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SELF-HEALING MECHANISM BASED ON FAULT MANAGEMENT FOR SMART-GRID DEVELOPMENT ON 20kV SPINDLE NETWORKS TO IMPROVE DISTRIBUTION SYSTEM RELIABILITY AT JAKARTA

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Abstract: The addition of new substations has an impact on the reconfiguration changes and the addition of new networks in the context of loading feeders and causing the topology of the distribution network to be increasingly complex and impure spindle systems, in addition to the jammed condition of Jakarta also has an impact on the longer time in investigating disturbances, as well as the limited investment budget of PLN (State Electricity Company in Indonesia) has not supported the installation of new keypoints in all distribution substations. This study aim is to study for the development of smart grid with the implementation of network automation in the spindle system to improve reliability, revenue and customer experience in the priority areas of PLN UID Jakarta. This research was carried out by system modeling in the SCADA Distribution Management System for N-1 contingency and a simulation of the Self-Healing Mechanism test based on static and dynamic data parameters in real-time according to the Load Flow and Load Forecast in the SCADA systems. Evaluation of technical and financial feasibility as a smart feeder design that will be implemented in the spindle system, on the other hand, it is expected to be a Distribution Grid Management design that is feasible to be implemented in the 20kV Spindle system as an alternative to Zero Down Time to accelerate the recovery time of distribution disruptions and improve reliability performance in controlling the operation of the distribution system at PLN UID Jakarta.

Keywords: recovery time, distribution automation system, system average interruption duration index, fault management.

INTRODUCTION

PLN (State Electricity Company in Indonesia) as a government corporation in the electricity sector has officially started the "PLN Transformation" program since April 21 2020 to improve the company's performance according to existing challenges. This transformation was motivated by changes/transformations in the electricity system, technological developments, and also internal challenges faced by PLN. One of the fundamental changes that occurred was the change in business strategy from supply driven to demand driven. This transformation gave birth to many Transformation initiative programs as corrective action steps in every line to achieve a Green, Lean, Innovative and Customer Focused company. PLN's transformation consists of four main aspirations, including Green, Lean, Innovative and Customer-focused [1].

Meanwhile, PLN has 24 breakthroughs or strategic initiatives, 12 of which are digital-based developments, namely: digital power plant, digital procurement, digitally enabled distribution excellence, dispatch optimization, antiblack-out, advanced meter infrastructure (AMI), billing and collection organization, fiber optics rollout, electric vehicle infrastructure, outage management, PLN Mobile relaunch and digitally enabling execution machine. Of the 24 strategic initiatives, there are several programs that are relevant and related to the smart grid, including: digital power plant, digitally enabled distribution excellence, dispatch optimization, antiblack-out, advanced meter infrastructure (AMI), fiber optics rollout, electric vehicle infrastructure, outage management, green booster and PLN Mobile relaunch [1], [2].

Smart Grid system that combines information technology and two-way digital communication in the electricity process starting from generation, transmission, distribution and retail/consumer to increase system reliability, efficiency and resilience, minimize environmental impacts, accommodate all types of electrical energy production and storage technology and increase the role of consumers in the electricity market so as to create new, sustainable products and services [3], [4], [5].

Indonesia has unique electrical energy supply challenges caused by the physical and natural nature of our country, namely being separated into five large islands and we are challenged with relatively high electricity production costs because electric power cannot be transmitted between neighboring islands as can be done by electricity companies such as in mainland Europe or North America. This geographic challenge makes balancing supply and demand more difficult because PLN cannot rely on the island's more established and reliable electricity grid to help overcome the short-term problem of electricity supply imbalances on other small islands. Smart Grid modernizes the electric grid allowing for a more flexible network when integrating renewable energy, increasing reliability and efficiency, helping the environment, and lowering costs—all without compromising safety or quality of electric service. Additionally, Smart Grid allows customers to make choices that better suit their energy needs and preferences [5], [6].

PLN continues to encourage the development of smart grids to answer challenges and disruptions in the supply of electricity. The smart grid is part of PLN's Long-Term Plan for 2020-2024 and PLN's draft Electricity Supply Business Plan (RUPTL) for 2021-2030. For the short-term period (2021-2025), smart grid development will focus on reliability, efficiency, customer experience and grid productivity. Some of the programs that will be carried out include digitalization of generators, automation of transmission and distribution substations, distribution grid management, building electric vehicle and e-mobility infrastructure, implementing smart micro grids, and implementing Advance Metering Infrastructure (AMI) in stages. Meanwhile, from 2026 onwards, smart grid development will focus on resilience, customer engagement, sustainability and self-healing [1], [7].

One of the breakthrough programs related to distributed grid management is the "Digitally Enabled Distribution Excellence" program. The Digitally Distribution Enabled Excellence program is basically a digitalization program to provide excellent service to customers in obtaining electricity supplies. This program has 3 targets, namely improving the operation and maintenance system, reducing network losses and increasing reliability [1], [7].

