation Unit oriented in implementing services to customers.

This study aims to determine the value of the average blackout parameter or SAIFI (System et al.) at PT. PLN (Persero) ULP Lancang Garam, Lhokseumawe City, will be used to determine PLN's average blackout failure time parameter value or SAIDI (System et al.). PLN (Persero) ULP Lancang Garam, Lhokseumawe City. Moreover, the reliability index of the distribution network system at PLN ULP Lancang Garam, Lhokseumawe City, must be determined.

II. METHOD

In this analysis, the case study research stage is used. According to Susilo Rahardjo, a case study is a method applied to understand a problem more deeply by practicing it in an integrative and comprehensive manner (Rahardjo & Gudnanto, 2022). This step is taken to understand the problem being studied in depth. In addition to studying the problem, it also helps determine solutions to the problems faced. The hope is that the problem faced can be resolved.

In this study (Figure 1), the variables to be studied are events that have occurred. Based on the level of explanation, this study is classified as causal associative research. According to Sugiyono, associative research aims to determine the relationship between two or more variables (Sugiyono, 2021). This study aims to analyze the service reliability index of the 20 KV electric power distribution system based on the SAIDI and SAIFI methods at PT. PLN (Persero) ULP Lancang Garam, Lhoksemawe City.

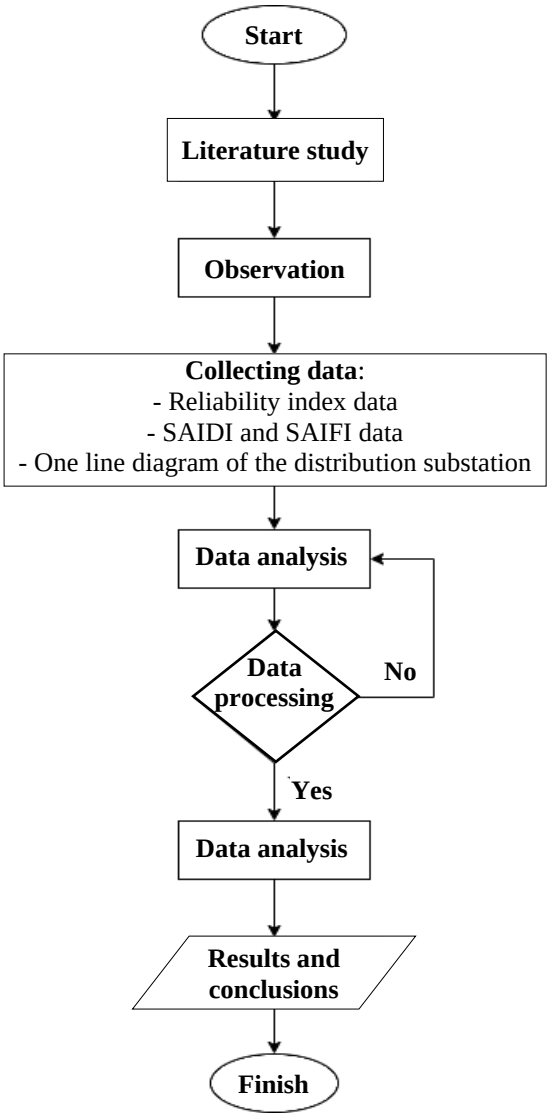

Figure 1. Research flowchart

The population is the total of all objects to be studied. Population in research is defined as a combination of several individuals who are general. Sugiyono explained that population is a combination of generalizations that include objects or subjects with their characteristics when used by analysts when studies are being studied, and conclusions are drawn (Sugiyono, 2021). Arikunto explained that the population is the total of research subjects (Arikunto, 1998). Related to the discussion above, the analysis determines this study's population, namely the total consumers who experienced power outages at ULP PT PLN Persero Lancang Garam, Lhokseumawe City. Part of a population studied is called a sample. Sugiono explained that the meaning of the sample is one of the whole and that the population possesses these characteristics (Mamahit et al., 2023; Olii et al., 2023; Rombot et al., 2022; Sugiyono, 2021).

The data collection method used in this study collects customer data at ULP PT PLN Persero Lancang Garam, Lhokseumawe City. The data taken in this study were from 6173 customers of ULP PT PLN Persero Lancang Garam Lhokseumawe.

