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Implementation of the Greedy Algorithm for Optimal Police Patrol Route Search in the Jurisdiction of Semendawai Suku III Police Sector

Vingky Nandra Sari[1], Tata Sutabri[2],
[1,2]Magister of Informatics Engineering, Universitas Bina Darma, Indonesia
Email: vingkynandra37@gmail.com[1], tata.sutabri@gmail.com[2]

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ABSTRACT

Police patrols represent a strategic effort to maintain public security and order. However, determining an optimal patrol route remains a challenge, particularly in ensuring time and distance efficiency. This study aims to identify the optimal police patrol route in the jurisdiction of the Semendawai Suku III Police Sector using the Greedy algorithm. This method was selected for its ability to rapidly generate solutions by choosing the most favorable option at each step. The data utilized in this research include ten villages identified as high-risk areas based on the number of criminal reports recorded in 2024, as well as inter-village distances collected through regional mapping. The application of the algorithm resulted in a total patrol distance of 121.2 kilometers, following the sequence: Police Sector (A) → Sriwangi (B) → Kerujon (C) → Karang Endah (D) → Margorejo (E) → Taman Agung (F) → Taraman (H) → Kota Tanah (I) → Melati Jaya (J) → Nirwana (K) → Karang Marga (G) → returning to the Police Sector (A). This study contributes to data-driven patrol strategy management, enhancing both the efficiency and effectiveness of police operations in maintaining regional security stability.

Corresponding Author:
Tata Sutabri,
Magister of Informatics Engineering,
Universitas Bina Darma, Indonesia
Email: tata.sutabri@gmail.com

1. INTRODUCTION

The Semendawai Suku III Police Sector oversees a jurisdiction comprising 45 villages, each exhibiting varying levels of criminal activity. Various criminal acts such as theft, assault, and other offenses occur in several villages with differing frequencies annually. Based on police reports from 2024, ten villages recorded the highest incidence of criminal cases and, therefore, require special attention in the implementation of police patrols. These patrols aim to reduce crime rates, enhance public safety, and ensure a stable and secure environment.

Currently, patrol routes are determined based on officers' experience and habitual practices. This approach often leads to inefficient patrols, as route selection does not consider inter-village distances or documented crime risk levels. Consequently, officers frequently travel on suboptimal routes, resulting in increased travel time and unnecessary fuel consumption. Hence, a method is needed to support the determination of more effective and efficient patrol routes.

This study applies the Greedy algorithm to determine the optimal patrol route based on inter-village distances and crime incidence rates. The Greedy algorithm is a heuristic approach used to construct optimal solutions by selecting the best possible option at each step of the process [1]. By applying this algorithm, each village is visited in a sequence that considers the shortest distance and highest crime rate, thereby minimizing travel time and enhancing the effectiveness of police patrols.

In the digital era, route optimization has become a significant challenge in various fields, including transportation, logistics, and public services. Several algorithms have been applied to solve route optimization problems, such as Dijkstra's algorithm, which is widely used in vehicle navigation and public transportation systems [2]. However, research focusing on route optimization for police patrol purposes remains limited. The Greedy

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algorithm is one of the methods frequently used for shortest pathfinding due to its iterative nature and capability to make optimal decisions at each step [3]. Several studies have demonstrated the effectiveness of this algorithm in various applications, including optimizing pilgrimage routes to the Walisongo tombs [2], shortest pathfinding between mosques in Samarinda City [3], and a web-based information system for determining the fastest route to hospitals in Palu City [4]. Additionally, research by Mahandika and Rosmala [5] developed an application for finding safe routes from criminal activity, highlighting that optimal route selection should consider not only distance but also safety aspects.

Based on these studies, the Greedy algorithm has proven effective in determining optimal routes, although it may have limitations in identifying globally optimal solutions. Therefore, this study examines the application of the Greedy algorithm in determining police patrol routes in the jurisdiction of the Semendawai Suku III Police Sector. The findings are expected to improve patrol efficiency compared to the conventional methods currently in use.

