

Strategic Study: The Role of Condition-Based Maintenance and Preventive Maintenance of Electrical Reliability

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ABSTRACT

Maintenance is an important performance factor for reliability in an electric power supply company. Maintenance is carried out regularly and intensively to maintain the reliability of electricity distribution. The maintenance strategy most often used is corrective and preventive maintenance, which are carried out by two different methods and with different results. Therefore, results-based research is needed to determine the effectiveness and efficiency of the two methods. This research was conducted by exploring the results of interviews with management as an experienced maintenance policymaker with data observations made at PLN as the only power company in Indonesia. The results showed that preventive maintenance or time-based maintenance increased the level of reliability higher than corrective maintenance (condition-based maintenance). This journal was created by conducting a case study on the strategy carried out by management at the Central Java Distribution Unit PLN, Indonesia in carrying out maintenance at distribution substations in Central Java.

Keywords: Maintenance; Preventive Maintenance; Condition-based Maintenance; Substations

1. Introduction

Maintenance is one of the performances at PT PLN UP2D Central Java-DIY which is an important factor in reliability for excellent electricity distribution to the community. Equipment maintenance is carried out regularly to maintain reliability, availability, equipment performance, and also equipment life. By maintaining the power supply equipment, it is expected that the equipment will be more reliable and durable so that it can support operational performance and indirectly will have a positive effect on company profitability.

PLN already has maintenance guidelines from the Director's Circular, but their implementation often differs depending on the situation and conditions of each work unit (Cahyani et.al, 2019). Therefore, PLN needs to know the effectiveness of the various maintenance methods that have been carried out so far. PLN employees who manage and carry out maintenance even in a small interview with the author admitted that maintenance methods at PLN often change every year. The method changes without evaluating or reviewing its effectiveness in terms of affecting electrical reliability performance.

Scheduled maintenance involves monthly, quarterly, or yearly activities. According to CIGRE (13.06), the mean interval between scheduled maintenance repairs is 8.3 years with partial repairs unsuccessful; 6.1 percent of major failures and 13.7 percent of minor failures were related to these maintenance activities (Janssen et al., 1996). This survey data shows that maintenance causes a large number of failures. Burgin et al. (1994) went on to categorize two types of maintenance-related errors: unnecessary maintenance and failed maintenance when due.

Maintenance activities based on these problems make it necessary to conduct a review of the effectiveness related to the effect on performance, so that failure can be anticipated. Research on the effectiveness of maintenance methods in terms of equipment reliability performance will be carried out based on the track record of equipment failure cases at PLN UP2D Central Java-DIY. The conclusion from this study will be a recommendation for further maintenance methods at UP2D Central Java-DIY.

2. Literature Review

2.1 Definition of Proactive Maintenance

Proactive maintenance is a strategy for maintenance where damage is avoided through activities that monitor equipment failures and make minor repairs to restore equipment to its proper condition. These activities, including preventive and predictive maintenance, reduce the chance of unexpected equipment failures.

2.2 Definition of Preventive Maintenance

Preventive maintenance is often referred to as use-based maintenance. It consists of maintenance activities that are carried out after a certain period of time or the amount of machine use [6,7]. This type of maintenance relies on the estimated probability that the equipment will fail within a set interval. The work performed may include equipment lubrication, parts replacement, cleaning, and adjustment. Production equipment can also be checked for signs of damage during preventive maintenance work.

The benefits of preventive maintenance are a reduced chance of equipment failure and an extension of the life of the equipment. The disadvantage of preventive maintenance is the need to interrupt production at scheduled intervals to perform work.

2.2 Definition of Corrective Maintenance (Condition-based Maintenance)

Predictive maintenance is often referred to as condition-based maintenance. In particular, maintenance is started in response to certain equipment conditions [5,6]. In predictive maintenance, diagnostic equipment is used to measure the physical condition of the equipment such as temperature, vibration, noise, lubrication, and corrosion [8]. When one of these indicators reaches the specified level, work is carried out to return the equipment to its proper condition. This means that equipment is removed from service only when there is direct evidence that damage has occurred.

Predictive maintenance is based on the same principles as preventive maintenance although it employs different criteria to determine the need for specific maintenance activities. Like preventive maintenance, predictive maintenance reduces the chance of equipment breakdown. Additional benefits come from the need to perform maintenance only when the need is imminent, not after a certain period of time [7,9].

2.2 Definition of Electrical Reliability

Reliability can be defined as the probability that a device, system component, or equipment will function under certain conditions for a certain period of time (Anumaka, et. Al., 2011). As defined in the IEEE Standard, the most common tools in defining the reliability of electricity supply are the System Average Interruption Duration Index (SAIDI) and the System Average Interruption Frequency Index (SAIFI).

3. Research Methodology

Researchers used the case study method to further study the relationship between maintenance and its effect on electrical reliability over time. The research was conducted during the Covid-19 pandemic, so data collection techniques were carried out online with respondents (using zoom and WhatsApp applications). The researcher immediately chose to research his own unit, namely at PT PLN UP2D Central Java-DIY. The author conducts online interviews with employees who are experienced and competent in their fields.

