Zero Down Time – Distribution Network Methods To Improve Industrial Reliability And Efficiency

Joko Windarto[1], Andhika Bayu Seta[2], Nabila Andieni Mileniawati[3], Andika Destriyana[4]
{jokowind@yahoo.com[1],andhikabs11@gmail.com[2], nabilaandieni9@gmail.com[3], destriyanaandika@gmail.com[4]}

Universitas Diponegoro, Indonesia[1,2,3,4]

Abstract. The industrial sector and companies must carry out economic recovery after the Covid-19 pandemic. In an industry and company, the supply of electricity is essential on the running of all economic activities in it. Therefore, a reliable and efficient system is needed to maintain the continuity of business and economic processes and one of these systems is called Zero Down Time (ZDT). Zero Down Time is the concept of an electric power grid on a distribution system that creates an area without blackouts. The purpose of this study is to assess the economic feasibility of implementing Zero Down Time. This study analyzes with 3 methods, Power Flow Analysis and Protection System, Reliability Analysis (SAIDI SAIFI), Economic Analysis for Zero Down Time implementation. The result of the implementation of Zero Down Time Reliability increased by 100% and no power outages for customer.

Keywords: Industries and companies; zero down time; economic feasibility

1 Introduction

Electricity is one of the most basic needs in everyday life. Almost all sectors of human work require reliable electricity supply. One of these sectors is the industrial and business sector. This is because in carrying out production or service activities, humans will use tools such as electronic devices or industrial equipment [1]. All of these tools require a reliable supply so that production continues to run well and can achieve targets.

The National Energy Policy aims to provide electrical energy and maintain the continuity of distribution. The most fundamental problem in electric power distribution is the quality, continuity and availibility of electric power services to customers. PLN as the holder of a business license to provide electricity for the public interest as set forth in article 29 and article of Law number 30 of 2009 concerning Electricity [2], [3] .

One of the most common electrical disturbances is a power outage. Power outages of erratic duration and unstable voltages are a reflection of poor electrical reliability. Companies and the public will suffer considerable losses in the event of a sudden power outage or unstable power supply. Due to this interruption, activities will be stopped or the resulting product will be damaged or defective [4].

Surakarta City is one of the big cities in Central Java Province with an area of 44.04 km^2 with many industrial areas and UMKM (Usaha Mikro Kecil dan Menengah) which in their

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production really require electrical energy. If the need for electrical energy is disrupted due to internal and external blackouts, it will cause production disruption so that it suffers losses.

One of the areas in Surakarta that requires a reliable electricity supply is in the area around the Manahan Stadium such as hotels, shops, offices, malls, hospitals, and other public facilities. This area is an example of an economic driving area in the Surakarta area. This area is also located between two substations which will later be used as a source of electricity in the design of the Zero Down Time (ZDT) system. The two substations are GI Jajar and GI Mangkunegaran. The purpose of this study is to assess the feasibility of a Zero Down Time (ZDT) system to be implemented in the city of surakarta, Therefore, a Zero Down Time (ZDT) system will be designed on a 20 kV distribution network in the Surakarta City area, especially around the Manahan Stadium which is expected to create an area without blackouts in the event of a power outage.

The objectives of writing this manuscript are distribution of 20 kV network power flow and protection system in the Surakarta City area which will implement a zero down time program, Analysis Analysis (SAIDI SAIFI) for the application of zero down time in the city of Surakarta, and the study of economics for the application of zero down time in the city of Surakarta

2 Literature Review

2.1 Zero Down Time

Zero Down Time is a distribution network concept that is designed without going out even if there is a short circuit on the network or network maintenance. Some areas that can be applied to the Zero Down Time system are VIP areas, business areas, areas that have a large enough burden, industrial areas [5]. The conditions that must be met to apply the Zero down time network concept are as follows:

1. Two Feeders must operate normally in parallel and sourced from the same power transformer (in 1 busbar)
2. The load of each parallelized feeder must be less than 50% of the OCR protection setting value in the circuit breaker.
3. Loads (customer transformers) must be clustered/centralized at distribution substations/connection substations
4. Circuit breaker at the substation / distribution substation must be CBO (Automatic Circuit Breaker)
5. Using the differential relay as the main relay
6. Communication lines between CT relays must have very high availability.