2. RESEARCH METHOD

2.1. Research Strategy

This study employs an experimental method to evaluate the effectiveness of the Greedy algorithm in determining the optimal patrol route within the jurisdiction of the Semendawai Suku III Police Sector. The experiment involves comparing the patrol routes generated by the Greedy algorithm with those derived from the conventional method currently utilized in police operations. In addition, a case study approach is adopted to analyze the existing problems and identify optimal solutions.

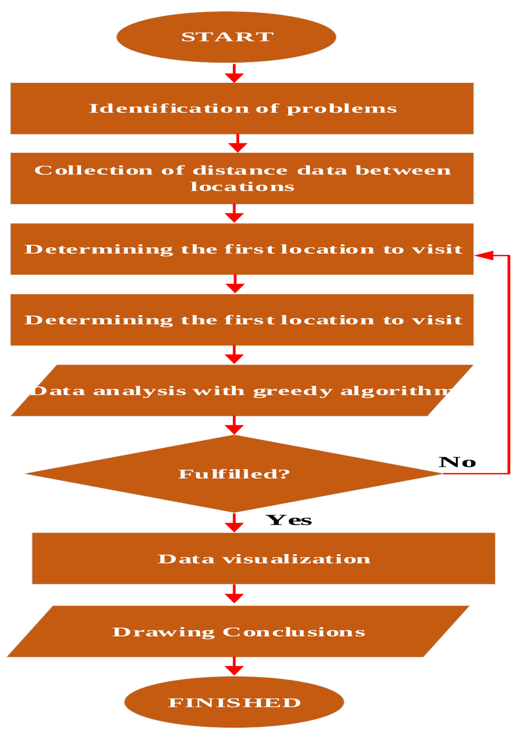

Figure 1. Research Flow Diagram

2.2. Data Collection Method

According to Sutabri [6], one critical factor in developing or enhancing an information system is understanding the existing system and its problems. Common techniques for data collection include interviews, questionnaires, direct observation, and sampling. Furthermore, Sutabri [7] defines data as factual information that can be processed into useful insights.

In this study, the data collected consists of a distance matrix between nodes representing patrol locations within the jurisdiction of the Semendawai Suku III Police Sector. The distances between nodes were calculated using Google Maps to obtain accurate estimations.

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Patrol operations at the Semendawai Suku III Police Sector are prioritized based on each village's crime vulnerability level. The Greedy algorithm is suitable for selecting the village with the highest crime rate first, then proceeding to the next most vulnerable village, and so forth. This study utilizes patrol data from 2024. The following is a visualization of the distribution of criminal incidents per village, which serves as the basis for determining patrol priority.

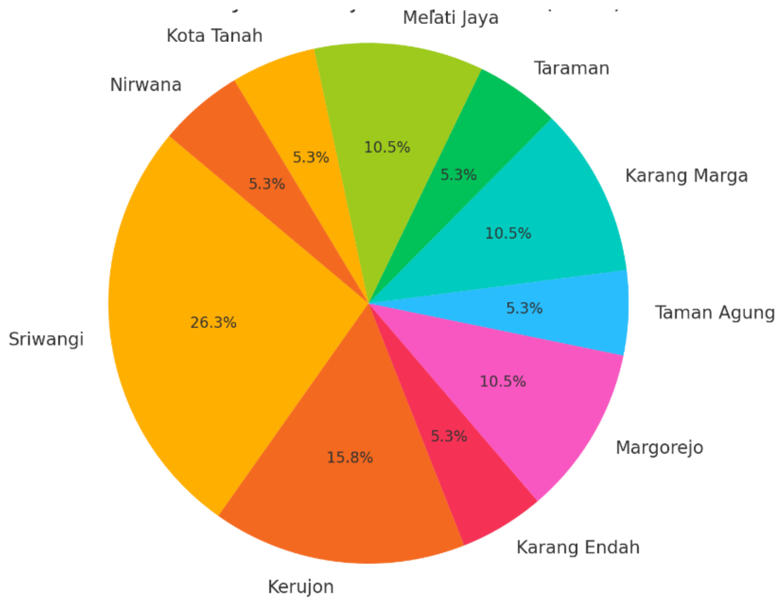

Figure 2. Distribution diagram of the number of events in 2024

The data collection process was carried out in several stages as follows:

a. Identifying key patrol route locations.

