Dijkstra Algorithm for Determination of The Location Feeder Distribution Network Interference

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Abstract **– The PLN (Persero) UP3 Manokwari consists of six feeders, each of which has up to 13–40 distribution transformers. When there is a disturbance, field officers (yantek) must go down each channel to locate the source of the interruption. It takes a significant amount of time and work. Dijkstra's algorithm is an algorithm for finding the shortest path between two points in a weighted graph. Djikstra's algorithm performs the shortest route calculation more simply and has a superior running time because the work system spreads over each graph node. The authors used the Dijkstra algorithm approach to calculate the shortest path at the point of interference. The goal of this research is to find the shortest path from the position of field officers (yantek) to the coordinate coordinates of network disruptions using the Dijkstra algorithm in the distribution network interference location detection application utilizing a mobile-based graph. The use of the Dijkstra algorithm in identifying the shortest path to the location of distribution network interruption at PLN UP3 Manokwari can assist field officers in locating the nearest route to the location of disruption with an accuracy of 98,33% as a result of this study.**

Keywords - Dijkstra's Algorithm, Shortest Path, Distribution Network Disruption, Graph.

I. INTRODUCTION

Problems in the electric power circulation system frequently arise, causing issues in the distribution of electrical energy to clients or buyers [1]. In general, interference distribution networks are classified into two types: internal disturbances induced by system faults and external disturbances caused by the operational environment, such as animal disturbances or being struck by lightning [2] [3]. The feeders for PT. PLN (Persero) UP3 Manokwari are made up of 13–40 distribution transformers. At the moment, If there is a disruption in the distribution line, The yantek officer must trace each feeder to find out the detailed location of the transformer that is experiencing distribution network disturbances, then traverse each feeder path to discover the fault spot. The yantek officer will go through each feeder and distribution transformer from each feeder to find the source of the disturbance, which of course will require a lot of time, money, and effort. related to the problems faced by these Yantek officers, then the author conducted research to establish the shortest path at the fault site.

Previous research relevant to the theme of this research is research with the title “Classification of points and Types of Disruptions for Efficiency of Standard Operating Procedures repair of Distributions Network Suppliers [4] and research "Determination location of disturbance of the electricity distribution network for efficiency SOP repair of distribution networks based on Google Maps" [5]. The author's initial research resulted in the classification of points and types of disturbances in the distribution network. To ensure that the disturbance occurs, the disturbance point is merely detected on the feeder without giving sub-coordinate information. The authors develop research by giving informed feeder coordinates and feeder subcoordinates where disturbances occur in the distribution network. The A* algorithm is used to determine the shortest path. Some of the limitations discovered in the A* algorithm in identifying the shortest route include that the A* algorithm requires a heuristic function that offers an estimate of the distance to the nearest target. Estimating the distance with high precision is challenging in the case of Determination of The Location Feeder Distribution Network Disturbance because one of the causes is the complexity of the network topology, and insufficient disturbance information. If the heuristic function is not correct, it may yield routes that are not optimal or take longer to compute. The A* Algorithm's next disadvantage is that it can have high time and space complexity, especially when utilized in large and complicated distribution networks. If the heuristic function is not correct, it may yield routes that are not optimal or need more calculation time. The next disadvantage is that the A* Algorithm can have significant time and space complexity, especially when utilized in large and complicated distribution networks. If there are undesirable loops or return pathways in the network, the A* algorithm cannot discover a valid and efficient shortest route.

The authors of this work used the Djikstra algorithm to identify the shortest path for detecting disruptions. Dijkstra's algorithm is a shortest path algorithm that works to solve the shortest path problem on a graph that has no negative values [8][9]. This algorithm is one of the greedy algorithm. Dijkstra's algorithm addresses the tracking problem in the shortest possible way, starting with a point and continuing to the next place where the diagram must have a positive weight [9]. This system will detect the closest route from the location of the disturbance using the Djikstra algorithm so that officers can deal with the disturbance quickly.