2.2 Load Flow Analysis And Protection System

Load flow analysis is the determination and calculation of power, voltage, current, and power factor or reactive power at different points in the power grid under normal operating conditions. Both the current power grid and those in the planning or system development stages in the future. In this study, ETAP software was used to simplify the simulation [6].

The protection system is an arrangement of protective devices consisting of the main equipment and other equipment needed to carry out certain functions based on the principle of protection. The protection system serves to protect against interference or eliminate abnormal conditions in the electric power system. Protection works when an error occurs in the area to be protected. The protection system must have requirements in carrying out its function to protect electrical power distribution equipment. Each protective equipment has requirements that must be met to protect the protected equipment. Some of the protection system requirements include sensitivity, reliability, selectivity, speed [4].

2.3 Reliability (SAIDI SAIFI) Analysis

In analyzing the reliability of the distribution system, saidi saifi is needed as a reliability index. SAIFI (System Average Interruption Frequency Index) is SAIFI is the average number of continuous interruptions or interruptions per consumer throughout the year. This is the ratio of the number of interruptions or annual changes to the number of consumers [5].

$$\text{SAIFI} = \frac{\sum(\lambda_i N_i}{\sum N}$$

Description :
λi = interruption frequency
Ni = number of consumer out
N = total number of consumer

SAIDI (System Average Interruption Duration Index) is the Average Duration Index value or the duration of the disturbance on the system. SAIDI is the average duration of interruptions or interruptions per consumer throughout the year. It is the ratio of the annual (continuous) interruption duration to the number of consumers [5].

$$\text{SAIDI} = \frac{\sum(T_i N_i}{\sum N}$$

Description :
Ti = duration of interruption
Ni = number of consumers out
N = Total number of consumers

The following are some standards regarding the reliability of the electric power system that are used as a reference:

Table 1. Standard Value of SPLN Reliability Index 68-2:1986

Network Configuration	SAIFI (Times/Consumer/Year)	SAIDI (Times/Consumer/Year)
SUTM Radial	3.2	21.09
SUTM Radial with PBO	2.4	12.8
SKTM without PPJD	1.2	4.36
SKTM with PPJD	1.2	3.33
SKTM with Cluster	0.6	1.75

Table 2. Standard IEEE Reliability Index Value std 1366–2003

Indicator	Standard Value	Unit
SAIDI	1.45	Times/Consumer/Year
SAIFI	2.30	Times/Consumer/Year

2.4 Investment Feasibility Economic Analysis Techniques

The application of engineering economic principles is not only needed in analyzing the economic feasibility of engineering projects but can also assist in making decisions for personal matters that will have a financial impact in the future.

Technical economics can provide an understanding of decision making based on economic parameters which include, among others, the rate of return on capital (rate of return), net present value (net present value), annual cash flow value (uniform annual cash flow), or the ratio of income to costs (benefit cost ratio). By using the analytical techniques studied in the Engineering Economics course, we can make the right decisions on the allocation of resources so that maximum benefits will be obtained from each invested resource. Based on the explanation above, it can be understood that engineering economics is a field that studies methods of systematically assessing the estimated costs and potential income of any engineering project that is planned or carried out [7].

a. Net Present Value (NPV)

The Net Present Value (NPV) method calculates the net value at the present time (present), basically the NPV method moves cash flows that are spread out throughout the life of the investment to the initial time of the investment by applying the concept of equivalence. The concept of equivalence says that if different amounts of money are paid at different times, they can produce the same value (equivalent) to each other economically [8].

