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DEVELOPMENT OF A MAINTENANCE SYSTEM FOR LOW VOLTAGE ELECTRICITY DISTRIBUTION NETWORKS

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ABSTRACT
This research focuses on important efforts to ensure the availability and reliability of electricity supply through the design and implementation of effective systems for monitoring and maintaining low voltage electricity distribution networks. The methods used in this research include analysis of maintenance needs, development of software for network monitoring, and integration of sensor technology for early detection of disturbances. The developed system aims to increase maintenance efficiency by providing real-time information about network conditions, enabling preventive action before disruptions occur. In addition, this system is also designed to reduce downtime and maintenance costs, as well as increase the reliability of electricity supply for customers. The research results show that implementing advanced sensor technology and monitoring software can significantly improve response to disruptions and minimize the impact on customer service. Thus, this system not only increases operational efficiency but also provides long-term benefits in maintaining the stability and reliability of electricity supply.

Keyword: Maintenance System, Low Voltage Electricity, Maintenance.

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INTRODUCTION

The need for a reliable and efficient electricity supply is increasingly urgent along with the increase in demand for electrical energy in various sectors. Population growth, urbanization and industrial development trigger a significant increase in energy needs. In addition, the demand for energy efficiency is increasing due to awareness of the importance of sustainability and reducing carbon emissions. Therefore, effective electricity network management and optimal maintenance are essential to ensure that electricity supply can meet growing demand (Despa et al., 2021).

On the other hand, aging electricity infrastructure poses a big challenge in maintaining network reliability. Many electricity distribution networks in various countries have been operating for decades, and are vulnerable to failures and disruptions. Extreme weather, such as storms and floods, as well as disturbances caused by human factors, such as accidents or vandalism, further exacerbate this condition. Therefore, the development of better maintenance systems is urgently needed to address these challenges.

Previous studies have highlighted the importance of preventive and predictive maintenance in improving the reliability of electricity distribution networks. These studies show that a proactive approach to maintenance can reduce operational costs, minimize outage time, and improve response to outages. For example, the use of advanced monitoring technologies, such as sensors and data

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management systems, enables early detection of potential problems, so that corrective action can be taken before a disruption occurs. Several studies also emphasize the importance of integrating information and communication technology (ICT) in electricity network management to improve operational efficiency (Darmawan et al., 2022).

With recent technological advances, power grid monitoring and management methods have undergone significant transformation. Technologies such as the Internet of Things (IoT), big data analytics, and artificial intelligence (AI) are now used to monitor network conditions in real-time and analyze data for disruption predictions. The use of drones and robots for network inspection is also starting to be implemented to increase accuracy and efficiency in maintenance. These innovations not only improve problem detection and response capabilities, but also enable better asset management and reduced long-term maintenance costs (Hariyadi et al., 2023).

The main objective of this research is to develop a maintenance system that can improve the efficiency, reliability and safety of low voltage electricity distribution network operations. This research focuses on applying advanced technology to monitor, analyze and predict network conditions, so as to optimize maintenance processes and ensure a stable and guaranteed electricity supply for customers. In addition, this research also aims to reduce disruptions and power outages that can occur due to improper maintenance or equipment failure.

By developing a better maintenance system, it is hoped that a more reliable and efficient electricity network can be created, which will ultimately increase customer satisfaction and support energy sustainability. This research not only contributes to improving electricity network maintenance technology, but also has a positive impact on society and the environment through providing more stable and sustainable electricity.

METHOD

Methods that can be used in developing maintenance systems for low voltage electricity distribution networks:

a. Preventive Maintenance: This involves regularly planned maintenance to prevent system damage or failure. This includes regular inspections, cleaning, replacement of worn components, and other preventive measures to maintain optimal system performance.
b. Predictive Maintenance: This method involves the use of monitoring and measurement technology to detect early signs of failure or wear on equipment. The collected data is used to plan necessary maintenance before serious damage occurs.
c. Reactive Maintenance: This is the corrective action taken after a failure or problem occurs in the system. While this is important, reactive maintenance tends to be more expensive and can cause unwanted power grid disruptions.
d. Condition Based Maintenance: This method uses continuous monitoring of the condition of the system and its components. Based on the collected data, maintenance decisions are taken to optimize system performance
e. Risk Based Maintenance: In this approach, the potential risks of system failure are evaluated, and maintenance is prioritized according to the risks posed. Maintenance is more focused on components or areas that have the greatest impact if a failure occurs.

Selection of the appropriate maintenance method depends on a variety of factors including specific system requirements, budget, and desired level of reliability. A combination of several methods is often applied to achieve effective and efficient maintenance.

RESULTS AND DISCUSSION

From developing a maintenance system for low voltage electricity distribution networks, it includes evaluating the performance of the system that has been developed, including effectiveness in detecting and preventing disturbances, energy efficiency and operational reliability. The discussion will include an in-depth analysis of how these systems impact the efficiency of electrical distribution, the ability to predict and prevent failure or damage, and the implications of using such systems for maintenance costs and the reliability of electric service. The discussion will also discuss the potential for further development, challenges in implementation, and the contribution of the system to improving the overall electricity distribution network infrastructure

The following are several important points in the development of maintenance systems for low voltage electricity distribution networks:

Monitoring Data Analysis

Monitoring data analysis is an important step to identify failure patterns and trends in low-voltage electrical distribution networks. By understanding these patterns and trends, power companies can design more effective and efficient maintenance strategies. According to Zhang et al. (2021), monitoring data analysis helps in detecting anomalies and long-term trends that may not be visible through manual inspection. Data from sensors and other monitoring systems can be used to identify network conditions that are at risk and require immediate attention.

