EVALUATION OF REALIBILITY POWER DISTRIBUTION SYSTEM 20 kV MEDIUM VOLTAGE METHOD IN PT. PLN (PERSERO) AREA PEKALONGAN JAWA TENGAH BASED ON SAIDI AND SAIFI

This report are made as one of terms to complete S1 program in Electrical Engineering Department in Faculty of Engineering

Made by:

M. KhoyruRoziqi

D 400 134 001

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SECIENTIFIC PUBLICATION

By:

M. KHOYRU ROZIQI

D 400 134 001

Have been inspected and approved to be tested by:

Supervisor

Ir. Jatmiko M.T

NIK.622

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Made by:

M. KHOYRU ROZIQI

D 400 134 001

Has been tested of examiner
Faculty Engineering
Universitas Muhammadiyah Surakarta
On ..31.., January 2018
And declared is eligible
Examiner:

1. **Ir. Jatmiko M.T** (.....)
   (Leader Examiner)
2. **Hayim Asy'ari S.T., M.T** (.....)
   (Examiner 1)
3. **Agus Supardi S.T., M.T** (.....)
   (Examiner 2)

Vice dean

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NIK.620

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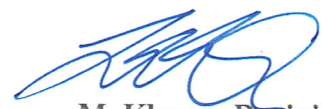

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Abstrak

Jaringan ditribusi tenaga listrik adalah jaringan antara pemakai dengan sumber daya besar (Bulk Power Source). Gangguan penyedia tenaga listrik tidak dikehendaki oleh sipapun, tetapi merupakan kenyataan yang tidak dapat dihindarkan. Oleh karena itu usaha-usaha perlu dilakukan untuk mengurangi jumlah gangguan yang terjadi. Yang dimaksud dengan gangguan dalam operasi tenaga listrik adalah kejadian yang menyebabkan bekerjanya proteksi atau relay dan menjatuhkan pemutus tenaga (PMT) diluar kehendak operator, sehingga menyebabkan putusnya alian jaringan yang melalui PMT tersebut. Pengertian pemeliharaan jaringan distribusi dilihat dari sifat dan jenis pemeliharaannya dibedakan antara pemeliharaan rutin (preventive maintenance), pemeliharaan korektif (corrective maintenance), dan pemeliharaan darurat (emergency maintenance). Keandalan sistem distribusi dalam melayani konsumen ditentukan oleh besarnya indeks keandalan terdiri dari SAIDI (System Average Interruption Duration Index) dan SAIFI (System Average Interruption Frequency Index). Menurut Gonen Toren (1986), keandalan sistem distribusi sebagai "kemungkinan perangkat atau sistem melakukan fungsi itu memadai, untuk periode waktu yang dimaksudkan, dibawah kondisi operasi dimaksudkan," dalam pengertian ini, tidak hanya kemungkinan kegagalan tetapi juga itu besarnya, durasi dan frekuensi penting. Secara fisik tidak mungkin memperoleh keandalan 100% karena kegagalan sistem yang kadang terjadi, peluang terjadinya pemadaman dapat dikurangi secara perlahan dengan menambah biaya selama masa perencanaan dan masa operasi atau keduanya.

Kata kunci: gangguan, pemeliharaan, kehandalan

Abstract

Power distribution network is a network between consumers with Bulk Power Source.. Power supply disturbance is not desired by anyone, but it is an unavoidable fact. Therefore, efforts should be made to reduce the number of occurrences that cause the work of protection or relay and dropping the power breaker (PMT) outside the will of the operator, causing the breaking of the network flow through the PMT. The maintenance of the distribution network is seen from the nature and type of maintainers distinguished between preventive maintenance corrective maintenance, and emergency maintenance. The reliability of the distribution system in serving the consumers is determined by the magnitude of the reliability index consisting of SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index). According to GonenToren (1986), the reliability of the distribution system as "the possibility of the device or system performing the function is adequate, for the intended time period, under the intended operating conditions," in this sense, not only the possibility of failure but also the magnitude, duration and frequency of importance.Physically it is impossible to obtain 100% reliability due to system failures that occasionally occur, the chances of blackouts being reduced gradually by increasing the cost during the planning and operation period or both.