SomethingInvestment cash flow consists of cash-in and cash-out. Cash flow the benefit only the calculation is calledPresent Worth of Benefit (PWB), whereas if only is taken into accountcash-out (cost) is calledPresent Worth of Cosf (PWC). using the appropriate interest rate, the NPV can be obtained from the PWB-PWC.

To count Net Present Value (NPV) the following equation is used:

$$PWB = \sum_{t=0}^{n} \text{Cbt(FBP)t}$$
$$PWC = \sum_{t=0}^{n} \text{Cct(FBP)t}$$
$$NPV = PWB - PWC$$

Keterangan :
Cb = Cash flow benefit
Cc = Cash flow cost
FBP = interest factor
t = time period
n = investment time

The criteria for making a decision whether the investment proposal is acceptable or worth rejecting are as follows:

1. If the NPV value obtained is positive, then the project is feasible because it indicates that the project investment calculation has reached a state that is able to provide benefits for the calculated period.
2. If the NPV value obtained is negative, then the project is not feasible because it indicates that the calculation of the project investment has not reached a state that is able to provide benefits until the calculated period.

b. Payback Period Method (PBP)

Analysis Payback Period basically aims to find out how long (period) the investment will be returned when the principal return condition occurs (break even point). The length of the payback period (k) when the BEP condition is:[8]

$$k_{(PBP)} = \sum_{t=0}^{k} CF_t \geq 0$$

Description :
k = Payback Period
CF_t = *cash flow* period to t

If the cash flow benefit and cost components have been discounted, then the formula becomes:

$$PBP = Tp - 1 + \frac{\sum_{i=0}^{n} Ii - \sum_{i=0}^{n} Bicp-1}{Bp}$$

Description :

PBP	= Payback period
Tp-1	= The year before was PBP
Ii	= The amount of investment that has been discounted
Bicp-1	= Amount of benefit before payback period
Bp	= Net cash flow in the payback period is

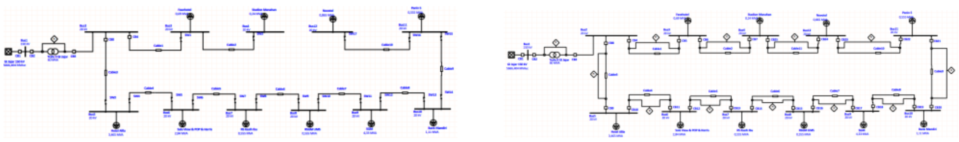
To find out whether the plan of an investment is economically feasible or not, a certain measure/criteria is needed. In method Payback Period This investment plan is said to be feasible (feasible) If the payback period is equal to or even less than the project time and vice versa, if these conditions are not achieved then the investment can be said to be unfeasible (unfeasible).

3 Method

This study employed a quantitative approach with a survey design. The area in this research is the Transformer II GI Jajar, 9 and 10 feeders. The 9 large loaders include Alila Hotel, Sala View Hotel, RS. Ibu Surakarta, RSG UMS, SGM, Mandiri, Panin S, Novotel. And the 10 loaders are Manahan Stadium, Manahan District, RS. Grayat Minulyo. Data collection was carried out directly and indirectly with PT. PLN UP3 Surakarta and UP2D Semarang. The data obtained include Single Line Diagram, Protection System, Distribution Network, Interference Data, total number of customers, premium customers. Prior to the research, a survey was conducted to the research location to find out the real conditions in the field.

4 Findings and Discussion

4.1 Zero Down Time System In Surakarta



(a) (b)

Figure 1. (a) Existing Network System, (b) Zero Down Time Network Sistem

As seen in Figure 1, the transformer used is Transformer II from the Jajar substation. Transformer II has five feeders, namely JJR 03, JJR 05, JJR 07, JJR 09, and JJR 10. The picture above shows two parallel feeders from one transformer at the Jajar substation, namely JJR 09 and JJR 10 because they supply loads in the same area. namely Manahan-Kota. To create a ZDT system, the radial network will be converted into a close loop system. To implement the ZDT system, the load break switch (LBS) will be converted into a circuit breaker, then an express feeder or no-load feeder will be added from a different substation, namely the Mangkunegaran Substation. This express feeder is connected to the network from the Jajar Substation through a connecting substation. So that when the electricity supply from the Jajar Substation does not allow it to flow, the electricity needs will be supplied by the Mangkunegaran Substation.

