Optimization of Maintenance Budget Using Condition Base Maintenance (CBM) Method based on Asset Management Principles

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ABSTRACT
The Health Index method is a maintenance method that combines preventive (time-base) and predictive (condition-base) methods in determining the maintenance priority scale by considering important factors in asset criteria, namely asset class, risk level, and customer service class profile [1], [2]. In this study, an analysis of the effectiveness of using the Health Index method was carried out as an effort to increase the effectiveness of budget use while maintaining network performance in the maintenance phase of the asset cycle. Before the application of this method, the inspection and maintenance process was carried out based on a routine schedule or maintenance plan with follow-up under the findings. After the maintenance work is carried out using the Health Index Method, the screening stage is carried out including historical performance data, utility levels with parameters in the form of load profiles, and risk levels outlined in an application Integration and maintenance with setup parameters referring to the Circular of the Board of Directors of PT PLN (Persero) Number: 0018.E / DIR / 2014 so that in its implementation it can reduce the volume of inspections in 2022 by 0.75% / 63.27 Kms and the implementation of maintenance programs Health Index by prioritizing inspection work and maintenance follow-up based on asset management principles can reduce the use of the 2022 maintenance budget by 7% or worth 697 million while still evaluating the level of equipment effectiveness or Overall Equipment Effectiveness (OEE) in the maintenance of 20kV SUTM &; SKUTM overhead line assets.

Keywords: Health Index, Manajemen Asset, maintenance, Performance.

1. INTRODUCTION

The growth of electrical energy customers that continues to increase every year has encouraged PLN to build a sustainable power distribution network with high utilization rates and better service quality [3]. Improving service quality and utilization of these assets requires good asset management so that these assets can be optimized with good performance and efficient costs. One of the important life cycles in the management of electric power distribution assets is the maintenance phase, which in this phase has the main objective of ensuring the reliability of electricity distribution to consumers by taking into account 3 main factors, namely performance, cost, and risk [4], [5]. Looking at the performance of the distribution network at PT PLN (Persero) Bali Distribution Main Unit, especially in the performance of SAIFI (System Average Interruption Frequency Index) and the number of distribution transformer disturbances in the last 3 years, PLN Bali's performance has increased with a significant decrease in the frequency of interruptions seen in tables 1 and 2.

Table 1. SAIFI's Performance at PT PLN (Persero) Bali Distribution Main Unit

UNIT	SAIFI (Kali/plug)				
	2017	2018	2019	2020	2021
UP3 SOUTH BALI	8,05	4,15	2,81	1,97	0,88
UP3 EAST BALI	7,21	4,26	3,05	2,20	1,09
UP3 NORTH BALI	5,1	2,55	1,61	1,10	0,64
UID BALI	7,21	3,85	2,63	1,85	0,89
PERFORMANCE IMPROVEMENTS		47%	32%	30%	52%

Table 2. Performance Times Transformer Disruption at PT PLN (Persero) Bali Distribution Main Unit

UNIT	TRAFO DISORDER (Times)				
	2017	2018	2019	2020	2021
UP3 SOUTH BALI	54	76	56	46	19
UP3 EAST BALI	12	22	25	11	7
UP3 NORTH BALI	0	2	0	5	0
UID BALI	66	100	81	62	26
PERFORMANCE IMPROVEMENTS		-52%	19%	23%	58%

In terms of costs, in the last 3 years, the operating budget ceiling for maintenance work at PT PLN (Persero) Bali Distribution Main Unit continues to be cut and is inversely proportional to the trend of budget usage that continues to increase as shown in figure 1. Based on these conditions, PLN Bali is required to be able to make efficient use of the budget in the maintenance phase of the asset cycle.