Distribution Grid Management is related to the modernization of networks that are currently installed, starting from the need to increase network reliability (reducing SAIDI and SAIFI), or minimize losses in the network. The method chosen to increase network reliability is to implement Zero Down Time (ZDT) and also Self-Healing Grid based on Fault Management [8], [9], [10], [11].

The high demand for the reliability of the electricity distribution network continues to increase, this results in the need to modernize and utilize computerization. Electricity for modern society has become as important as human blood vessels, so that if the electricity supply is cut off, the process of community activities, especially in urban areas, will also be disrupted. Moreover, if this happens to customers in large electricity tariff categories, especially business or social, it will certainly have a significant impact on social costs [12], [13], [14], [15].

PLN UID Jakarta's electrical energy needs are increasing with the increasing number of customers who always demand higher levels of electrical energy services such as continuously better quality, stability and reliability. However, power outages still occur due to activities on the 20 kV electric power system which are caused by planned (maintenance) and unplanned (interruption) activities. From a technical perspective, widespread outages reduce the reliability of the PLN distribution network. Meanwhile, from an economic perspective, this is detrimental to PLN because it cannot sell electrical energy to areas that do not experience disruption. Apart from that, widespread blackouts also reduce the level of customer service satisfaction and give PLN a bad image in the community [1], [7], [16].

Jakarta is a barometer for the quality and reliability of national electricity so it is necessary to improve customer experience towards World Class Services, especially areas with high revenue and VIP/VVIP so reliability must be improved and ENS minimized due to Unplanned Outage. The current condition of distribution reliability is greatly influenced by Medium Voltage Cable Channels and Jointing as the dominant cause of Unplanned Outage, so that load recovery and evacuation scenarios are needed in the event of a blackout to fulfill the N-1 contingency in order to accelerate maneuvering in the event of a disruption [1], [7], [16].

In accordance with the Jamali Distribution Priority Program for 2024 and the Realization of Reliability Performance of PLN UID Jakarta, the realization of the System Average Interruption Duration Index (SAIDI) target in 2023 is 29.86 minutes/customer, so a strategy to increase distribution system reliability is needed. According to PLN's RUPTL until 2024, it is planned to add 20 new main substations from the existing 60 main substations, as a result, this will result in reconfiguration changes and the addition of new networks in the context of feeder loading and causing the distribution network topology to become increasingly complex, not pure spindle systems changing to mixed and mesh, therefore the load evacuation scenario must always be updated to fulfill the N-1 contingency. Jakarta's congested conditions also have the effect of taking longer for officers to investigate disturbances. Apart from that, PLN's limited investment budget does not yet support the installation of new Keypoint points at all distribution substations. Therefore, an accelerated disruption recovery program is needed to increase the reliability of the distribution network with economical investment costs but the Service Quality Level (TMP) is maintained in controlling distribution system operations at PLN UID Jakarta [1], [7], [16]. This research aims to analyze the feasibility of optimizing a Distribution Automation System by implementing Fault Management based on Fault Locator and Short Circuit for the Smart Feeder program on a 20kV spindle network for developing a distribution system as an alternative to Zero Down Time.

RESEARCH METHOD

This research consists of several stages, where each stage becomes one inseparable phase. The scope of research related to the study of smart grid development by optimizing the SCADA DMS FLISR (Fault Location, Isolation and System Restoration) system to increase reliability, efficiency and customer experience at PLN UID Jakarta, includes:

a. Collection of technical data specifically related to Fault Management based on Fault Locator and Fault Current on the 20 kV network side.
b. Mapping the condition of existing PLN assets, concepts and technology in implementing DAS (Distribution Automation System) to support the ZDT (Zero Down Time) program.
c. Carrying out feeder assessments as a watershed development study with the FLISR (Fault Location, Isolation and System Restoration) program.
d. Carrying out simulations using the Siemens Spectrum 7.2 SCADA Master Software at PLN UP2D Jakarta.
e. Conduct operational feasibility studies related to the implementation of DAS with FLISR based on Fault Management.

RESULTS AND DISCUSSION

Zero Down Time Design

The reliability of the electric power system from upstream to downstream is expected to improve the quality of electrical energy supply to customers. In an effort to increase the reliability of the electricity distribution system and improve electricity supply services to the community, PLN is implementing a Zero Down Time (ZDT) system. The ZDT program is an effort to reduce customer complaints related to power outages and disruptions. This program targets no power outages throughout the year [8].

ZDT is an electric power distribution concept from PLN in an effort to increase network reliability without power outages in main business areas such as SCBD. The SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index) figures in Indonesia have continued to decline in the last 3 years [1], [7], [8], [16].