The locations identified were crime-prone areas based on recorded criminal reports. The data used include ten priority villages selected based on the frequency of reported incidents received throughout the year 2024. The selection of these villages was based on the intensity of recorded incidents as well as equitable distribution across the sub-district patrol coverage area. Based on the data, the order of villages by the number of criminal incidents is as follows:

Table 1. Distance from Village to Police Station

Village	Number of Incidents	Distance from police Station (Km)
Desa Sriwangi	5	3,5 km
Desa Kerujon	3	4,9 km
Desa Karang Endah	1	5,6 km
Desa Margorejo	2	7,6 km
Desa Taman Agung	1	8,3 km
Desa Karang Marga	2	10,5 km
Desa Taraman	1	13, 2 km
Desa Melati Jaya	2	17,5 km
Desa Kota Tanah	1	17,3 km
Desa Nirwana	1	37 km

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b. Distances Between Villages Frequently Included in Patrol Routes.

Table 2. Distance Between Villages

From /To	Sriwangi	Kerujon	Karang Endah	Margo rejo	Taman Agung	Karang Marga	Tara man	Melati Jaya	Kota Tanah	Nirwana
Sriwangi	0 km	5,5 km	6,8 km	8,8 km	9,8 km	11,5 km	9,4 km	13,8 km	13,6 km	33,2 km
Kerujon	5,5 km	0 km	3,0 KM	5,5 km	6,1 km	14,8 km	11,7 km	16,1 km	15,8 km	35,5 km
Karang Endah	6,8 km	3,0 km	0 km	7,4 km	10, 6 km	16,0 km	12,4 km	16,8 km	16,6 km	35,5 km
Margorejo	8,8 km	5,5 km	8,1 km	0 km	2,7 km	18,1 km	15,7 km	20,0 km	19,8 km	39,4 km
Taman Agung	9,8 km	6,1 km	10,6 km	2,7 km	0 km	19,1 km	16,6 km	21,0 km	20,8 km	46,1 km
Karang Marga	11,5 km	14,8 km	16,0 km	18,1 km	19,1 km	0 km	23,6 km	28,0 km	27,8 km	37,1 km
Taraman	9,4 km	11,7 km	12,4 km	15,7 km	16,6 km	23,6 km	0 km	10,6 km	4,8 km	23,0 km
Melati Jaya	13,8 km	16,1 km	16,8 km	20,0 km	21,0 km	28,0 km	10,6 km	0 km	9,3 km	20,8 km
Kota Tanah	13,6 km	15,8 km	16,6 km	19,8 km	20,8 km	27,8 km	4,8 km	9,3 km	0 km	23,2 km
Nirwana	33,2 km	35,5 km	35,5 km	39,4 km	46,1 km	37,1 km	23,0 km	20,8 km	23,2 km	0 km

The distances were then represented in the form of a weighted graph, in which each edge was assigned a value corresponding to the distance in kilometers between villages. In this graph, each town is represented as a node, and each path between nodes is an edge with a weight corresponding to the travel distance. The patrol route begins at the Semendawai Suku III Police **Sector** Office and returns to the same point after visiting all designated villages.