This system will detect the closest route from the location of the disturbance using Djikstra's algorithm so that officers can quickly overcome these disturbances. Algorithm Dijkstra is one of the most popular shorthand computation methods. Edsger W. Dijkstra is the researcher who defined Dijkstra's calculation in 1956 and distributed it in 1959. So, if the graph has negative weights, the path cannot be traversed, and the answer is infinity [11]. Because it only processes each point on the graph once, Dijkstra's algorithm is simpler and may be used to handle graphs. The pace is determined by the numberof points. Determine the answer using Dijkstra's calculations. Geographic Information Systems is a branch of planning that is now widely used for a variety of applications. The advancement of technologies has permeated all aspects of life today, one of which is a smartphone, whose benefits include GPS (Global Positioning System) advancements. Geographic numbers from GPS technologies can be used as directions [10].

Figure 1. shows that the Rajawali Feeder has 40 distribution transformers, the Cassowary Feeder has 28 distribution transformers, the Nuri Feeder has 61 distribution transformers, the Maleo Feeder has 13 distribution transformers, the Maleo Feeder has 28 distribution transformers, and the Merpati Feeder has 14 distribution transformers.

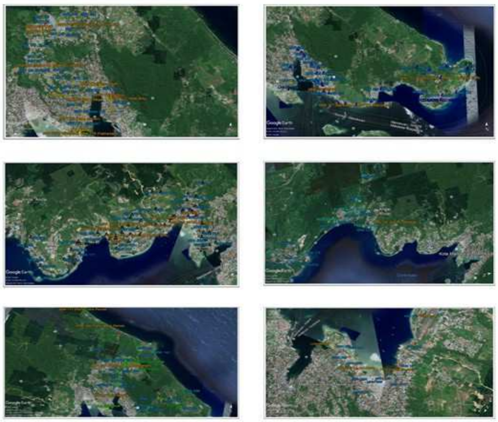

Fig. 1. Flow of the PLN UP3 Manokwari Feeder Distribution Transformer

In a power generation system, Figure 2. depicts the process of transforming mechanical energy into electrical energy. This cycle employs a transformer to generate voltage for future systems, most notably power transmission systems. Power is conveyed or sent to a remote location within the framework of electric power transmission. When the force is applied to a remote place, it passes through the transformer, and the voltage reduces to 20 kV. Then, employ the third system, the distribution system. The system provides the client with electrical capacity.

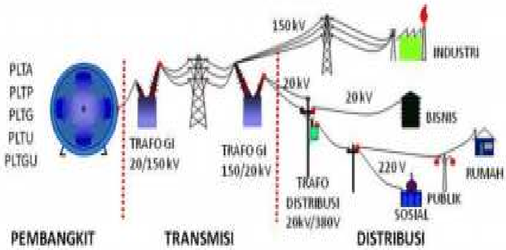

Fig. 2. Scope of Electric Power System

The electrical distribution system is divided into [11], for example, based on voltage: The Medium Voltage Network (JTM) connects the substation's optional side of the force transformer as well as the deployment substation. This network serves as the foundation for the Low Voltage Network (JTR), which connects the deployment substation to consumers. The current is 220 volts.

In the power deployment process, several main parts are needed that help the distribution of electric power, among them: Substation (GI) consists of buildings and electrical equipment that cover medium voltage networks (JTM), Tingi voltage networks (JTT), and extra high voltage networks (JTET) [10]. The Hubung Substation (GH) has the capacity to get electricity from the substation that is transferred to medium voltage, then deploy the electric force without changing the voltage through the evocative voltage network (JTM) to the substation or spread transformer. A distribution substation (GD) is a working electrical installation where there are breakers, connectors, safety transformers, and transport transformers to spread electrical voltage equivalent to customer pressure needs. The primary distribution network is useful for the distribution of electric power. Primary-sorted networks are fed by connecting substations or directly from the production focus. The secondary distribution network is responsible for channeling electrical force directly from the circulation transformer to the client.

II. Related Work

Some examples of similar work with the title "Dijkstra Algorithm for Determination of the Location Feeder Distribution Network Disturbance" [13], that can be used as a reference for research is "A Comparative Study of Shortest Path Algorithms for Network Routing" by R. K. Yadav; Giriraj Kishor; Himanshu; Kishan Kashyap: This study compares several shortest path algorithms, including Dijkstra's algorithm, for network routing applications. You can use this research as a reference to understand the strengths and weaknesses of Dijkstra's algorithm in the context of selecting fault locations in a distribution network.