The SAIDI value in Jakarta is 272.4 minutes/customer and the SAIFI value is 1.40 times/customer, this can still be improved much better, see. To realize this need, PLN needs to implement the ZDT concept for electricity distribution. ZDT also focuses on achieving a very high level of reliability while also paying attention to the comfort of PLN electricity consumers, especially in very strategic areas [1], [7], [8], [16].

ZDT is part of one of PLN's strategic goals, namely Digitally Enabled Distribution Excellence, to realize a streamlined electricity supply. As one of PLN's stages in implementing the ZDT concept in Indonesia, PLN uses the ZDT Breakthrough Initiative analysis as PLN's transformation program towards the use of ZDT. ZDT is a concept developed by PLN and has the potential to be developed for wider and more complex systems, so there needs to be a description of the configuration that is capable of using the ZDT system. The main protection on the ZDT is the Line Current Differential relay, but there needs to be an alternative protection system if the Line Current Differential doesn't work [1], [7], [8], [16].

The ZDT concept can provide operational benefits for consumers and operators, including making it easier for regulators or dispatchers to determine which segments are experiencing electrical disturbances with the help of differential relays installed on each existing network. Apart from that, ZDT also reduces the occurrence of blackouts due to network maintenance because ZDT uses a cable network that does not require routine maintenance so that the application of ZDT can reduce the SAIDI and SAIFI index values in the electric power system network [1], [7], [8], [16].

PLN also provides services to ZDT customers, namely PLN will provide services without power outages under any conditions, PLN will provide mobile generators that can compensate for the electricity supply when there is an electricity disruption, PLN will provide a reduction in electricity costs if a blackout does occur, PLN will provide executive accounts along with free consultations to customers to serve when there is a disruption in the ZDT system [1], [7], [17].

Fault Detection and Automation Design

Regarding increasing the reliability of the distribution system and the continuity of electricity distribution, this can be done by narrowing the area of interference that occurs. One way to narrow the area of interference that occurs is to use a Loop Scheme system with the help of an actuator in the form of a Recloser. This system is used to detect faults in a distribution system, then isolate areas affected by faults, and restore the electricity distribution network in areas affected by faults. The Loop Scheme system uses a Recloser component which is placed between Substation Feeders which are installed in series. This Loop Scheme system is expected to be able to detect faults in the distribution system quickly so that it can reduce the occurrence of power outages in an area and maintain electricity distribution in areas that are not affected by faults [10]. As technology continues to develop, the Loop Scheme system also develops and currently, the use of detection, isolation and restoration systems in distribution systems uses automation systems to make operations more efficient and easier to operate. This is characterized by the existence of Supervisory Control and Data Acquisition (SCADA) to monitor and process the database using real time data in the system. With the development of SCADA, there is a detection, isolation and restoration system that uses SCADA technology, namely Fault Location Isolation and Service Restoration (FLISR) [18], [19], [20], [21]. The Fault Detection and Automation system is implemented to obtain a safer and more optimal distribution system. One example of the application of FLISR for monitoring distribution systems such as DMS and SCADA, includes for example the Medium Voltage Air Line (SUTM) which is explained in Figure 1 and the SKTM in Figure 2.

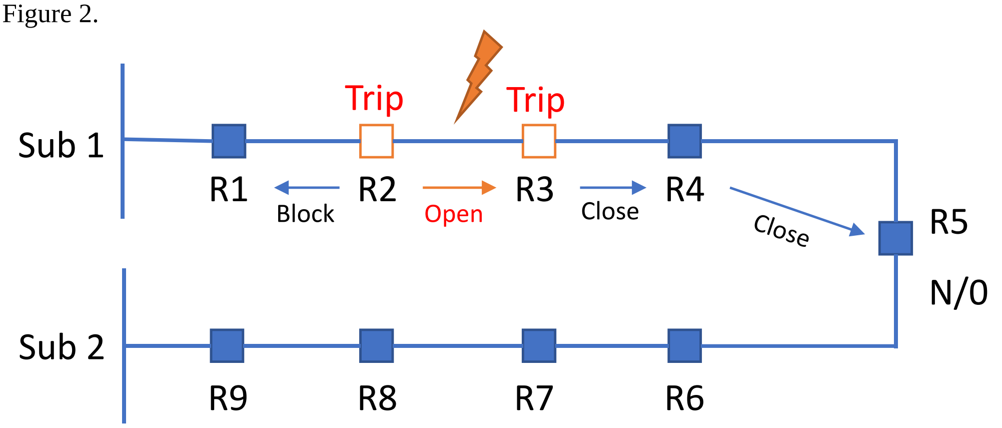

Figure 1. Application of FLISR in SUTM Network Loop configuration.