4.2 Reliability Existing Condition and Zero Down Time System

The following is a table of interruption data that occurred at Feeder 9 and 10 GI Jajar Surakarta City in 2020-2022. This Data is obtained from PLN UP3 Surakarta.

Table 3. Interruption Data at Feeder 9 and 10 GI Jajar in 2020

No	Date	Feeder	Time of Interruption	Normal Time	Duration	Number of Consumer Out	Total Number Consumer
1	29/01/2020	JJR 10	00.40.06	01.10.00	0.50	3323	11510
2	25/02/2020	JJR 10	12.08.45	12.48.00	0.65	4966	11510
3	25/02/2020	JJR 10	12.08.45	12.51.00	0.70	3323	11510
4	25/02/2020	JJR 10	12.08.45	13.29.00	1.34	1557	11510
5	05/03/2020	JJR 10	07.03.00	07.58.00	0.92	3338	11510
6	07/09/2020	JJR 10	12.24.00	12.46.00	0.37	3338	11510
7	11/02/2020	JJR 10	20.03.24	20.33.20	0.5	1840	11510
Total (Interruption>5minutes)					4.98	21685	11510
8	07/09/2020	JJR 10	12.24.00	12.26.00	0.03	4986	11510
9	11/02/2020	JJR 10	20.03.24	20.06.46	0.06	1138	11510
10	11/02/2020	JJR 10	20.03.24	20.11.43	0.14	3656	11510
Total (Interruption<5minutes)					0.23	9780	11510
Total					5.21	31465	11510

Table 4. Interruption Data at Feeder 9 and 10 GI Jajar in 2021

No	Date	Feeder	Time of Interruption	Normal Time	Duration	Number of Consumer Out	Total Number Consumer
1	05/06/2021	JJR 10	10.50.40	11.54.29	1.06	1886	11510
2	13/08/2021	JJR 10	20.57.27	22.57.00	1.99	2160	11510
3	23/09/2021	JJR 10	21.41.37	22.09.25	0.46	3732	11510
Total (Interruption>5minutes)					3,51	7778	11510
4	13/08/2021	JJR 10	20.57.27	20.59.51	0.04	1155	11510
Total (Interruption<5minutes)					0,04	1155	11510
Total					8933	3.55	11510

Table 5. Interruption Data at Feeder 9 and 10 GI Jajar in 2022

No	Date	Feeder	Time of Interruption	Normal Time	Duration	Number of Consumer Out	Total Number Consumer
1	0	0	0	0	0	0	11510
Total (Interruption>5minutes)					0	0	11510
2	0	0	0	0	0	0	11510
Total (Interruption<5minutes)					0	0	11510
Total					0	0	11510

From the data above, it can be calculated SAIDI SAIFI with enter the data into the formula: $\text{SAIDI} = \frac{\sum(T_i N_i}{\sum N}$ and $\text{SAIFI} = \frac{\sum(\lambda_i N_i}{\sum N}$. Then do the comparison of the saidi saifi value with the SPLN and IEEE standard. The Comparison of SAIDI SAIFI Existing Circuit with SPLN Standard :

Table 6. The Comparison of SAIDI SAIFI Existing Circuit with SPLN Standard

No	Year	Feeder	SAIDI	SPLN	Description	SAIFI	SPLN	Description
1.	2020	JJR 10	9.38		Reliable	27.34		Unreliable
2.	2021	JJR 10	2.37	21.09	Reliable	3.1	3.2	Reliable
3.	2022	JJR 10	0		Reliable	0		Reliable