This research was conducted in April 2022 in the ULP area of PT PLN (Persero) Lancang Garam, Lhokseumawe City. The research instrument to be taken is the customer blackout data analysis sheet and single line at PT. PLN Persero Lancang Garam, Lhokseumawe City.

In carrying out this data collection, the author took data using several methods, including:

1. Observation Method

The observation method is conducting a field review to obtain information and data regarding SAIDI and SAIFI at PLN Lancang Garam, Lhokseumawe City.

2. Data Collection

The data collection needed for the research is consumer data, disruption data, and blackout data at ULP PT PLN Persero Lancang Garam, Lhokseumawe City.

After data collection was carried out at PT. PLN Persero Lancang Garam, Lhokseumawe City, the next stage of processing the data obtained was as follows:

1. Collecting data.
2. Analyzing the data obtained by calculating based on the disruption data that occurs to customers.
3. Analyzing to determine the SAIDI and SAIFI values of PT. PLN Persero Lancang Garam Lhokseumawe based on the results of SAIDI and SAIFI calculations.
4. Determining the conclusion of the reliability index of the electric power distribution system at PT. PLN Persero Lancang Garam Lhokseumawe City is based on the results of the calculations and analysis. For more details, see the flow diagram or flowchart in Figure 2:

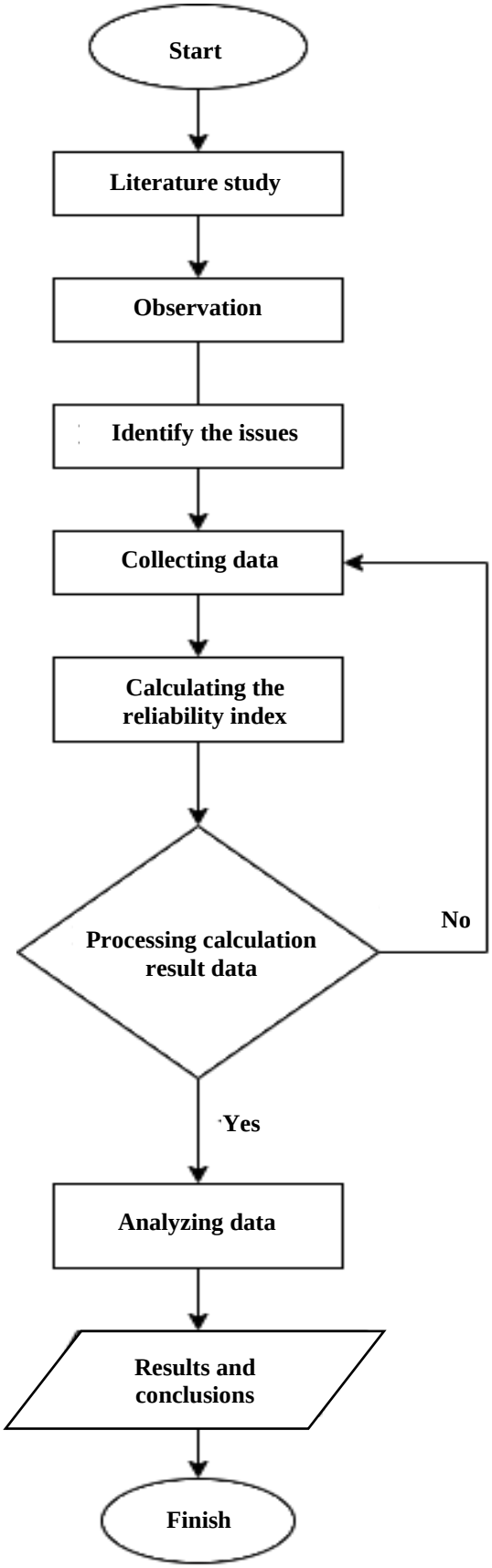

Figure 2. Flowchart of distribution system reliability study

III. RESULTS AND DISCUSSIONS

A. ULP Lhokseumawe Customer Data

The following is data on the number of customers at PT. PLN Rayon Lancang Garam, Lhokseumawe City. The total number of customers of the Lancang Garam Customer Service Unit (ULP) of Lhokseumawe City in January 2021 was 58,418 and continues to increase, customer data of the Lancang Garam Customer Service Unit (ULP) of Lhokseumawe City can be seen in Table 1.