Key word: *Disturbance, Maintenance, Reliability*

1. PRELIMINARY

The need for increased electrical energy should be supported by efforts to improve the quality of customers. Quality means the quality of technical services that can provide the flow of electrical energy with sufficient power and reliable.

Community welfare is an indicator of national economic growth. How PLN succeeded in improving the supply and reliability of national electricity to meet the demands of people's lives while supporting industry activities is a community challenge and a question to be answered.For that PLN as a company that manages the supply of electricity consisting of three main components, namely:

- Power plants, components that generate electricity from the central power.
- Transmission lines, which are channels that deliver electricity from the power station to service areas.
- Distribution channels, which are channels that distribute electricity to consumers, so that the energy that reaches the consumer meets the specified limits.

Some factors that determine the quality of electrical energy used is the stability of voltage, frequency, continuity of service and power factor.But from some of the above factors that are clearly felt by the customer is the continuity of electrical energy services because many complaints from customers about frequent power outages and extinguishers are long gone too long.So in this research will be discussed about the various disorders and how to reduce the disorder.To be able to serve customers well, PT.PLN has quality standards in the distribution of power district where the electric current back and forth which is distributed either one phase or three phase has a frequency of 50Hz with deviation ± 0.5 Hz,on a low voltage network having nominal 220 volt between phase with neutral and 380 volts between phase and phase, at medium and medium voltage having nominal 20 kV,both low and medium voltage have variation of allowed voltage is maximum 5% nominal and minimum 10% nominal.

Reliability of electric power is the level of performance success of a system or part of a system, to be able to provide better results over a period of time and in certain operating conditions.To be able to determine the reliability level of a system, must be examined by way of calculation and analysis of the success rate of performance or operation of the system reviewed, at a certain period and then compare it with the standards previously applied.

Reliability of electric power is to maintain continuity of electricity distribution to customers, especially large power customers that require continuity of distribution of electricity distribution absolutely.If the power is broken or not channeled will result

in the production process and large customers are disrupted.The medium voltage network structure plays an important role in determining the voltage maneuver by allocating the disturbance spot and the load can be moved through other networks.

Continuity of service which is one element of service quality depends on the type of channeling equipment and security equipment.The distribution network as a means of power supply has a continuity level depending on the arrangement of channels and how to regulate its operation.The degree of continuity of service from the channeling method is arranged according to these levels, among others:

- Level 1: possible hours; that is what is needed to find andrepairing the damaged part due to interference.
- Level 2: a few hours off; is the time it takes to send the dispatcher to the site of disturbance, localize and manipulate to temporarily turn back from another direction or channel.
- Level 3: a few minutes off; manipulation by officers who guard at substations or detection or measurement and implementation of remote manipulation.
- Level 4: a few seconds off; security or manipulation automatically
- Level 5: without outages; equipped with separate backup and full automation installations.

Generally, the out-of-town (rural) distribution network consists of a type of air duct with a radial network system having continuity level 1,while for the service in the city network arrangement used is the type of ground cable with spindle system that has continuity level 2.

Over the past few decades, distribution systems have been poorly considered in terms of reliability or reliability modeling compared to generating systems.This is because the generating system has a large investment cost and the failure of the plant can cause enormous disaster impacts for human life and environment.

Disturbances in the distribution system can be caused by natural factors, human negligence, or the age of the equipment is too long so it is not able to make the process of distribution and security.The source of the disturbance in the airway distribution system is largely due to outside influences. According to the intensity, the source of the disturbance can be divided as follows:wind and trees, lightning, rain and weather, failure or damage to equipment, people, animals, foreign objects, and so on.The occurrence of interference can cause a power outage so dissipated resulting in outages to customers. Power outages may cause losses to customers, especially large power customers.

