

Application of the dijkstra method in finding the shortest route for hospitals in Kabupaten Tegal

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ARTICLE INFO	ABSTRACT
Article history: Received Sept 6, 2023 Revised Sept 14, 2023 Accepted Sept 16, 2023 Keywords: Dijkstra Algorithm ; Hospital; Kabupaten Tegal; Shortest Route.	Health services are one of the most critical aspects of human life. Getting medical care quickly and efficiently can be a determining factor in saving a person's life in an emergency. In this article, we will review the application of the Dijkstra Method in finding the shortest route to Mitra Siaga hospitals in Kabupaten Tegal. This article is expected to contribute to understanding and developing a more efficient transportation system in Kabupaten Tegal, focusing on health services. Dijkstra algorithm for determining the shortest route. Dijkstra's algorithm is an algorithm that intends to find the shortest path on a graph. The principle of the Dijkstra Algorithm is searching for two passes with the most negligible weight. Based on the results of testing 10 times, the accuracy of this application is 100%. In this study, limited to the initial location tested, this application has not used the current location at its initial location. For the development of this application, you can use the current location at the initial location so that this application runs optimally. <i>This is an open access article under the CC BY-NC license.</i> 

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1. INTRODUCTION

Health services are one of the most critical aspects of human life (Cholik, 2021). Getting medical services quickly and efficiently can be a determining factor in saving a person's life in an emergency (Nursofwa et al., 2020). Therefore, planning and developing a transportation system that can optimize accessibility to hospitals is essential (Elawati & Pujiyanto, 2022). Like many regions worldwide, Tegal district faces similar challenges in ensuring its residents can access necessary medical services quickly. In today's information technology era, route modeling and planning have become a significant focus in improving accessibility to health facilities. One method that has proven effective in solving the shortest route finding problem is the Dijkstra Method (Syahbana, 2022). The Dijkstra method is the shortest path search algorithm introduced by Edsger W. Dijkstra in 1956 (Syahbana, 2022). This algorithm has been used in various applications, including GPS navigation, computer networking, and transport modeling (Hidayah, 2021).

In the context of Tegal District, applying the Dijkstra Method in the search for the shortest route to the hospital can have a significant impact. This can help ensure that patients can immediately reach the nearest hospital in an emergency or routine care. In addition, applying the Dijkstra Method can also help optimize the use of transportation resources, reduce travel time, and save costs (Puspita, 2023). In this article, we will review the application of the Dijkstra Method in finding the shortest route to Mitra Siaga hospitals in Kabupaten Tegal. This article will explain how this algorithm

works, how local geographic and transport data is integrated, and how the results can improve accessibility to health facilities. In addition, it will also evaluate the performance of the Dijkstra Method in the context of Kabupaten Tegal and identify potential improvements that can be made. This article is expected to contribute to understanding and developing a more efficient transportation system in Kabupaten Tegal, focusing on health services. This effort aligns with the vision to create a healthier and safer society where access to quality medical services is a fundamental right of every individual.

The Dijkstra method, invented by Edsger W. Dijkstra in 1956, is a widely used algorithm in modeling the shortest route in graphs. This algorithm calculates the shortest distance from one point to all other points in the graph (Sulaiman et al., 2020), considering the weight (distance or cost) between points. In the context of finding a route to a hospital, the Dijkstra Method has been used extensively to find the shortest path from the initial location to the nearest hospital (Al Hakim et al., 2021). Geographic Information Systems enable the processing, analysis, and visualization of geographic data. GIS plays a crucial role in the application of the Dijkstra Method for the search for the shortest route to a (Zahro et al., 2023)], as it requires accurate spatial information about the location of the hospital, roads, and other geographical factors affecting route selection (Rahmanto & Hotijah, 2020). Accessibility to medical services is a significant public health issue (Saputro et al., 2021). Previous research has highlighted the link between good accessibility to health facilities and improved public health outcomes. Therefore, research on applying the Dijkstra Method in the context of health can positively contribute to improving the health service system (Purnomo et al., 2022).