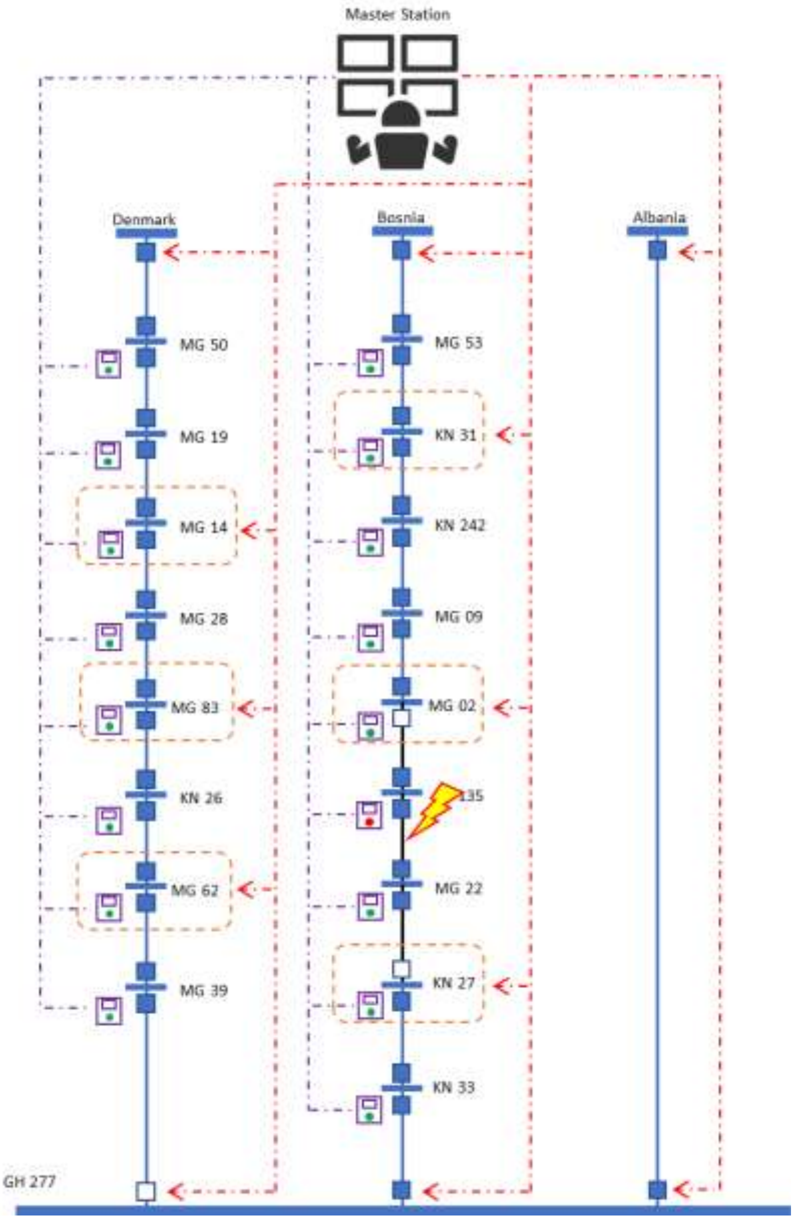

Figure 2. Application of FLISR in the SKTM Network with Spindle configuration.

According to Figures 1 and 2, FLISR is a distribution network automation system that will automatically perform the function of opening and closing the Circuit Breaker (CB) or Load Break Switch (LBS) when a disturbance occurs by quickly detecting the disturbance so that it can isolate and speed up recovery of safe points from disturbances by using several technological systems others such as Automated Feeder Switches and Reclosers, Line Monitors, Distribution Management System (DMS), Outage Management System (OMS), and Supervisory Control and Data Acquisition (SCADA). In other words, FLISR is a method of controlling switching devices in distribution networks to increase the reliability of electricity distribution channels. It is hoped that by implementing the FLISR system, the electricity distribution system can reduce the time it takes to find the location where tripping is occurring and isolate the location quickly and restore the distribution system [18], [19], [20], [21].

Integrated FLISR uses automation devices such as SCADA so that it can implement DMS operations and it has been proven that the FLISR module from DMS is very applicable to real conditions and has been running in several distribution systems in Indonesia. This operation can be carried out by exchanging signals or communicating with the FLISR system itself so that monitoring and controlling the electricity distribution system can be carried out automatically. With the further development of basic SCADA technology, the development of the FLISR system will also be supported and its operation more optimal as part of the DMS. There are 2 parameters that can be used to evaluate the performance of FLISR, namely the number of

Customers Interrupted (CI) and the number of Customer Minutes of Interruption (CMI) and these two parameters are parameters used to measure the System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI) [18], [19], [20], [21].

FLISR can reduce the CI value by up to 45% and CMI by up to 51%, therefore the use of FLISR can improve the performance and efficiency of the Electrical Distribution System. On the other hand, the DMS operating system requires an operator or dispatcher to control and operate the work of the system. By implementing FLISR in a DMS, the operator is given the choice to operate it, namely Fully Automatic, Semi-Automatic and Manual operation [22].