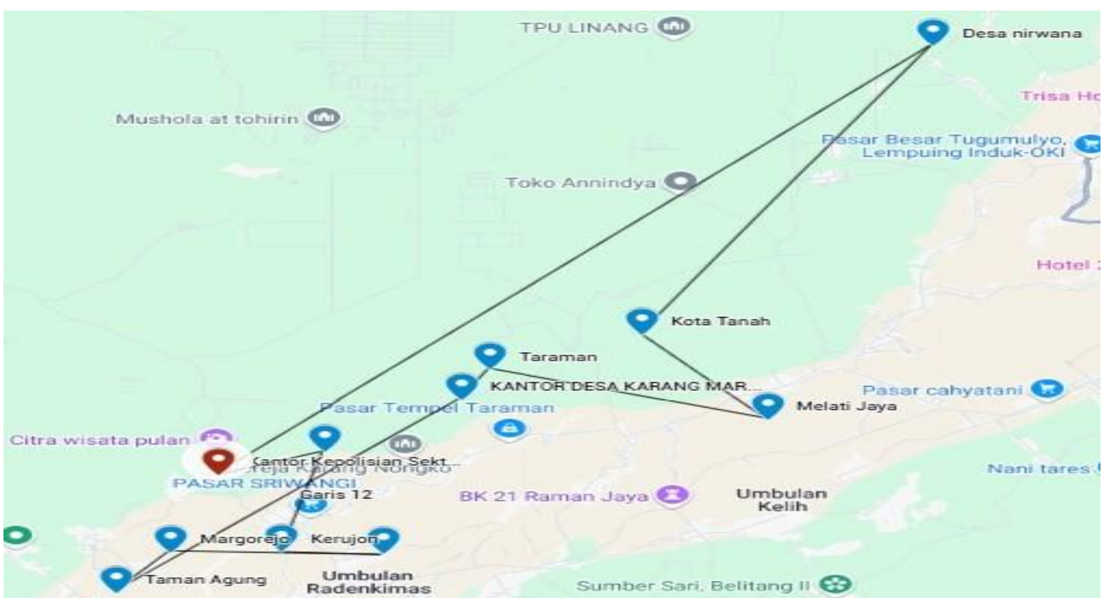

Figure 3. Graph Representation of Patrol Route Between Villages

c. Greedy Algorithm

The Greedy algorithm solves optimization problems by making the most favorable (locally optimal) choice at each step. Decisions made in each stage are not reconsidered in subsequent steps, meaning that the algorithm does not account for the impact of current choices on the overall solution. The core principle of this algorithm is "take what you can get now," reflecting the strategy of selecting the most beneficial option at each stage without evaluating alternatives that may yield better results in the future [8].

d. Data Analysis Technique

This study processes the test results through a result-based analysis approach. The distance matrix obtained is used as input to execute the Greedy algorithm to determine the optimal police patrol route. As this research focuses solely on the distance between patrol points, other weighting factors are not considered. Each experiment produces an iteration table or distance matrix representing the connections between patrol points. From this analysis, a weighted graph is constructed to visualize the route optimization. In the final stage, all processed data are visualized in the form of a digital map to facilitate the interpretation of results and their implementation in the field.

3. RESULTS AND DISCUSSION

To simplify calculations, each village is represented by the following symbols:
A = Polsek Semendawai Suku III
B = Sriwangi
C = Kerujon
D = Karang Endah
E = Margorejo
F = Taman Agung
G = Karang Marga
H = Taraman
I = Kota Tanah
J = Melati Jaya
K = Nirwana

3.1. Implementation of the Greedy Algorithm

The Greedy algorithm operates by selecting the best local option at each stage in the hope of achieving a globally optimal solution. In the context of patrol route determination, the algorithm determines the nearest unvisited village from the current location and continues this process until all villages are visited, then returns to the initial starting point.