The second article, entitled "Distribution Network Fault Location Using a Hybrid Algorithm," by Y. Zhou, S. Zhang, and Y. Chen: This study proposes a hybrid algorithm that combines Dijkstra's algorithm with genetic methods to determine fault locations in distribution networks [14]. You can explore this approach and see how Dijkstra's algorithm combines with other techniques to improve accuracy and efficiency in determining fault locations.

H. Li, L. Yao, and Z. Xu's essay "Application of Dijkstra Algorithm in the Selection of Distribution Network Protection Schemes" follows: The Dijkstra algorithm is used in this study to select protection methods in distribution networks [15]. Although the primary goal is not to determine fault location, this study can provide insight on the application of Dijkstra's algorithm in the context of a distribution network.

The following paper is titled "Improved Dijkstra Algorithm for Power Distribution Network Reconfiguration" and was written by R. Liu, Z. Sun, and Y. Jiang: The purpose of this research is to improve Dijkstra's method for reconfiguring electricity distribution networks [16]. Although this research is not directly connected to fault location determination, it can provide insight into how to tweak Dijkstra's method to satisfy unique needs in the distribution network setting.

By examining these connected works, the author can obtain a more comprehensive grasp of the application of Dijkstra's algorithm in the context of distribution networks and discover new ideas that can be used in this research.

III. Research Method

The research design used is Dijkstra's Algorithm Method [6] [8] [9]. To determine the shortest route at the location of the feeder distribution network disturbance, there are several stages of research, including:

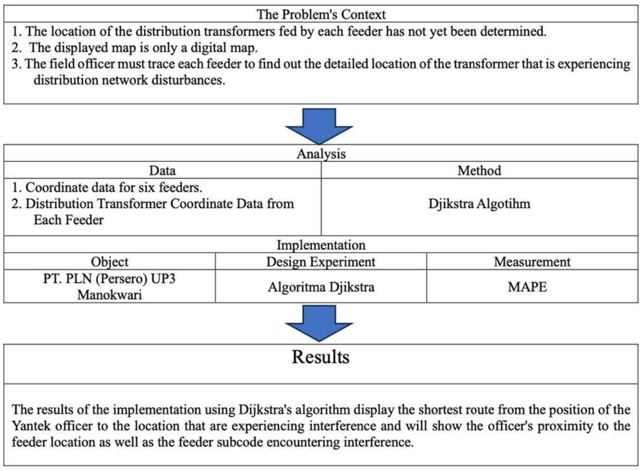

Fig. 3. Research Method

Figure 3. shows that the data used in this study are data point coordinates for the location of the PLN UP3 Manokwari distribution network, which has a total of 6 feeders and 178 distribution transformers. The Eagle Feeder Consists of 40 distribution transformers; the Cassowary Feeder Consists of 28 distribution transformers; the Nuri Feeder Consists of 53 distribution transformers; and the Mambruk Feeder consists of 28 distribution transformers; the Maleo Feeder consists of 13 distribution transformers; and the Merpati Feeder consists of 14 distribution transformers. The research design used is the Dijkstra Algorithm Method [6] [8] [9]. The results of the implementation using Djikstra's algorithm is display the shortest route from the position of the yantek officer to the location that are experiencing interference and will show the officer's proximity to the feeder location as well as the feeder subcode encountering interference.

IV. Result and Discussion

The information about disturbances in the feeder distribution network through the point classification system and types of interference in the distribution network that yantek officers get from the data is obtained from secondary data notifications from the SCADA system displayed on the UP3 Dispatcher to applications installed on mobile devices [4].