The application of FLISR to the electricity distribution system in Indonesia will maximize the efficiency of electricity production in Indonesia by reducing losses incurred when a disturbance occurs at one of the feeders in the distribution system. One component of the application that is important to pay attention to when using FLISR is the communication system between the FLISR system and the operator and several technologies used to assemble a FLISR system, so it requires high costs to replace the existing distribution system with this FLISR system starting from maintenance, purchase price, software used, and the cost of installing the components [19], [20].

*Fault Detection and Automation*that can be implemented in the Jakarta's metropolitan electrical system is FLISR technology, as conceptually explained above, but to be able to implement the FLISR concept, there need to be several criteria that must be met. In terms of the purpose of the technology application, FLISR has the same goal as the ZDT concept, namely minimizing disruptions experienced by customers, or in other words improving the value of SAIDI and SAIFI. However, there is a difference in that in the ZDT concept, interference on the network is isolated between the two distribution substations that have ZDT implemented, so that the security on the main substation side does not need to be active and disconnect the line. Meanwhile in FLISR, interference on the channel still keeps the security on the substation side active, so that customers still feel interference on the network, then the interference is isolated by a Key Point (KP) that has been determined on the relevant feeder [20].

FLISR is one of the features of DMS, so it is necessary to ensure that the FLISR feature itself is included in the DMS features that are already available at PLN UID Jakarta [20]. Based on asset data information at PLN UID Jakarta, the DMS features that are available are DSPF, DSSE, FM, SCC, OFR, DV, and OMS. Considering that Jakarta's medium voltage distribution system is very large, complex and has a lot of potential for network maneuvering, the Centralized FLISR system would be more suitable for application in Jakarta.

Distribution Network Automation

Some of the data collected to implement distribution network automation includes distribution substation asset data, SKTM and SCADA, power flow and load profile data, historical data on distribution disruptions, data on realization of Recovery Time, SAIDI SAIFI and ENS, data on construction plans for main substations, SLD and Operational SOP, SCADA and Telecommunications Roadmap, and short circuit current data [19]. The SCADA system (explained in Figure 3) at the Jakarta location is installed at PLN UP2D Jakarta, which consists of hardware and software in the form of a Master Computer consisting of a server and Front-End Computer, data communication facilities consisting of Modem, Radio, Fiber Optic, GSM, Remote Station, and supporting equipment.

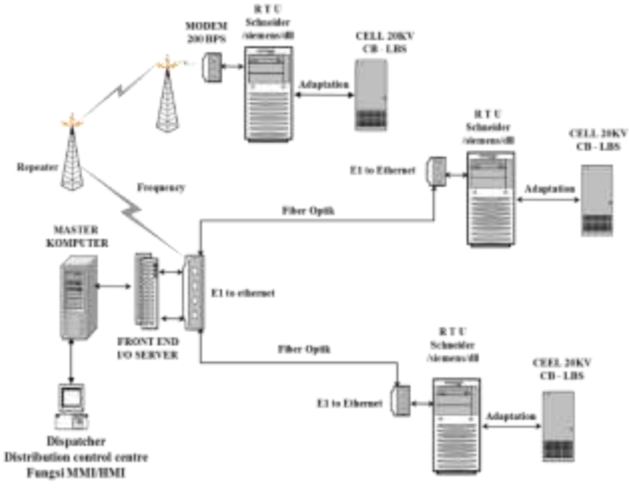

Figure 3. SCADA Equipment UID Jakarta.

Master Station of SCADA (see Figure 4) installed on PLN UID Jakarta is classified as level 3 category based on SPLN S3.001: 2021 where DMS and DTS servers are available, with a system description as in Figure 5.

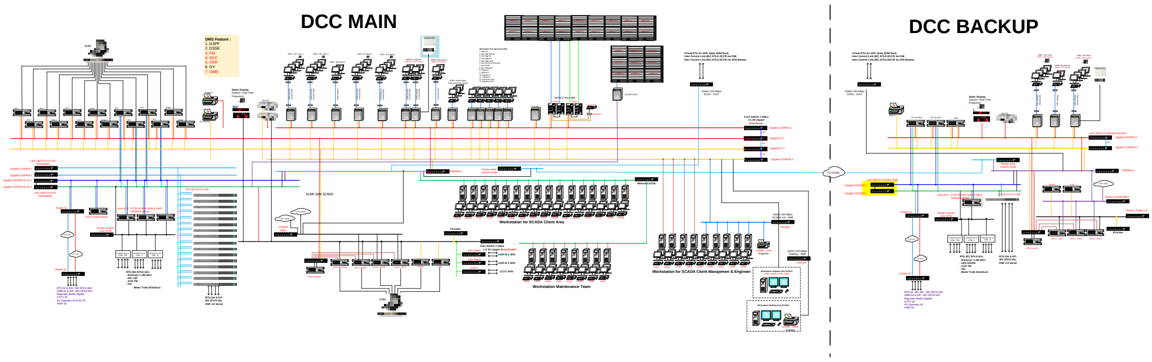

Figure 4. SCADA Master Station.