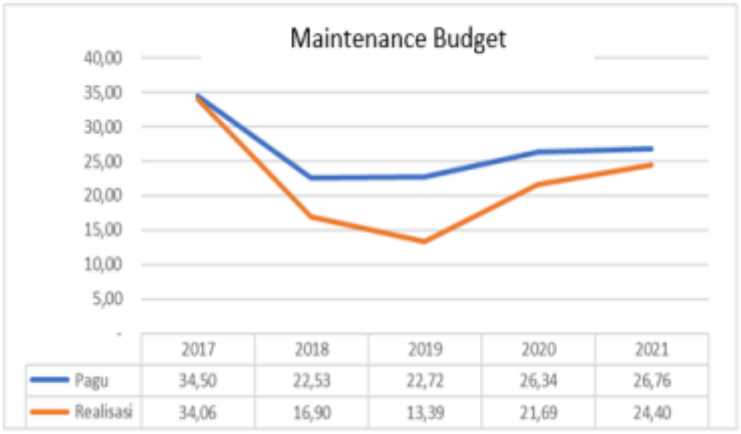

Figure 1. Budget Trends and Maintenance Budget Realization at PT PLN (Persero) Bali Distribution Main Unit

Based on these conditions, to increase the effectiveness of budget use while maintaining network performance in the maintenance phase in the asset cycle, the application of distribution equipment maintenance methods based on asset management rules (Health Index) is carried out.

The Health Index method is a maintenance method that combines preventive (time-base) and predictive (condition-base) methods in determining the maintenance priority scale by considering important factors in asset criteria, namely asset class, risk level, and customer service class profile[6], [7]. With the application of the Health Index method on network assets at PT PLN (Persero) Bali Distribution Main Unit, it is expected to be one of the alternatives in increasing the effectiveness of the use of maintenance budgets while maintaining reliable and quality network performance in the distribution of electrical energy to consumers [8]–[10].

Asset management is a coordinated and systematic activity carried out by the company optimally, in managing the company's physical assets, related to performance, risks, and costs during the asset life cycle, which includes planning, installing, operating, maintaining, repairing, replacing and ending in the disposal (disposal) of assets that cannot be used [11].

In the above asset management sense, PLN's efforts in servicing load growth must be carried out most efficiently, using modern maintenance planning and techniques, to improve the performance of the electric power distribution network, reduce maintenance costs by optimizing the lifetime of equipment assets, operating reliability, equipment capacity, equipment use and Return on investment, as well as by taking measures to reduce the risk of surgery. In general, the purpose of asset management is for proper decision-making for the assets under management to function effectively and efficiently.

METHOD

This research was conducted in three stages ranging from direct observation in the company, literature study, data collection, planning, program implementation, and result analysis. Good system design is needed to explain the working system of an overall plan such as the block diagram below.

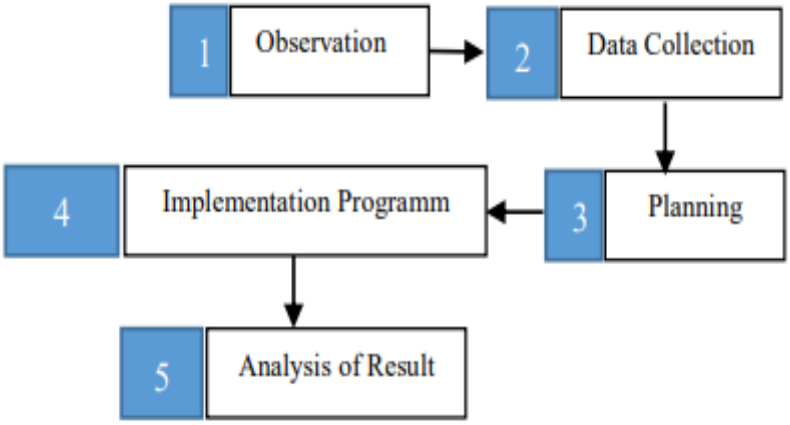

Figure 2. System Plan Block Diagram

Power distribution network asset life cycle management is a methodology for managing assets both physically and financially, so that these assets can be installed properly and correctly, can operate properly, and get appropriate maintenance [11], [12]. Some of the factors that provide control over the lifecycle management of distribution network assets can be seen in the following Figure 3 [13], [14].

Figure 3. Power Distribution Network Asset Life Cycle

In Figure 3 above, it is explained that the life cycle of distribution network assets begins with installation, operation, maintenance, asset repair, and asset replacement and ends at the disposal of assets that are no longer usable. In the asset maintenance phase, to ensure the reliability of electricity distribution to consumers which in its implementation is always faced with the optimization of three conflicting factors consisting of cost, performance, and risk. For this reason, best-practice concepts such as asset classification, risk matrix, and life-cycle assessment of main distribution equipment are also used in the implementation of maintenance activities for distribution assets as shown in Figure 4 below [15].