Table 1. Lancang Garam Customer Service Unit, Lhokseumawe City

Month	Number of customers (Ni)
January	58,418
February	58,613
March	58,857
April	59,024
May	59,131
June	59,317
July	59,546
August	59,811
September	59,862
October	60,185
November	60,404
December	60,607
Total	**713,775**

Table 1 explains that every month, the number of customers at the Lancang Garam Customer Service Unit in Lhokseumawe City continues to grow; in this case, the customers referred to are the community or residents' homes, excluding customers of industrial actors, home businesses, and medium-scale industrial MSMEs (UMKM in Indonesia), with a total of 713,775 customers in December 2021.

B. Frequency of Interruptions and Duration of Interruptions

The frequency of Lancang Garam Customer Service Unit, Lhokseumawe City, experiencing outages during 2021, including the month, number of interruptions, and duration of customer outages. The frequency of outages is obtained from the number of outages at the Lancang Garam ULP, Lhokseumawe City, in one year—the frequency of interruptions and duration of outages at the PT.PLN Rayon (Customer Service Unit) Lhokseumawe City feeder can be seen in Table 2.

Table 2. Data on Disturbances of Lancang Garam ULP, Lhokseumawe City

Month	Number of Disturbances	Blackout Duration	Customer Outage
January	40	12.96	13,527
February	28	13.78	55,754
March	20	5.1	4,261
April	23	6.93	1,306
May	24	6	117
June	29	10.19	7,723
July	246	77.61	4,689
August	177	39.9	1,008
September	172	41.68	2,180
October	65	41.42	5,108
November	77	75.85	8,433
December	52	32.11	9,744
Total	**953**	**363.53**	**230,733**

Based on the results of the frequency of disruptions of PT.PLN Rayon (Customer Service Unit) Lancang Garam, Lhokseumawe City for the period of 2021, it is shown in Table 2. The table explains that every month at ULP Lancang Garam, Lhokseumawe City throughout 2021, there were 953 disruptions and the total time of the disruption was 363.53 hours.

C. Calculation of SAIFI Reliability Index

The SAIFI calculation value is obtained using the following formula (Pratama et al., 2023):

$$f = \frac{Number\ of\ customers\ experiencing\ outages}{number\ of\ customers\ in\ a\ period}$$

$$f = \frac{\wedge i}{\mathrm{Ni}}$$

Formula description:

f = Frequency of blackouts (times/year)
$\wedge i$ = Number of customers experiencing outages
Ni = Number of customers in a period

1. SAIFI ULP Lhokseumawe value in January:
$$f = \frac{13527}{58418} = 0{,}23\ times/month$$
2. SAIFI ULP Lhokseumawe value in February:
$$f = \frac{55754}{58613} = 0{,}95\ times/month$$
3. SAIFI ULP Lhokseumawe value in March:
$$f = \frac{4261}{58857} = 0{,}072\ times/month$$
4. SAIFI ULP Lhokseumawe value in April:
$$f = \frac{1306}{59024} = 0{,}022\ times/month$$
5. SAIFI ULP Lhokseumawe value in May:
$$f = \frac{117}{59131} = 0{,}0019\ times/month$$

A summary of the SAIFI index value calculation for each month in 2021 can be seen in Table 3.

Table 3. SAIFI Calculation Data

Bulan	SAIFI
January	0.23
February	0.95
March	0.072
April	0.022
May	0.0019
June	0.13
July	0.078
August	0.016
September	0.036
October	0.084
November	0.91
December	0.16
Total	**2.68**

Based on the SAIFI calculation results table above, the total number of customers who went out in a year was 713,775, and the total SAIFI index value was 2.68 times/year. Based on Table 3, the SAIFI value at ULP Lancang Garam, Lhokseumawe City, is 2.68 times/year and can be categorized as reliable because its value does not exceed the standard set by PLN in SPLN 68-2 in 1986, which is 3.2 times/year.