From table 6 above, it can be seen that in 2020 the SAIDI value is 9.38 hours/customer/year, this indicates that the system is said to be reliable because it does not exceed the SPLN, which is 21.09 hours/customer/year, in 2021 the SAIDI value is 27.34 hours/customer/year, and in 2022 the SAIDI value is 0 hours/customer/year so in 2021 and 2022 this indicates that the system is said to be reliable because it does not exceed the SPLN, which is 21.09 hours/customer/year. While for SAIFI in 2020 it is 27.34 times/customer/year, this indicates that the system is said to be unreliable because it exceed the SPLN, which is 3.2 times/customer/year, in 2021 the SAIFI value is 3.1 times/customer/year, and in 2022 the SAIFI value is 0 times/customer/year, this indicates that the system is said to be reliable because it does not exceeds the SPLN, which is 3.2 times/customer/year.

Table 7. The Comparison of SAIDI SAIFI Existing Circuit with IEEE Standard

No	Year	Feeder	SAIDI	IEEE	Description	SAIFI	IEEE	Description
1.	2020	JJR 10	9.38		Unreliable	27.34		Unreliable
2.	2021	JJR 10	2.37	1.45	Unreliable	3.1	2.3	Unreliable
3.	2022	JJR 10	0		Reliable	0		Reliable

From table 7 above, it can be seen that in 2020 the SAIDI value is 9.38 hours/customer/year,and in 2021 the SAIDI value is 2.37 hours/customer/year. This indicates that the system is said to be unreliable in 2020 and 2021 because it exceed the IEEE Standard , which is 1.45 hours/customer/year. But the system is reliable in 2022. While for SAIFI in 2020 it is 27.34 times/customer/year and in 2021 the SAIFI value is 3.1 times/customer/year, this indicates that the system is said unreliable because it exceeds the SPLN, which is 2.3 times/customer/year. And in 2022 the SAIFI value is 0 times/customer/year this indicates that the system is said to be reliable.

To calculate the Energy Not Supplied (ENS) need to multiple power loss with duration of fault **:**

$$ENS = \sum Power\ Loss(kW) \times Duration\ (Hour)$$

Table 8. The Data for Calculate ENS 2020

No.	Feeder	Time of fault		Normal time		Duration (Hour)	Power Loss (kW)
		Date	Time	Date	Time		
1	JJR 10	29/01/2020	00.40.06	29/01/2020	01.10.00	0.50	1748
2	JJR 10	25/02/2020	12.08.45	25/02/2020	12.48.00	0.65	2860
3	JJR 10	25/02/2020	12.08.45	25/02/2020	12.51.00	0.70	1697
4	JJR 10	25/02/2020	12.08.45	25/02/2020	13.29.00	1.34	1568
5	JJR 10	05/03/2020	07.03.00	05/03/2020	07.58.00	0.92	1647
6	JJR 10	07/09/2020	12.24.00	07/09/2020	12.26.00	0.03	2233
7	JJR 10	07/09/2020	12.24.00	07/09/2020	12.46.00	0.37	1289
8	JJR 10	11/02/2020	20.03.24	11/02/2020	20.06.46	0.06	750
9	JJR 10	11/02/2020	20.03.24	11/02/2020	20.33.20	0.5	1308
10	JJR 10	11/02/2020	20.03.24	11/02/2020	20.11.43	0.14	1950
		TOTAL				5.21	17050

Table 9. The Data for calculate ENS 2021

No.	Feeder	Time of fault		Normal time		Duration (Hour)	Power Loss (kW)
		Date	Time	Date	Time		
1.	JJR 10	05/06/2021	10.50.40	05/06/2021	11.54.29	1.06	1100
2.	JJR 10	13/08/2021	20.57.27	13/08/2021	20.59.51	0.04	650
3.	JJR 10	13/08/2021	20.57.27	13/08/2021	22.57.00	1.99	1129
4.	JJR 10	23/09/2021	21.41.37	23/09/2021	22.09.25	0.46	1776
		TOTAL				3,55	4655