The coordinates for the location of the PLN UP3 Manokwari distribution network with a total of 6 feeders and 178 distribution transformers. The coordinate point data for distribution transformers and their feeders are as follows, figure 4. describes the graph of 6 repeaters, where the distance of each feeder is expressed in units of km and symbolized as follows: symbol 0 Feeder Rajawali has a distance of 14 meters to the Cassowary Feeder and 190 meters to the Nuri Feeder; the symbol of 1 Cassowary Feeder has a distance of 13 meters to the Eagle Feeder; symbol 2 Feeder Nuri has a distance of 9 meters to the Mambruk Feeder, 13 meters to the Maleo Feeder, and 8 meters to the Pigeon Feeder; symbol 3 Mambruk Feeder has a distance of 9 meters to Feeder Nuri and 12 meters to Feeder Maleo; symbol 4 Feeder Maleo has a distance of 12 meters to the Mambruk Feeder, 13 meters to the Nuri Feeder; and the 5 Pigeon Feeder symbols have a distance of 8 meters to the Feeder Nuri and 4 meters to the Maleo Feeder.

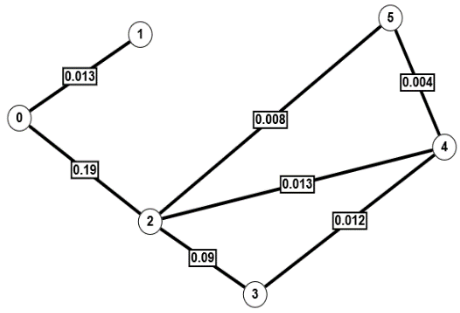

Fig. 4. Graph of PLN UP3 Manokwari Feeder

Figure 5. shows the Nuri Feeder, which contains 61 distribution transformers, is an example of a feeder with the most distribution transformers. The feeder graph is depicted below, with the distance between each transformer measured in kilometers.

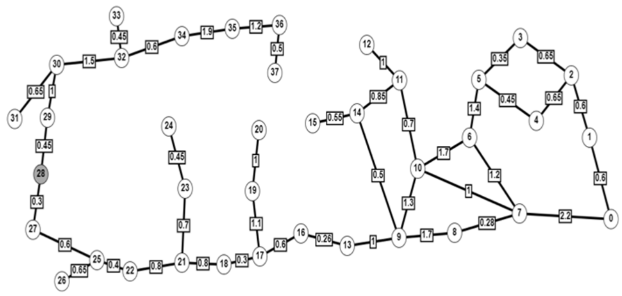

Fig. 5. Graph of Nuri Feeders

The first step in calculating Dijkstra's algorithm is to make a graph of the coordinates to be calculated, then determine the starting node or starting point and ending node. The starting node is point A, and the ending node is point Z. The first step for calculating the shortest route with Dijkstra's algorithm is:

1. Initialize, set the initial node as the source node, then set the initial distance to the source node as 0 and the distance to all other nodes as infinite, and set all nodes to unvisited.
2. The next step is to select the node with the shortest distance. Starting from the source node, select the node with the shortest distance that has not been visited. This can be done by checking the smallest distance between the nodes that have not been visited.
3. The next step is to update the distance. For each neighbor connected to the selected node, update the distance if a shorter distance is found. Calculate the new distance by adding the distance of the selected node to

the neighbor with the current distance to the selected node. If the new distance is shorter than the current distance to the neighbor, update the neighbor's distance with the new distance.

4. The next step is to mark the selected node as visited. After updating the distance, mark the selected node as visited so that it is not re-selected.
5. Repeat steps 2-4 and repeat step 2 until there are no unvisited nodes or all unvisited nodes have been reached.
6. Finally, the shortest path can be constructed by tracing back from the destination node to the source node based on the minimum distance stored during the calculation.

In Table I, calculations are carried out using Dijkstra's algorithm and generate the shortest routes A-B-C-E-G-H with a distance of 9.49 km.

TABLE I. ITERATION OF DIJKSTRA'S ALGORITHM

v	A	B	C	D	E	F	G	H
A	0a	1.1a	∞	∞	∞	∞	∞	∞
B		1.1a	2.4b	3.8b	∞	∞	∞	∞
C			2.4b	3,8b	4.2c	6.0c	∞	∞
D				3.8c	4.2c	6.0c	∞	∞
E					4.2c	6,0c	6.1e	∞
F						6.0c	6.1e	∞
G							6.1e	9.49g
H								9.49g

The initial graph in figure 6. and the final graph after the calculations are described in figure 7. and figure 8.