Interviews with respondents were conducted using the video conference method by researchers in early September 2020. Interviews were conducted for about 40 minutes divided into 3 parts, namely: definition, process, and results, with the three of them to explore respondents' knowledge about maintenance at PT PLN UP2D Central Java. -DIY.

Respondents themselves are expert staff in their fields who have planned and analyzed maintenance results for more than 10 years with their positions, namely supervisor planning and maintenance evaluation. The results of the interviews were recorded and analyzed using the Miles and Huberman model method which consisted of three stages, namely: data reduction, data presentation, and conclusion drawing.

4. Results

Maintenance is work done on equipment, to maintain the condition of the equipment or repair it so that its performance remains good. Maintenance work on the electricity supply system equipment is not a simple matter, considering that the electricity demand cannot be cut off in the community.

From the results of interviews with sources, the author can formulate the results of the research with the following description.

4.1 Definition of Maintenance System at PLN UP2D Central Java-DIY

The maintenance method at PLN based on the results of initial interviews with respondents is divided into 2 according to its nature, namely condition-based maintenance and time-based maintenance. Condition-based maintenance is carried out when the equipment has been damaged (corrective), while time-based maintenance is more of scheduled routine maintenance. The essence of the definition of maintenance that has been used by PLN according to our respondents is like that.

As previously explained, maintenance work carried out by electricity supply companies is complicated, especially if it is carried out in a country as big as Indonesia, especially on the island of Java where the people are many and are diverse. Therefore, according to the respondent, it is commonplace if there are many differences between units in PLN. In particular, according to respondents that in the PLN transmission and distribution sector two different methods also produce different results. For transmission units, maintenance is more often done by a condition-based method, with less routine maintenance. Whereas distribution units, with more equipment being maintained than transmissions, perform more frequently scheduled routine maintenance than perform equipment condition-based methods. The results of these two different method policies will be explained in the conclusions at the end of this section.

4.2 Maintenance Process at PLN UP2D Central Java-DIY

There are many differences in views in the methods used in maintaining electricity distribution equipment at PT PLN. As previously explained, there are different maintenance methods in the transmission and distribution sector. Although there are standards in carrying out maintenance, namely in the National Electricity Company Standard (SPLN), there are still differences due to the different conditions of equipment and personnel in each field.

For maintenance at transmission, respondents said they prioritized corrective maintenance over preventive maintenance. The maintenance method used is more suited to condition-based maintenance by repairing the tool more frequently than maintaining its performance regularly. Thus, in the transmission sector, according to respondents, more force outages were carried out on purpose.

Meanwhile, in the distribution sector, there is more routine maintenance or preventive maintenance. This was conveyed by the respondent not without basis, but because the equipment that works in the distribution sector is more frequent and affected by interference than transmission, so it needs more frequent maintenance.

With what is usually done at PT PLN, the distribution side will follow the transmission maintenance schedule if the transmission transformer goes out, so it will reduce the disconnection of electricity continuity on the customer side. Furthermore, according to respondents, the distribution gets around the infrequent schedule of outages from the transmission, by adding an independent maintenance schedule from the distribution side. Maintenance schedules on the distribution side, at the beginning of the year or the first semester, will be mostly done on the preventive side. Meanwhile, in the following semester, according to respondents, a lot was done on the corrective side. This, according to respondents on the distribution side, uses more collaborative methods between preventive and corrective.

Furthermore, the respondent conveyed a special statement that the transformer maintenance schedule on the distribution side during the Covid-19 pandemic was cut by 20% so that costs and operational personnel were also reduced.

5. Conclusion

Maintenance or repair of electrical equipment is not simple to do considering that electrical equipment must be turned off for the safety of maintenance workers. To create reliable electricity, PT PLN always tries to prioritize customer satisfaction by minimizing downtime and zones.

The author analyzes from the results of interviews with respondents and can conclude that so far, in addition to the many different views of the perpetrators, that preventive maintenance has the most effect on the reliability of electricity. This was conveyed by respondents during the interview at the end, that preventive maintenance policies can reduce equipment failures due to:

- Routine maintenance performed can predict equipment failure early thorough inspection of existing equipment.
- Routine maintenance reduces schedule outages (force outage) due to equipment failure.
- Routine maintenance (Time Based Maintenance) indirectly reduces operational costs compared to condition-based maintenance (Condition Based Maintenance) because of the cost of making repairs decreases.

From the interviews with these respondents, it can also be concluded that the differences in transmission and distribution in the maintenance methods produce different results. On the transmission side, which uses the Condition Based Maintenance method, maintenance will more often be done unplanned or suddenly. So that the operational costs are more often used to repair. Then in terms of reliability, according to respondents, transmissions often perform force outages or forced blackouts.

As for maintenance on the distribution side using Preventive Maintenance, reliability can be maintained compared to the CBM method. This is because the preventive method of equipment failure can be predicted in advance by routine inspection and maintenance beforehand.

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