2. RESEARCH METHOD

The first phase of this research is to find data obtained in PT.PLN (PERSERO) AREA PEKALONGAN together with the implementation of practical work activities (KP), in the form of a report on the basic data recap of the extinction and disturbance reports in February 2017. From that the author get some data included total customer are 423.035 customer.The author also made observations from various internet sources, books, scientific articles, as well as journals to gain knowledge in conducting analysis and also summed up the problem.

The reliability index which is the basis of analysis in knowing the reliability of distribution system in PT.PLN AREA PEKALONGAN is System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI).The reliability index is selected based on usability in distribution system reliability analysis.

System Average Interruption Frequency Index (SAIFI)

SAIFI is a reliability index that represents the sum of the frequency multiplication of outages and customer outages divided by the number of customers served.With this index a picture of the average failure frequency occurring in parts of the system can be evacuated so that it can be grouped according to its reliability level. The units are blackouts per customer.Mathematically can be formulated as follows:

$$SAIFI = \frac{\text{The number of times the frequency goes off and the customer goes out}}{\text{Number of customers}} \quad (1)$$

$$SAIFI = \frac{\sum \lambda i Ni}{\sum Ni} \quad (2)$$

By means of:

λi : average failure / frequency outages
Ni : amounts served at the load point i

System Average Interruption Duration Index (SAIDI)

SAIDI is a reliability index that represents the sum of the old outages and customer outages divided by the number of customers served.With this index a description of the average duration of blackout caused by interference on parts of the system can be evaluated.Mathematically can be formulated as follows:

$$SAIDI = \frac{\text{The number of hours of outages and customer outages}}{\text{Number of customers}} \quad (3)$$

$$SAIDI = \frac{\sum UiNi}{\sum Ni} \quad (4)$$

By means of:

Ui : time out of customers within a certain period

Ni : number of customers

Service Quality Level (TMP)

Determination of Service Quality Level is intended so that PLN can give an illustration of how good the quality of electricity service, how big the challenges in service improvement efforts, how urgent the funds needed to improve service quality and how far the success of PLN in improving service to its customers.Below will explain the level of service quality in PT.PLN Area Pekalongan third month.

Table 1 Quality Service Level Commitment
PT.PLN AREA PEKALONGAN

Indicator	Value	Unit
High Voltage At point Usage	146-151	kV
Medium Voltage At the point of Use	19 - 21	kV
Low Voltage At point of Use	195 - 230	V
Frequency	43,02 - 50,50	Hz
Duration of Customer Disorder (SAIDI)	20	hour/month
Number of Customer Disorders(SAIFI)	15	times/month
Speed of Service New Connections Medium Voltage	70	working days
Speed of New Connection Service at Low Voltage	60	working days
Speed of Service of Medium Voltage Power Changes	60	working days
Speed of Service Low Voltage Power Changes	15	working days
Speed Responding to Complaints	3	Hour
Error reading kWh meter	1	times/customer
Account Error Correction Time	1	Working days

*When the realization of ≥110% of the figure, the customer is compensated by 10% of the cost of the load