SCADA *Remote Station* was shown in Figure 4, with the existing condition configuration installed at the main substation. Apart from that, there are also SCADA facilities at the KP (Key Point) and also the Switching Substation. *Key Points*is a distribution substation located in the middle of a feeder line which generally has communication facilities and capabilities for long distance operations. Determining this key point substation must consider aspects of reliability, revenue and social aspects. Currently the key point substation installed at PLN UID Jakarta has a ratio of 4/1 (1 key point for every 4 distribution substations).

20kV System Modeling

The 20kV system modeling was carried out in DMS and then the Load Flow simulation program was carried out in Master SCADA. If the Load Flow is not optimal, the Optimal Feeder Reconfiguration (OFR) process will be carried out to configure the 20kV system modeling and the Load Flow will be run again. The Distribution Automation System program with the implementation of Fault Management based on Fault Locator and Short Circuit for the Smart Feeder program on the 20kV spindle network is carried out with the DMS function in the Master SCADA Fault Locator (FLOC) module and Fault Isolation and Service Restoration (FISR) becomes the FLISR function by optimizing the module Distribution Network Analysis (DNA). Then, in carrying out the simulation process, the Distribution Network Analysis (DNA) module, namely Distribution System State Estimator, Short Term Load Scheduler and Distribution System Power Flow continuously in Master SCADA [20]. Figure 6 is a snapshot of the 20kV system modeling in Master SCADA.

Figure 5. Modeling a 2kV system in Master SCADA.

On the other hand, the FLISR algorithm is used to determine if a 20 KV Feeder Disturbance occurs, the CB/CBOG will Open/Trip and send a CBTR signal and Type of Disturbance to the Master Station which triggers the DCC Alarm to sound. After the CBTR and Type of Interruption are received by the Master Station, DMS will then check network connectivity of the *spindle.* If it is connected, the DMS will be active, then it will check the FI (Fault Indicator) and LBS status on the 20 KV network. After completing the check, the DMS will then determine the fault segment of the fault point. After determining the fault point segment, FLISR then ensures the enable/active status, so that the stage of determining the Isolation and Restoration scenario can be carried out. After determining the isolation and restoration scenario, a quality flag is then carried out to ensure the RC readiness status of the feeder. If the quality flag is successful, FLISR will then check the reservoir feeder current, and then carry out the fault isolation and restoration process. If the Isolation and Restoration process is successful, FLISR will send a Pop-Up Massage resulting from FLISR [19], [20].

1. *Semi-Automated Operation Pattern*

   In the semi-automated operation pattern, the condition of the 20 kV network will be evaluated by the system, then the evaluation results (Recommendations) will be decided by the operator (Dispatcher) whether to continue according to the recommendations or not. For example, if a disturbance occurs at one feeder, the SCADA application will directly provide recommendations to the Dispatcher on the HMI screen regarding the condition of the network at the time of the disturbance (the magnitude of the fault current, the switching that will be operated to maneuver/localize the disturbance and the magnitude of the end voltage at the during maneuvers), from these recommendations the Dispatcher will then make a decision whether the recommendation is implemented or not. So the semi-auto pattern is a network operating pattern that is evaluated by the system and then operated by the Dispatcher [20].

2. *Fully Automated Operation Pattern*

   In a fully automated operating pattern where network operations are fully evaluated and operated by the system. For example, if a disturbance occurs at a feeder, the SCADA application will directly evaluate the condition of the disturbed network, the results of the evaluation, then the SCADA application system operates medium voltage network switching to localize the area of disturbance and normalize areas that do not experience disturbance [19], [20].

FLISR Implementation

Based on the mapping of existing asset conditions, a case study will be carried out on the implementation of FLISR technology which is included in Distribution Grid Management [16]. FLISR can be implemented on predetermined feeders, in the following order:

1. Create an SLD model in the SCADA DMS software used.
2. After the model is created, the status of the substations along the feeder is synchronized with the model created in the DMS.
3. Drawing electrical parameters based on the installed SCADA, such as measuring the load on the feeder, fault status on the fault indicator, and so on.
4. Takes the amount of load on the anchor point and also the Keypoint. This can be done with the help of metering, but if metering is not available, an approach can be taken based on transformer loading or load flow calculations.
5. After the model and parameters are formed, a simulation can be carried out showing the work in a fully automated manner.
6. The next stage is field simulation, which can be done by injecting secondary current into the fault indicator, or by providing real interference.
7. Evaluate the performance of the FLISR system, and when it is ready, it can be implemented in the system.