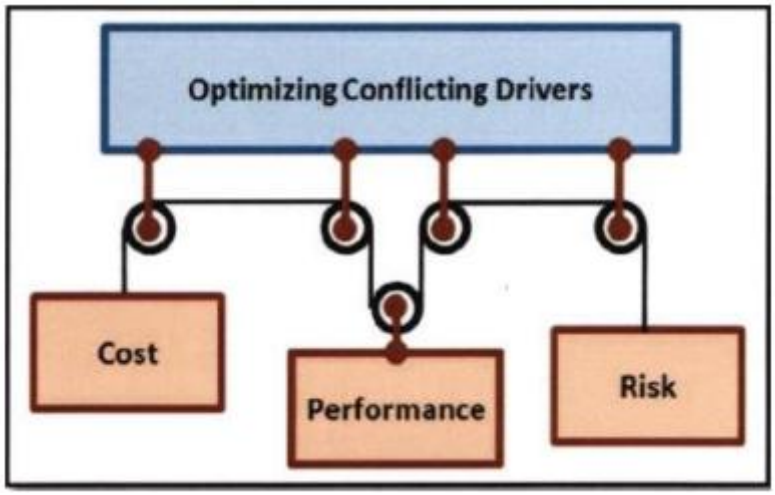

Figure 4. Aspects in Asset Management Philosophy

Asset maintenance is divided into two forms of maintenance, namely planned maintenance and unplanned maintenance in the form of emergency maintenance [16]. Planned Maintenance is maintenance that is organized and carried out with future thinking, control, and recording according to a predetermined plan. Unplanned maintenance is emergency maintenance or breakdown/emergency where this type of maintenance activity allows equipment to operate until complete damage.

RESULTS AND DISCUSSION

The Health Index maintenance method is a combination of preventive and predictive maintenance methods with the main objective being as a form of maintenance optimization based on asset conditions and maintenance priority levels.

In the implementation of the Health Index maintenance program, several stages (setup) are carried out both in terms of application tools, and asset screening, to the stages of socialization and implementation in the field with detailed steps can be seen in Figure 5.

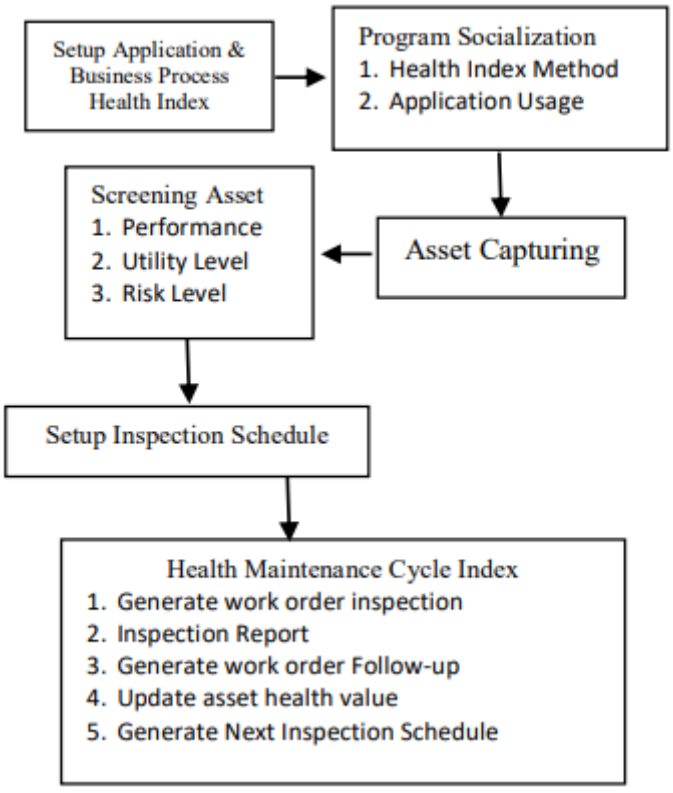

Figure 5. Stages of Health Index Program Implementation

Screening and asset class determination at UP3 South Bali
The asset screening process used as the initial master data in the Health Index application is carried out by integrating asset data in the asset management application into the Health Index application master data. The asset class determination process is carried out by referring to the history of performance and disruption in distribution equipment in the last 2 years as well as the asset classification in UP3 South Bali as seen in Table 3 with results shown in Table 4.