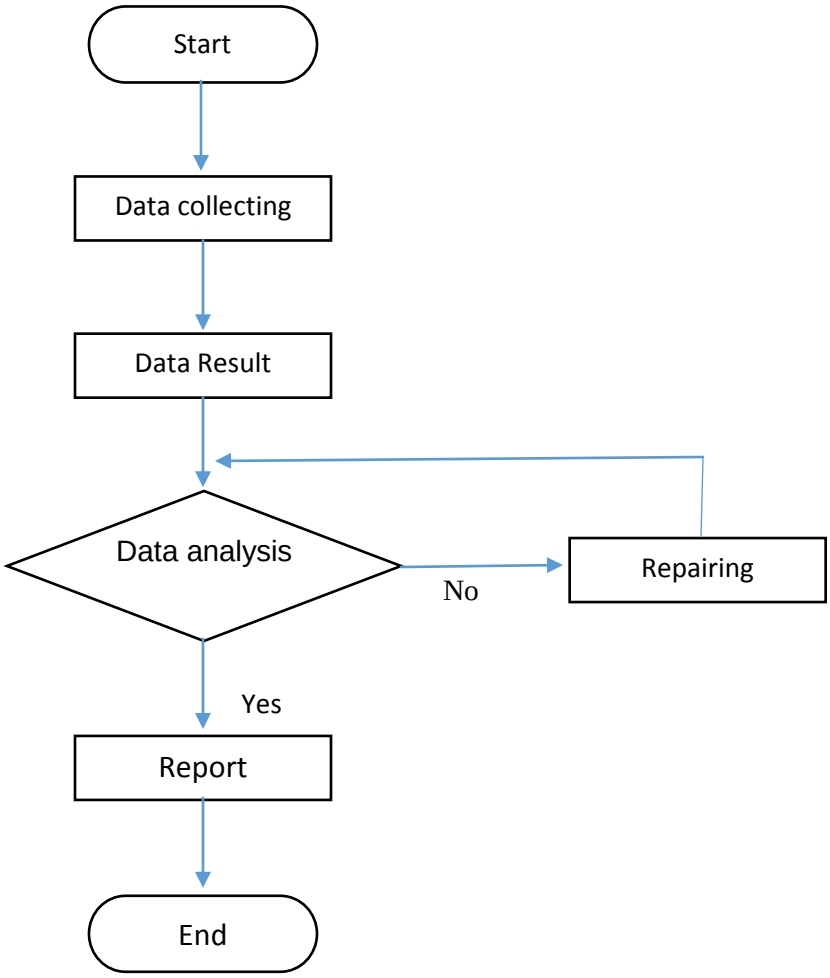

Figure 1 Flowchart of progress

3. RESULT SESSION

3.1 Number of disorders customer based on cause of extinguishing

The number of customer experiencing blackout during February 2017 reached 923,739, due to disruptions to distribution systems, transmission, substations, power sources, and by planned blackout.

Table 2.Number of Customer Disorders Based on Cause of Extinction

NO	Cause of extinguishing	Total customer disorders
1	Group of exposure of electricity and APP	106
2	Group of low voltage network	386
3	Distribution transformer group	0
4	Group of electrically low and medium voltage	0
5	Medium high voltage air channel (SUTM)	814,456
6	Medium voltage chain cables (SKTM)	0
7	Interruption of transmission and distribution	0
8	Group of power source	0
9	Natural disaster group	0
10	Group of extinction planned	108,791
Total		923,739
Average		92,374

3.2 Flammability Frequency Average Index (SAIFI) Based on Cause of extinction

To know the average frequency of outages on each customer, it is indicated by the SAIFI reliability index. The SAIFI value of each group of interruptions during February 2017 that each customer experienced 2.1837 outages / customers / month.Furthermore, SAIFI values for each group of disorders are presented in Table 4.

Example of SAIFI calculation:

Table 3 the amount of damage to the Group of exposure of electricity and APP sectors (SAIFI)

No	Cause of extinguishing	amount of damage (λi)	Customer disorder (Ni)	Hour off (Ui)
1	MCB delimiter is damaged	1	42	20.96
2	Inside customer service	1	4	4.70
3	Outside customer connection	1	8	5.13
4	Connector damage	1	29	86.06
5	other	1	23	25.07

	TOTAL (Group of exposure of electricity and APP)		106	141.92

In the basic disorder data it has been explained that damages in the group of exposure of electricity and APP reach 106 customers.In the SAIFI calculation example (table 3) we have described the types of disturbances (λi) and number of subscribers experiencing outages (Ni).