FLISR implementation was carried out on SP2772, GH10, GH12, and SP1782 belonging to PLN UID Jakarta. Network configuration checks and other conditions that could disrupt the performance of the FLISR system after implementation are also checked, evaluated and repaired. After considering all of this to meet the previous technical requirements, all feeders owned by PLN UID Jakarta are suitable to be involved in FLISR [16].

SCADA DMS Network Model Parameterization

Modeling was carried out with *Sinaut Spectrum 7* software which is used as the master SCADA distribution at *PLN Main Distribution Unit Jakarta Raya* [16]. The testing process is carried out by simulating on the Distribution Operator Training Simulator server by taking dynamic data snapshoots according to real-time conditions, entered into study mode combined with static data and the FLISR algorithm is run automatically to isolate and restore disturbances.

DMS data is distribution system data covering feeders, substations and cables which is used to determine operational readiness data for the 20 kV distribution network [16]. DMS Data Modeling is a development of SCADA features to analyze 20 kV distribution system networks such as 20 kV distribution network connectivity. Meanwhile, the parameterization of the DMS data entered to carry out the automation process can be seen in Table 1.

Table 1. List of required DMS data parameterizations.

No.	Parameterization	Information
1.	Distribution Substation Load	Distribution substation load data includes information such as voltage, current and power at the distribution substation at a certain time. This allows the DMS system to identify the load distributed in an area or distribution substation in real time.
2.	Distribution Substation	Distribution substation data includes substation capacity, equipment condition, as well as 3 operational patterns in normal operating conditions or abnormal operating conditions.
3.	Load Breaker Switch (LBS)	LBS readiness data is normal or not.
4.	Circuit Breaker (CB)	CB readiness data is normal or not.
5.	Busbars	Number of busbars installed
6.	Conductor Cable Type	Determining the resistance of cable insulation in distribution networks
7.	Conductor Cable	Length of cable in the distribution network
8.	Fault Indicator	Determine the type of fault such as short circuit, current leakage, or ground fault.

DMS data parameterization is carried out by adding static data to the distribution substation load profile, distribution substation type, switching type, busbar, conductor cable type, conductor type, and fault indicator data. Parameterization in Short Circuit Calculation (SSC) aims to determine the point or segment of the fault that occurs so that the fault location can be sent to the SLD with an indication of the Fault Location (FLOC) signal. Figure 6 displays the *input* process of SCC parameterization is carried out. On the other hand, Load Flow, Short Term Load Scheduler and State Estimator are run to estimate (forecast) distribution network conditions in real time so that the automation system can continue to operate in accordance with ideal conditions by considering historical daily loads, peak loads and the electrical energy produced [16]. Apart from that, the output of the Distribution Network Analysis application in Master SCADA for Distribution System Power Flow (DSPF) can be seen in Figure 7.

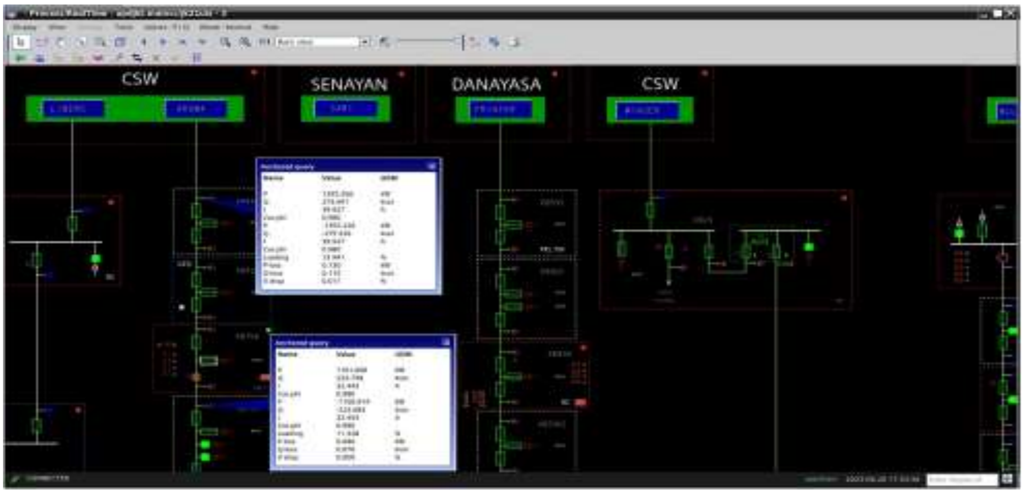

Figure 6. SCC Parameterization Input Process.