Table 3. JTM Asset Class and UP3 South Bali Distribution Substation December 2021

Asset Classes	Asset Group		% Data	Pollution Levels	Priority
	Air Duct 20Kv	Distribution Substation			
	Network Length (Kms)	Number of Substations (Unit)			
Class 1	397,92	1.219	16%	High	1
Class 2	1.740,90	5.241	70%	Keep	2
Class 3	348,18	1.020	14%	Low	3

The following is a history of the use of maintenance budgets in 2020 and 2021 before the implementation of the health index program, maintenance based on routine work plans at UP3 South Bali.

Table 4. History of UP3 South Bali Maintenance Budget Usage

Budget	Realization			2021		
	Budget	Realization	% Real	Budget	Realization	% Real
Service Operations	**4.456.534.182**	**3.072.675.103**	**69%**	**6.684.473.310**	**5.028.894.032**	**75%**
JTM Services	2.501.078.869	1.724.434.832	69%	4.851.179.525	3.649.661.930	75%
JTR Services	84.378.102	58.176.709	69%	470.671.927	354.098.092	75%
Substation Services	1.435.490.207	989.736.607	69%	1.347.610.367	1.013.840.495	75%
SR Services	435.587.004	300.326.955	69%	15.011.492	11.293.515	75%
Unit Maintenance	**8.127.498.782**	**5.568.536.783**	**69%**	**9.779.244.879**	**5.132.305.857**	**52%**
JTM Services	4.561.283.417	2.534.125.933	56%	7.097.174.351	3.667.805.338	52%
JTR Services	153.882.567	75.163.000	49%	688.583.201	195.952.665	28%
Substation Services	2.617.941.305	2.171.235.150	83%	1.971.525.828	1.251.368.854	63%
SR Services	794.391.493	788.012.700	99%	21.961.499	17.179.000	78%
Total Budget Usage	**12.584.032.964**	**8.641.211.886**	**69%**	**16.463.718.189**	**10.161.199.889**	**62%**
JTM Services	7.062.362.286	4.258.560.765	60%	11.948.353.876	7.317.467.268	61%
JTR Services	238.260.669	133.339.709	56%	1.159.255.128	550.050.757	47%
Substation Services	4.053.431.512	3.160.971.757	78%	3.319.136.195	2.265.209.349	68%
SR Services	1.229.978.497	1.088.339.655	89%	36.972.991	28.472.515	77%

Based on realization data for the last 2 years, it can be seen that the average budget usage is 65% with a realization of 69% or worth 8.6M in 2021 and 62% or worth 10.1M.
The maintenance program based on asset management principles (health index) at UP3 South Bali will be implemented in early 2022 with the main objective of reducing budget usage by prioritizing inspection and maintenance by considering health index parameters and the impact on distribution equipment performance.
The following is data on the realization of the use of maintenance budgets after applying the health index method from January – June 2022 with the realization of budget absorption against the ceiling of 61% or worth 4.7M.
Based on the calculation of Overall Equipment Effectiveness on the maintenance of 20Kv overhead line assets in UP3 South Bali before the implementation of the Health Index method from 2020 to 2021 and after the implementation in 2022 as Table 5.

Table 5. OEE scoring before and after Health Index implementation

Year	Availability Rate (AR)	Performance Rate (PR)	Quality Rate (QR)	Value EE (AR x PR x QR)	Skoring OEE
2020	99.97%	100%	96.89%	96.86%	Good
2021	99.98%	100%	96.89%	96.87%	Good
2022	99.98%	100%	96.50%	96.48%	Good

CONCLUSION

From the results of the analysis of Maintenance Budget Optimization Using the Condition Base Maintenance Method based on Asset Management Rules, it can be concluded as follows:
The application of the Health Index maintenance method in the work environment of PT PLN (Persero) UP3 South Bali following asset management principles indicated by the maintenance system to determine the priority scale by taking into account asset condition, budget use, and distribution equipment performance at the inspection stage and maintenance follow-up
The design of the Health Index method design is carried out by setting the time and volume of inspections and prioritizing follow-up work on maintenance of Distribution equipment following asset management principles.
The optimization results of the use of the Health Index maintenance method resulted in a decrease in budget use by 7% (from 10.1M to 9.4M) and a decrease in inspection volume by 0.75% / 63.27kms (from 5,248.14 to 5,184.87 kms).

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