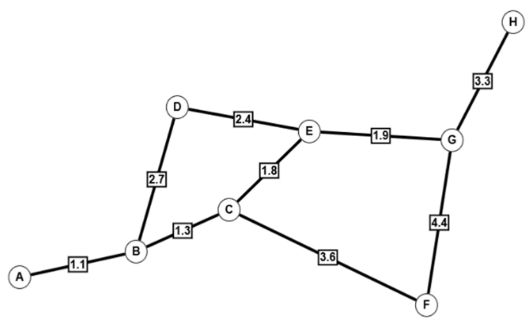

Fig. 6. Initial Graphics

The final graph after the calculations are described in figure 7. and figure 8.

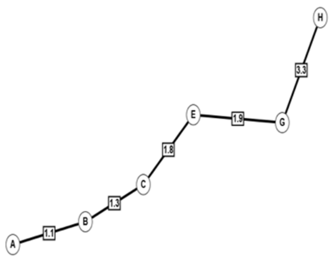

Fig. 7. Final Graphics

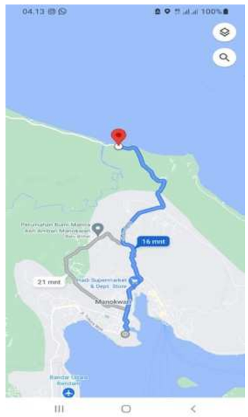

Fig. 8. Testing Output

From previous research on finding the shortest route using the A-Algorithm Star (A*), which is entitled " Determination location of disturbance of the electricity distribution network for efficiency SOP repair of distribution networks based on Google Maps" [5], with starting nodes at points A and an end node at point G, containing the coordinate values as follows:

TABLE II. RESULTS COORDINATES OF A-STAR ALGORITHM (A*)

FCO PAMI								
Initial Coordinate : -0.871881, 134.065136								
Final Coordinate : -0.810628, 134.059139								
A	B	C	D	E	F	G	H	T
-0.871881, 134.065136	-0.871670, 134.063389	-0.857751, 134.066114	-0.854209, 134.069393	-0.852993, 134.068298	-0.834664, 134.067515	-0.831267, 134.073362	-0.810560, 134.059225	-0.810628, 134.059139
Path : A-B-C-D-E-F-G-H-T				9.8 Km				

From Table II, calculations are carried out using the A-Star Algorithm (A*) and produce the shortest route as ABCDEFGHT with a distance of 9.8 km. Based on the calculation results of Dijkstra's algorithm, it can be concluded that Dijkstra's algorithm and the A-Star algorithm (A*) have different distance results. The route distance generated by Dijkstra's algorithm is 0.31 km shorter than the A-Star algorithm (A*).

Figure 9. depicts the results of the implementation of Dijkstra's algorithm utilizing graphs in identifying the shortest route in mobile-based distribution network disruption network detection applications (case study: PT PLN (Persero) UP3 Manokwari):