Table 10. Comparison of SAIDI, SAIFI, and ENS before and after ZDT

No	Index Reliability	2020			2021		
		SAIDI	SAIFI	ENS (kWh)	SAIDI	SAIFI	ENS (kWh)
1.	Realisasi tanpa ZDT	9.38	27.34	88.830,5	2.37	3.1	16.525,25
2.	Realisasi dengan ZDT	0	0	0	0	0	0
	Difference	9.38	27.34	88.830,5	2.37	3.1	16.525,25
	% Difference	100%	100%	100%	100%	100%	100%

From table 10. the interruption 2020 and 2021 are 0%, it can be said that after the installation of the Zero Down Time network for the Surakarta area it can be said to be reliable because if the percentage of interruption is already 0%, then the SAIDI and SAIFI values are 0. Reliability increased by 100%. This indicates that the Zero Down Time network is very reliable and very influential to overcome interruption that often occur on the network, but this network is still possible to occure interruption if there is a blackout interruption of the generator system. ZDT only reduces or minimizes blackouts due to network interruption, because in the event of a blackout disturbance, almost all generators experience disturbances so that even though the Zero Down Time network concept is very reliable, it is unable to anticipate blackouts due to generator disturbances. Disturbance in the transmission network or at the generator is something that cannot be avoided or stopped because this disturbance is very rare and the cause of this disturbance usually occurs due to natural factors such as natural disasters. This does not mean that the Zero Down Time network in the Surakarta area cannot be said to be reliable in the event of a blackout disturbance.

4.3 Investment Feasibility Economic Analysis Techniques

In determining the value of the investment feasibility, the things that must be known are cash inflows, cash outflows, discount rates, so that it can produce a Net Present Value and payback period.

a. Cost calculation

The investment costs incurred for the construction of this zero down time are spent on network reconfiguration costs, circuit breaker changes, and the implementation of the aws system whose value is IDR 40,589,861,220.

Cash inflows are obtained from the sale of electrical energy where the sale of electrical energy for each customer who participates in the Zero Down Time zone is subject to an increase in electricity prices of IDR 130.00 of the regular fare and other cash inflows are obtained from not sell energy where the electrical energy cannot be used because the energy is lost due to blackouts so that the total cash inflows in the first year amounted to IDR 4,042,057,711.

other costs for expenses are operational and maintenance costs where the value is IDR 63,400,000 which is used for operational and maintenance costs for the zero down time system as well as the existing protection system.

In the calculation to find the feasibility of investing in the zero down time system, the discount rate value is 4.5% and the inflation rate value is 4.69%. This data is obtained from the official website of Bank Indonesia in August 2022 so that the following table is obtained.