Table 3. Algorithm greedy calculation

Steps	From	To	Distance (km)	Temporary Total (km)	Explanation
1	A	B	3,5	3,5	From the Police Station to the nearest village
2	B	C	5,5	9	Sriwangi From Sriwangi to Kerujon, the next nearest village
3	C	D	3	12	From Kerujon to Karang Endah
4	D	E	7,4	19,4	From Karang Endah to Margorejo
5	E	F	2,7	22,1	From Margorejo to Taman Agung
6	F	H	16,6	38,7	From Taman Agung to Taraman
7	H	I	4,8	43,5	From Taraman to Kota Tanah
8	I	J	9,3	52,8	From Kota Tanah to Melati Jaya
9	J	K	20,8	73,6	from Melati Jaya to Nirwana
10	K	G	37,1	110,7	From Nirwana to Karang Marga
11	G	A	10,5	121,2	Back to the starting point (Polsek)

Final route: A → B → C → D → E → F → H → I → J → K → G → A
Total distance traveled: 121,2 km.

3.2. Comparison before and after applying the greedy algorithm

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Table 4. Comparison Before and After Applying the Greedy Algorithm

Aspect	Manual Route (Without Algorithm)	Route Using Greedy Algorithm
Basis of Route Determination	Based on officers' habits	Based on the nearest unvisited location
Village Order	Unstructured, random, based on experience	Structured based on the shortest distance
Distance Efficiency	Less efficient	More efficient
Total Distance Traveled	±130–140 km (estimation)	121.2 km
Advantage	Flexible to real-time field conditions	Efficient and easy to replicate
Disadvantage	Prone to repeated or inefficient routes	Does not always yield a globally optimal solution

Table 3 compares the manual approach previously used by patrol officers to the route determined through the Greedy algorithm. The results show that the Greedy algorithm can systematically construct a more efficient route, reducing total travel distance significantly. This has the potential to improve patrol time effectiveness and resource usage, such as fuel consumption and manpower efficiency.

3.3. Weighted Graph

A weighted graph is used to represent the interconnection between villages and their travel distances mathematically. In this study, each town is modeled as a node, and the distance between villages is modeled as an edge with a weight value in kilometers. This graph is constructed based on real-world distance data between villages, with both the starting and ending points set at the Semendawai Suku III Police Sector Office (node A).

The graph serves as the foundation for the Greedy algorithm process, wherein at each step, the algorithm selects the edge with the smallest weight that connects the current node to an unvisited node. This graph-based representation not only clarifies the analyzed route structure but also functions as a visual aid to understand the complexity of the village network within the patrol area.

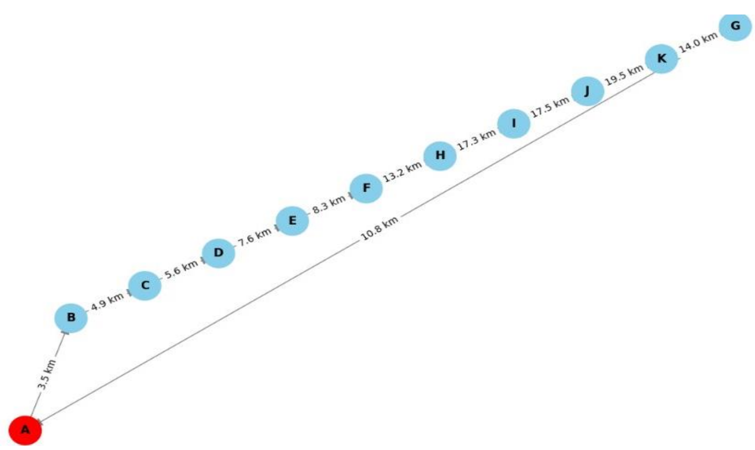

Figure 4. Weighted graph

3.4 Digital Map Visualization

To enhance the clarity of results and simplify data interpretation, the patrol route calculated using the Greedy algorithm is visualized using Google My Maps. Each village is marked with a label according to its assigned symbol (A–K), and the patrol route is drawn according to the order generated by the algorithm. The start and end point, the Semendawai Suku III Police Sector Office (A), is marked in red, while other villages are marked in blue to distinguish the sequence of visits. This digital visualization provides a clear spatial representation of the village distribution and

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the geographic pattern of the resulting route. The digital map can also be accessed online by relevant authorities, making it a practical reference for actual field patrol planning.