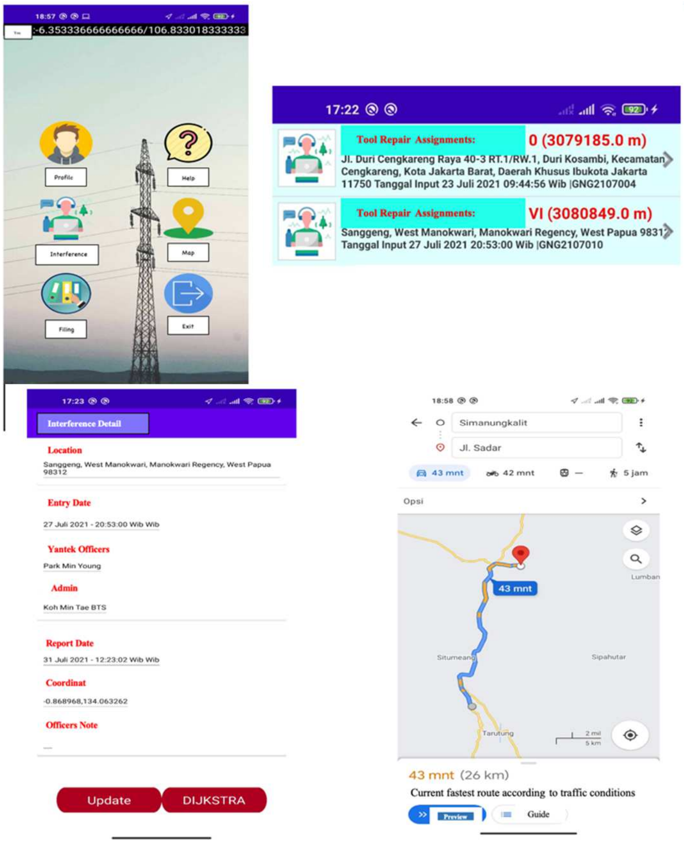

Fig. 9. Depicts The outcomes of Dijkstra's algorithm implementation in mobile-based distribution network disruption and network detection applications.

Test the accuracy of the results of implementing Dijkstra's Algorithm, the author uses the MAPE (Mean Absolute Percentage Error) method to compare the results of manual calculations with the results of calculations on the system, as follows:

Initial location: Amban, West Manokwari, West Papua.
Testing locations:

1. Transformer 61, Mambruk Feeder,
2. Transformer 147: Mambruk Feeder,
3. Mambruk Feeder.

Comparative analysis of the results of manual and system calculations shows on table III.

TABLE III. COMPARISON OF CALCULATION RESULTS

No	Location Testing	Manual Calculation Results (Mt)	System Calculation Results (At)
1	Transformer 61: Mambruk Feeder	7.65 km	7.6 km
2	Transformer 147: Mambruk Feeder	7.1 km	7.0 km
3	Mambruk Feeders	9.49 km	9.2 km

Furthermore, the following equation is used to calculate the error difference:

$$e = M_t - A_t \tag{1}$$

The calculation:

1. e1 = 7.65 - 7.6 = 0.05
2. e2 = 7.1 - 7.0 = 0.1
3. e3 = 9.49 - 9.2 = 0.29

Then, proceed with the equation $e = \frac{M_t - A_t}{M_t}$ where the calculation is:

1. e1 = |0.05/7.65| = 0.006
2. e2 = |0.1/7.1| = 0.014
3. e3 = |0.29/9.49| = 0.030

The results of the equation are described shows on table IV.

TABLE IV. VALIDATION TEST EQUATION TABLE

No	M_t	A_t	$e = M_t - A_t$	$e = \left\lvert\frac{(M_t - A_t)}{M_t}\right\rvert$
1	7.65 km	7.6 km	0.05	0.006
2	7.1 km	7.0 km	0.1	0.014
3	9.49 km	9.2 km	0.29	0.030
Total			0.44	0.05

The final step is to calculate the MAPE method formula as follows:

$$MAPE = \frac{\sum \frac{\left|\frac{(M_t - A_t)}{M_t}\right|}{M_t}}{n} \times 100\%$$

$$MAPE = \frac{0.05}{3} \times 100\%$$

$$MAPE = 1.667\%$$

$$Akurasi = 100\% - 1.667\% = 98.3\%$$

Based on the results of the accuracy test using the MAPE method in this application, an accuracy value of 98.3% is obtained.

V. CONCLUSION

Based on the results of the research that has been done, several conclusions, in this research, we have successfully implemented Dijkstra's algorithm to determine the fault location in a feeder distribution network. Through this study, we have analyzed and studied the basic concepts of distribution networks, Dijkstra's algorithm, and other related aspects. The research results show that the use of Dijkstra's algorithm is effective in determining the location of disturbances in the distribution network. Implementation of Dijkstra's algorithm in determining the shortest route to the fault location distribution network at PLN UP3 Manokwari assists field officers in finding the closest path to the fault location. The results of the comparison of Dijkstra's algorithm and the A-Star algorithm (A*) in previous studies produce two different route distances, where Dijkstra's algorithm has a shorter distance than the A-Star algorithm (A*) with an accuracy of 98,33%. For further development, this research can be integrated with a more comprehensive distribution network management system to help monitor and restore networks in real-time. In addition, this research can also be expanded to include optimizing network recovery decisions by considering other aspects such as cost and resource availability.

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