Table 11. Zero Down Time system planning cash flow

Years	Cash Inflows (IDR)	FBP	*Present worth*	Cash Outflows (IDR)	FBP	*Present worth*	Net Cash Flows (IDR)
0	0	1	0	40.589.861.220	1	40,589,861,220	-40.589.861.220
1	4,231,630,219	0.962	4,068,875,211	66,373,460	0.962	63,820,635	4.165.256.759
2	4,430,093,676	0.925	4,095,870,633	69,486,375	0.925	64,244,060	4.360.607.301
3	4,637,865,070	0.889	4,123,045,159	72,745,286	0.889	64,670,295	4.565.119.783
4	4,855,380,941	0.855	4,150,399,978	76,157,040	0.855	65,099,357	4.779.223.901
5	5,083,098,308	0.822	4,177,936,285	79,728,805	0.822	65,531,266	5.003.369.502
6	5,321,495,618	0.790	4,205,655,286	83,468,086	0.790	65,966,041	5.238.027.532
7	5,571,073,763	0.760	4,233,558,191	87,382,740	0.760	66,403,700	5.483.691.023
8	5,832,357,122	0.731	4,261,646,221	91,480,990	0.731	66,844,263	5.740.876.132
9	6,105,894,671	0.703	4,289,920,605	95,771,449	0.703	67,287,749	6.010.123.223
10	6,392,261,131	0.676	4,318,382,578	100,263,129	0.676	67,734,178	6.291.998.002
11	6,692,058,178	0.650	4,347,033,386	104,965,470	0.650	68,183,568	6.587.092.708
12	7,005,915,707	0.625	4,375,874,280	109,888,351	0.625	68,635,940	6.896.027.356
13	7,334,493,154	0.601	4,404,906,523	115,042,114	0.601	69,091,313	7.219.451.039
14	7,678,480,883	0.577	4,434,131,384	120,437,590	0.577	69,549,707	7.558.043.293
15	8,038,601,636	0.555	4,463,550,140	126,086,113	0.555	70,011,143	7.912.515.523
16	8,415,612,053	0.534	4,493,164,078	131,999,551	0.534	70,475,640	8.283.612.501
17	8,810,304,258	0.513	4,522,974,494	138,190,330	0.513	70,943,218	8.672.113.928
18	9,223,507,528	0.494	4,552,982,690	144,671,457	0.494	71,413,899	9.078.836.071
19	9,656,090,031	0.475	4,583,189,979	151,456,548	0.475	71,887,703	9.504.633.483
20	10,108,960,653	0.456	4,613,597,682	158,559,860	0.456	72,364,650	9.950.400.793
	Total		**86,716,694,781**			**41.950.019.545**	**92.711.158.634**

b. Net Present Value

Net Present Value (NPV) can be determined by the feasibility of an investment from the present worth of benefits and present worth of costs. From Table 4 it is known that the total value of present worth benefit is IDR 86,716,694,781, while the present worth cost is IDR 41,950,019,545. Then the NPV value can be found as follows:

$$NPV = PWB - PWC$$

= IDR 86.716.694.781 – IDR 41.950.019.545

= IDR 44.766.675.236

Based on the results of the NPV calculation which is worth IDR 44.766.675.236 (> 0), it shows that the Zero Down Time investment that will be designed in Surakarta City is feasible to implement.

c. Payback Period (PBP)

Payback Period (PBP) is obtained by calculating how many years the total net cash flow value will now be equal to or greater than the initial investment value.

$$PBP = Tp - 1 + \frac{\sum_{i=0}^{n} Ii - \sum_{i=0}^{n} Bicp-1}{Bp}$$

$$PBP = 9 + \frac{40.589.861.220 - 36.615.407.424}{5.080.548.908}$$

$$PBP = 9{,}8$$

The results of the PBP calculation which is worth 9.8 under the investment age of 20 years, indicate that the Zero Down Time investment that will be designed in the Surakarta is feasible. This is because PBP has a shorter time than the life of the project (cutoff period).

5 Conclusions and Recommendations

5.1 Conclusions

Based on the calculation and discussion of the advantages and benefits provided by the Zero Down Time system, it means that this system could be run and applied to the electricity system in the city of Surakarta and coupled with major events which are held every year at both national and international levels in the city of Surakarta, meaning the need for electricity reliable is needed in the city of Surakarta and For PLN the implementation of Zero Down Time can increase revenue every year.

5.2 Recommendations

In planning and implementing a zero down time system, an appropriate installation plan is needed because during installation, blackouts will be carried out so that in the application, a back-up network must be determined to ensure that the customer's electricity is still on during installation.

The implementation of the zero down time system can be added to the Jajar 04 network in the loop system to add a backup network so that it is more reliable and the local government of the city of Surakarta is expected to be able to help and support the zero down time system because with this system it can improve the image of the city of Surakarta so that the economy and business in the city of Surakarta can increase.

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