Ni (total customer): 423.035
$\sum \boldsymbol{\lambda}$iNi: 106

$$SAIFI = \frac{\sum \boldsymbol{\lambda} iNi}{\sum Ni}$$

$$SAIFI = \frac{106}{423.035}$$

SAIFI= 0.0003 Times

Table 4.Value of SAIFI Reliability Index Based on Cause of Extinction Period February 2017

NO	Cause of extinguishing	SAIFI	
		Total	Average
1	Group of exposure of electricity and APP	0.0003	0.00002
2	Group of low voltage network	0.0009	0.0001
3	Distribution transformer group	0	0
4	Group of electrically low and medium voltage	0	0
5	Medium high voltage air channel (SUTM)	1.9253	0.128353333
6	Medium voltage chain cables (SKTM)	0	0
7	Interruption of transmission and distribution	0	0
8	Group of power source	0	0
9	Natural disaster group	0	0
10	Group of extinction planned	0.2572	0.03215
Total		2.1837	0.16063

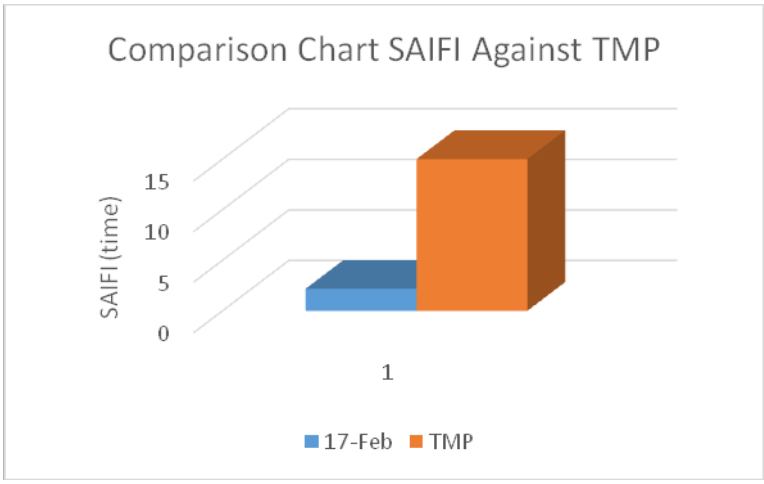

Figure 2 Comparison chart SAIFI against TMP

From the graph above shows SAIFI values in February of 2017 are still within normal limits. The value of SAIFI in February 2017 reached 2.1837 times / customer / month and SAIDI reached 2.0742 hours / customer / month.This value is still far below the TMP of 15 times / customer for SAIFI.

3.3 The Old Average Force Index (SAIDI) Based on the Causes of Extinction

To know the average length of outages on the system, indicated by SAIDI reliability index.The total SAIDI value of all outage groups in February 2017 can be seen that on average each subscriber suffered outages for 2.0742 hours / customer / month.This value is a high increase, which means that the length of outages to customers has reached a low level compared to quality service level.

NO	Cause of extinguishing	Total customer disorders
1	Group of exposure of electricity and APP	141.92
2	Group of low voltage network	421.68
3	Distribution transformer group	0
4	Group of electrically low and medium voltage	0
5	Medium high voltage air channel (SUTM)	584,032.42
6	Medium voltage chain cables (SKTM)	0
7	Interruption of transmission and distribution	0
8	Group of power source	0
9	Natural disaster group	584,596.32
10	Group of extinction planned	292,871.72
Total		877,467.09
Average		212,685

Example of SAIDI calculation:

Table 4 Table 3 the amount of damage to the Group of exposure of electricity and APP sectors (SAIDI)

No	Cause of extinguishing	amount of damage (***λ***i)	Customer disorder (Ni)	Hour off (Ui)
1	MCB delimiter is damaged	1	42	20.96
2	Inside customer service	1	4	4.70
3	Outside customer connection	1	8	5.13
4	Connector damage	1	29	86.06
5	Other	1	23	25.07
	TOTAL (Group of exposure of electricity and APP)		106	141.92

In the basic data seendisturbance in Group of exposure of electricity and APP reaches 141.92 hour. And in table 4 explained in detail each interruption and its clock, then the authors can calculate SAIDI mathematically as below:
Ni (total customer): 423.035 customer
∑UiNi: 141.92

$$SAIDI = \frac{\sum UiNi}{\sum Ni}$$

$$SAIDI = \frac{141.92}{423.035} \qquad SAIDI = 0.0003 \text{ Hour}$$

Table 5 Value of SAIDI Reliability Index Based on Causes of Extinction Period February 2017