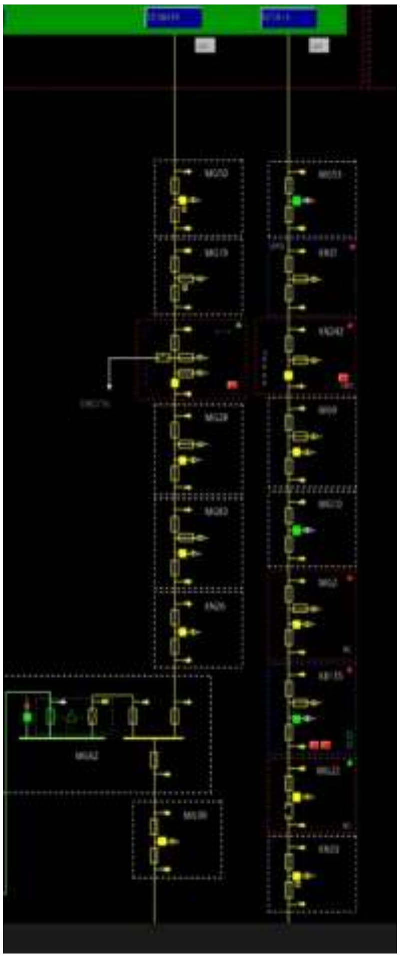

Figure 7. Illustration of Load Flow in Master SCADA.

Based on Figures 6 and 7, in the next stage, simulation testing is carried out on the system on the Distribution Operator Training Simulator (DOTS) of SCADA server. Simulations are carried out as analysis material to reduce the potential for failure in real-time system testing. The simulation testing process is carried out by taking snapshots of dynamic data according to real-time conditions and entered into study mode combined with static data and algorithms.

FLISR Testing

The automation system trial was tested using a disruption or trip scenario on the Pistil Feeder on the GH0038 Spindle. Apart from that, another test on the automation system was tested using a fault or trip scenario on the Poci Feeder on the GH0178 Spindle. On the other hand, the next trial was to test the automation system using a disruption or trip scenario on the Lae Feeder on the GH010 Spindle. Apart from that, other trials on the automation system were tested using a disruption or trip scenario on the Bosnian Feeder on Spindel GH0277. All test results produce outcomes that prove the implementation of FLISR on each feeder runs well and smoothly.

Operation Feasibility Analysis

The FLISR program, which has been parameterized and activated in the Master SCADA, has produced results of 9 disturbance events and FLISR has successfully worked perfectly in terms of detection, isolation and restoration with FLOC working. The FLISR program, which was run for 3 months, had an impact on improving the performance of SAIDI, SAIFI and ENS in 2024. The achievement of the unplanned SAIDI figure realized in May 2024 was 4.81 minutes/customer compared to the realization in May 2023 of 6.06 minutes/customer, there was a decrease of 21 %. SAIDI planned realization in May 2024 was 1.86 minutes/customer compared to realization in June 2023 of 4.36 minutes/customer, a decrease of 57%. Apart from that, the achievement of the SAIFI unplanned figure realized in May 2024 was 0.15 times/customer compared to the realization in May 2023 of 0.03 times/customer, a decrease of 21%. On the other hand, the achievement of the unplanned ENS figure realized in May 2024 was 339,008 kWH compared to the realization in May 2023 of 447,457 kWH, a decrease of 12%. ENS planned realization in May 2024 was 240,421 kWH compared to realization in June 2023 of 347,647 kWH, a decrease of 31%. SAIFI's planned realization in May 2024 is 0.03 times/customer compared to the realization in June 2023 of 0.06 times/customer, a decrease of 50%. On the other hand, in particular, the benefits of developing Distribution Grid Management with FLISR Implementation in the Spindle system [16]:

1. Increasing the reliability of the distribution network by accelerating recovery time for 20KV feeder disturbances. The benefits of accelerating recovery time with the FLISR system are from 10.01 minutes to 28 seconds.
2. The reduction in SAIDI as a result is directly proportional to the acceleration of feeder disruption recovery time. One measure of success in improving the quality of electricity services to the community is SAIDI (System Average Interruption Duration Index) or the duration of electricity interruptions/outages per customer.
3. Speeding up the implementation of smart feeders due to the ease of implementing automation systems with a Centralized system.
4. FLISR can be a standard Distribution Grid Management design for network automation that is feasible to be implemented in the Spindle network to accelerate recovery time for 20kV distribution system disruptions

Meanwhile, the acceleration of recovery time indicates that the implementation of excellent service has been realized so it is hoped that it can increase customer satisfaction and improve the company's image [16]. The development of a Distribution Automation System with the Implementation of Fault Location, Isolation and System Restoration (FLISR) based on FLOC and Fault Current is expected to be a design that is feasible to be implemented in 20kV spindle systems as a Zero Down Time alternative to accelerate recovery time for distribution disturbances and improve the performance of SAIDI, SAIFI and ENS at PLN UID Jakarta.

CONCLUSION

Optimizing the Distribution Automation System with the implementation of Fault Locator and Short Circuit based Fault Management for the Smart Feeder program on the 20kV spindle network for the development of a distribution system as an alternative to Zero Down Time is feasible to be implemented at PLN UID Jakarta with fairly good operational feasibility evaluation results.

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