D. Calculation of SAIDI Reliability Index

The SAIDI calculation value is obtained using the following formula (Pratama et al., 2023):

$$d = \frac{ti \; x \; \wedge i}{Ni}$$

Formula description:

d = Duration/length of outage failure (hours/years or months)
ti = Duration of interruption (hours)
$\wedge i$ = Number of customers experiencing outages
Ni = Number of customers served

1. SAIDI value at ULP Lhokseumawe in January:

$$d = \frac{12.96 \; x \; 13{,}527}{58{,}418} = 3 \; hours$$

2. SAIDI value at ULP Lhokseumawe in February:

$$d = \frac{13.78 \; x \; 55{,}754}{58{,}613} = 13.10 \; hours$$

3. SAIDI value at ULP Lhokseumawe in March:

$$d = \frac{5.1 \; x \; 4{,}261}{58{,}857} = 0.36 \; hours$$

4. SAIDI value at ULP Lhokseumawe in April:

$$d = \frac{6.93 \; x \; 1{,}306}{59{,}024} = 0.15 \; hours$$

5. SAIDI value at ULP Lhokseumawe in May:

$$d = \frac{6 \; x \; 117}{59{,}131} = 0.011 \; hours$$

A summary of the SAIDI index value calculation for each month in 2021 can be seen in Table 4.

Table 4. SAIDI calculations

Month	Blackout Duration (hours)	Customer Outage	SAIDI
January	12.96	13.527	3
February	13.78	55.754	13.1
March	5.1	4.261	0.36
April	6.93	1.306	0.15
May	6	117	0.011
June	10.19	7.723	1.32
July	77.61	4.689	6.1
August	39.9	1.008	0.67
September	41.68	2.180	1.51
October	41.42	5.108	3.51
November	75.85	8.433	10.58
December	32.11	9.744	5
Total	**363.53**	**230.73**	**45.30**

Based on Table 4, the SAIDI value at ULP Lancang Garam, Lhokseumawe City, is 45.30 hours/year, which can be categorized as unreliable because it exceeds the standard set by PLN in SPLN 68-2 in 1986, namely 21 hours/year.

E. Determination of the Reliability Index of PLN Lancang Garam Rayon Lhokseumawe

Based on the results of the discussion above, the total number of customers who went out in a year was 713,775, and the total SAIFI index value was 2.68 times/year. The SAIFI Rayon Lhokseumawe reliability index is categorized as reliable because its value does not exceed the standard set by PLN in SPLN 68-2 in 1986, which is 3.2 times/year.

Based on the results of the discussion above, the total duration of the disturbance was 363.53 hours, and the total value of the SAIDI index was 45.30 hours/year. Rayon Lhokseumawe's SAIDI reliability index is categorized as unreliable because its value exceeds the standard set by PLN in SPLN 68-2 in 1986, which is 21 hours/year.

SPLN 1986 is a standard set in 1986; SPLN 1986 has been used as a standard for more than 30 years. Along with its development, the SPLN 1986 is still the same as in 1986, so it is necessary to conduct further research on whether the SPLN 1986 standard is still in current conditions. The difference in infrastructure, electrical equipment, and number of customers in 1986 compared to the current years is

undoubtedly different; this has a different effect on the value of electrical reliability, such as SAIDI and SAIFI (Pratama et al., 2023).

In this study, the SAIDI and SAIFI values in 2021 were calculated and then compared with the 1986 SPLN. From the calculation, it is known that the SAIFI value of the 2021 field data was obtained at 2.68 times/year, while the SAIFI SPLN standard was 45.30 times/year, and the SAIDI value of the 2021 field data was 45.30 hours/year, while the 1986 SPLN 68-2 standard was 21 hours/year.

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IV. CONCLUSION

The total value of the SAIFI index is 2.68 times/year. The SAIFI reliability index of Lhokseumawe unit is categorized as reliable because its value does not exceed the standard set by PLN in SPLN 68-2 in 1986, which is 3.2 times/year. The total value of the SAIDI index is 45.30 hours/year. The SAIDI reliability index of Lhokseumawe unit is categorized as unreliable because its value exceeds the standard set by PLN in SPLN 68-2 in 1986, which is 21 hours/year.

The differences in infrastructure, electrical equipment, and number of customers in 1986 compared to the current years are undoubtedly different; this has a different impact on the value of electrical reliability, such as SAIDI and SAIFI.

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