NO	Cause of extinguishing	SAIDI	
		Total	Average
1	Group of exposure of electricity and APP	0.0003	0.00002
2	Group of low voltage network	0.0010	0.0001
3	Distribution transformer group	0	0
4	Group of electrically low and medium voltage	0	0
5	Medium high voltage air channel (SUTM)	1.3806	0.09204
6	Medium voltage chain cables (SKTM)	0	0
7	Interruption of transmission and distribution	0	0
8	Group of power source	0	0
9	Natural disaster group	0	0
10	Group of extinction planned	0.6923	0.0865375
Total		2.0742	0.17871

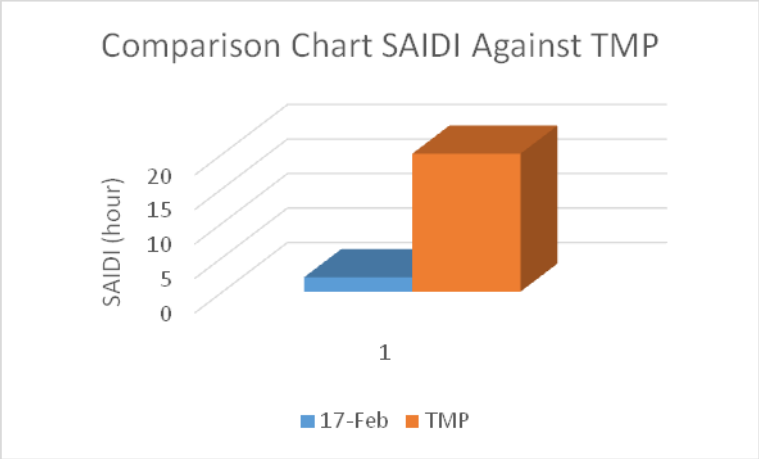

Figure 3 Comparison chart SAIDI against TMP

From the graph above shows SAIDIvalues in February of 2017 are still within normal limits. The value of SAIDI in February 2017 is20 hours / customer for SAIDI.From the results of these values can be concluded that PT.PLN AREA PEKALONGAN has managed to maintain and improve the reliability of the system to deliver electricity to its customers.

4. CONCLUSION

From the discussions in the previous chapter we can draw some conclusions as follows:

1) The implementation of management in the operation of 20 kV medium voltage system is very important because it directly affects the corporate image in the eyes of customers and large consumers.So the maintenance that has been compiled based on existing experience for reference use in accordance with possible conditions is one way to minimize the disturbance.
2) Based on the commitment of service quality level PT.PLN AREA PEKALONGAN which has set the level of quality for the reliability of the system and smoothness in distributing electricity to customers - customers specify that for SAIFI ≤ 15 times / customer / month and this value can still be met by PT. PLN with a value of 2.1837 which means the channel system can still be said reliably. So also for SAIDI value which set the standard value ≤ 20 hours / customer / month is still able to be fulfilled by PT.PLN with only reached value of 2,0742 hours / customer / month which means handling from PT.PLN quick response in handling disturbance to customer.
3) Judging from the outage frequency (SAIFI) and interruption duration (SAIDI) in the medium voltage airway is the highest contributor of value which is due to interference from outside of PT PLN control,disturbances such as fallen trees, animals, and weather are still dominant and become routine activities of PT.PLN to control the planting of trees on the roadsides and make the channel to stay reliable in the face of weather conditions that could affect the network system.

COMPANSATION

Alhamdulillahirabbil'alamiin.. all blessing and gratefully to Allah S.W.T who has given fluency and ease of preparation of this final project, and don't forget shalawat and greetings are extended to the Prophet Muhammad S.A.W gratitude to my parents who have given encouragement, prayer and counsel. Acknowledgements the author didn't forget to tell supervisor Mr. Jatmiko, for help and give suggestion. Acknowledge the author also says thank you to all friend of Electrical Engineering student who have helped in the preparation of this final project, so that the final report can be resolved.

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