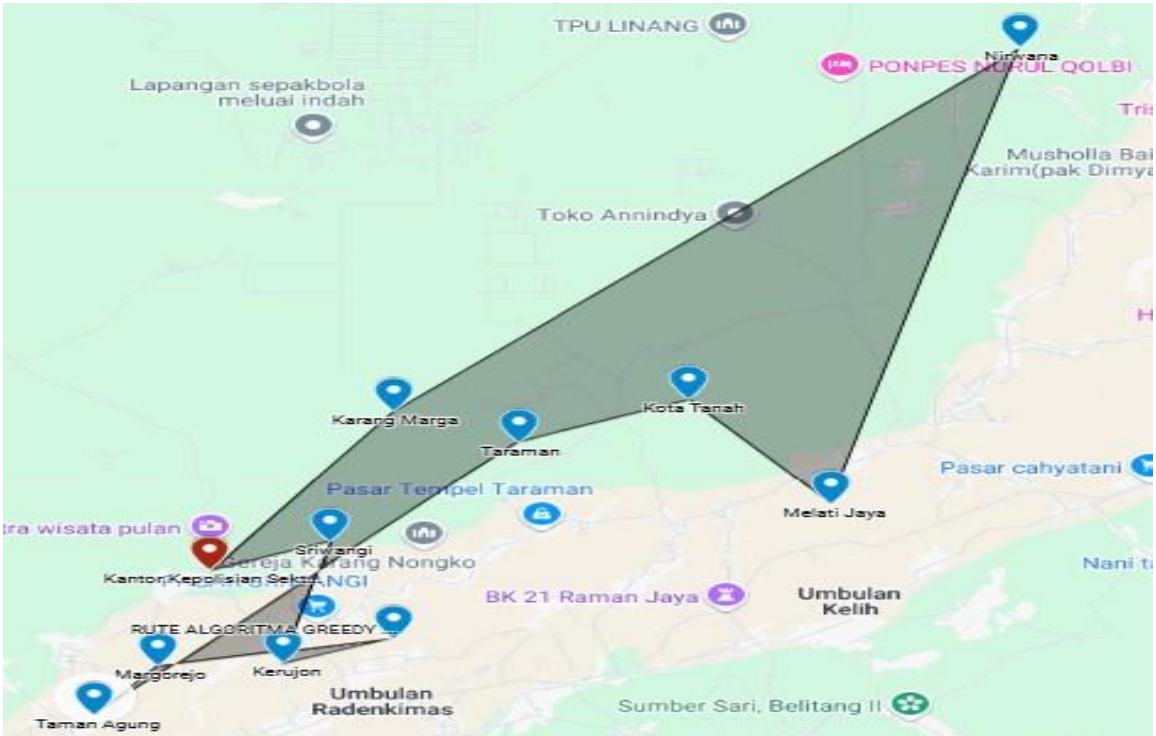

Figure 5. Visualization of patrol routes

4. CONCLUSION

Based on the results of this study, the Greedy algorithm has proven effective in providing an efficient and systematic solution in police patrol route planning in the Semendawai Suku III region. By utilizing the principle of locally optimal selection, the algorithm produces a patrol path that covers all villages within the jurisdiction in a logical sequence and with an optimal total distance of approximately 121.2 km.

Compared to the previous manual method, this approach offers significant advantages in terms of time efficiency, fuel savings, and easier decision-making processes on the ground. In addition, the use of a weighted graph and digital map visualization enhances the readability and practical implementation of the system in actual police operations. Future development could involve integrating real-time incident reporting systems or testing alternative algorithms such as Dijkstra or Ant Colony Optimization (ACO) for comparative analysis. However, in the context of this study, the Greedy algorithm has delivered practical and reliable results as an initial step toward the digitalization of patrol planning.

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