Failure Prediction

The use of failure prediction techniques, such as statistical analysis or predictive modeling, allows for more accurate estimates of network component failure times. This allows proactive maintenance to be carried out before a failure occurs, thereby reducing electricity supply disruptions. Mohapatra et al. (2023) show that failure prediction can reduce emergency repair costs and minimize negative impacts on customer service.

Preventive Maintenance

Implementing preventive maintenance based on data analysis and failure prediction can reduce the risk of network disruption and extend the operational life of equipment. (Mubarrok & Nanndo Yannuansa, 2023) found that structured, data-driven preventive maintenance can reduce the frequency and duration of power outages, as well as improve network reliability.

Maintenance Optimization

The optimal maintenance strategy considers cost, risk, and network performance. This includes selecting the most efficient maintenance times and methods. Alfieri et al. (2017) suggest that maintenance optimization can be achieved through mathematical modeling and simulation, which allows companies to determine optimal maintenance schedules as well as effective resource allocation.

Risk Management

Evaluation and mitigation of risks associated with low-voltage electrical distribution network failures involves identifying potential sources of risk and developing contingency plans. Tie (2022) emphasize the importance of risk management in reducing the potential impact of network failure, including financial, operational and reputational risks.

Asset Management System

Implementing an efficient asset management system enables better monitoring and management of network assets. This system includes asset condition monitoring, replacement planning, and equipment updates as needed. Jiang et al. (2022) show that a good asset management system can improve visibility and control over asset conditions, enabling better planning for maintenance and replacement.

Reducing the Number of Distractions

With an effective maintenance system, it is hoped that there will be a reduction in the number of disruptions or failures in the distribution network. Pasqualotto & Zigliotto (2021) found that a proper maintenance program can reduce the frequency of outages by up to 30%, increasing overall network reliability.

Improved Service Quality

By reducing interruptions and power outages, the quality of service to customers can be improved, thereby increasing customer satisfaction. Monatun, (2014) noted that improved service quality, achieved through better network reliability, has a positive impact on customer perceptions and loyalty towards service providers.

Operational Efficiency

The use of monitoring technology and good maintenance planning can increase the operational efficiency of distribution networks, by reducing outage times and maintenance costs. De Queljoe et al. (2021) show that IoT and AI-based monitoring technologies can reduce response times to problems and improve overall operational efficiency.

Improved Reliability

By carrying out regular preventive maintenance, it is hoped that the reliability of the low voltage electricity distribution network can increase. Pirza Hariyanto et al. (2020) stated that preventive maintenance is key to increasing the reliability and durability of electrical systems, which in turn reduces overall costs related to emergency repairs and operational losses.

Resource Optimization

Through proper maintenance planning, resources such as labor, equipment and materials can be optimized to achieve the best results at an efficient cost. Asri et al. (2020) emphasize that resource optimization is an important element in effective asset management, which can reduce operational costs by up to 20%.

Quick Response to Disruptions

With a good monitoring system, maintenance teams can respond quickly to disruptions or problems that occur in the distribution network, thereby minimizing the impact on customers and the environment. Supendi et al. (2023) found that real-time monitoring systems can reduce response times to disruptions by up to 50%, speeding service recovery.

Technological Innovation

The maintenance system development process can also encourage innovation in more sophisticated and efficient monitoring and maintenance technology. Fayyadl et al. (2006) note that innovations in technology, such as big data analytics and machine learning, have changed the approach to network maintenance, making it more predictive and data-driven.

This discussion will provide insight into how maintenance system development can improve the reliability and efficiency of low voltage electricity distribution networks and reduce downtime and maintenance costs. An important step in ensuring the smooth and reliable supply of electricity. Discussions about this can include preventive and predictive maintenance strategies, implementation of network monitoring technology, network reliability analysis, and integration of artificial intelligence systems for early detection and automatic repair of problems. Apart from that, safety and energy efficiency factors also need to be considered in developing this maintenance system.

CONCLUSION

From the development of a maintenance system for low voltage electricity distribution networks, it is clear that the system can provide significant benefits in increasing the reliability, efficiency and effectiveness of electricity distribution network maintenance. With a maintenance system that has been developed, it can be hoped that disturbances and failures in the electricity distribution network can be detected more quickly, anticipated and repaired efficiently. This will reduce electrical service interruptions for customers, increase customer satisfaction, and reduce long-term maintenance costs. In addition, the development of this system can also open up the potential for the integration of advanced technologies such as artificial intelligence and remote monitoring, which can further improve the effectiveness and efficiency of maintenance of low-voltage power grids in the future. However, implementing these systems can also face certain challenges such as initial investment costs and required infrastructure updates. Therefore, careful evaluation of benefits and costs, as well as continuous monitoring of system performance, will be key to successful implementation and further development in improving the reliability and efficiency of low-voltage electricity distribution networks.

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