In addition to route search to hospitals, the Dijkstra Method has been applied in a variety of contexts, including motor vehicle navigation (Pratama & Dermawan, 2022) [14] and data flow modeling in computer networks (Hermanto et al., 2020)(Rangkuty et al., 2020). Previous studies can provide insight into the practical application of the Dijkstra Method in transport and route planning (Hutauruk, 2022). In the context of Kabupaten Tegal or similar regions, it is essential to consider the integration of the Dijkstra Method into the more extensive transport system. Previous research may have examined how to integrate transportation systems and information technology to improve the efficient use of transportation resources (Perdani et al., 2021).

Some previous studies discussed implementing the Dijkstra method (Cantona et al., 2020); this research was designed to run on smartphones with the Android platform. Based on the test, the shortest route selection using the Dijkstra algorithm is considered very effective based on finding the shortest route from each calculation of the distance weight with the node routed to the destination. (Sumaryo et al., 2020) The methods of this research are the Dijkstra algorithm for deciding the shortest rate and the Harversine method for giving the value of the passed node. Google Maps and GPS applications are used for mapping and finding the location coordinates. This data will be processed using PHP and MySql databases. The research results are that this application can be used efficiently using a smartphone, and the feasibility test shows a "Good" value with a 77% average. (Rifendy & Nerisafitra, 2023) The purpose of this study will be to create a geographic information system based on the Mount Penanggungan climbing website, where the website will use the Dijkstra Algorithm used in solving the shortest path problem by calculating the existing costs (distances) and also Fuzzy Tahani's calculations to determine the best climbing recommendation route according to the specified criteria. (Triase & Aprilia, 2020) The Dijkstra method functions to search for graphics that solve the problem of the path or shortest route from the courier to the address of the intended online shopper. Its application is expected to be able to optimize the performance of the distribution of objects or packages to online shoppers so that they can compete and increase profits. (Mustika et al., 2020) NPC creation in the game that can perform specific tasks such as walking around in the game (wandering) and moving to follow orders (following the leader) using the Dijkstra Shortest Path Spinning method. (Amijaya et al., 2021) In the Dijkstra algorithm, nodes are used because the Dijkstra algorithm uses a directional graph for the shortest list route determination. From the research results, the author can draw conclusions applying the Dijkstra method carried out at point (A), the initial location with the purpose of point (J). Then, several route choices total 4 routes with units of Kilometers. For the first route, get the result (0.67), the second (0.7), the third (0.9), the fourth (0.69).

2. RESEARCH METHOD

The research methods used are as follows:

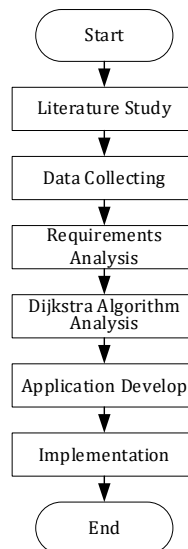


Figure 1. Research methods

In Figure 1, it is explained that the first stage is the study of literature, which is the stage of collecting some books, journals, and scientific writing related to research, and the second is the data collection stage. The data collection itself in this study came from Google Maps. Designing this hospital application requires supporting devices such as Hardware, a Laptop (Asus) with the following specifications: Core i3 Processor, 8GB RAM, 500GB SSD Hard Drive, Software (Software): Windows 10 pro 64bit OS, and Android Studio 3.6.

The author applied the Dijkstra Algorithm method to determine the shortest route in this study. Dijkstra's algorithm is an algorithm that intends to find the shortest path on a graph. The principle of the Dijkstra Algorithm is searching for two passes with the most negligible weight (Nugroho et al., 2021). Analysis of finding the shortest route to the hospital using the Dijkstra algorithm, determining the nodes, creating graphs between predefined nodes, and then calculating the value between distances from one node to another. At the application design stage, several stages range from designing the splash screen, initial display, hospital menu, hospital information, and maps that display the shortest route to the hospital. The following stages of application design can be seen in Figure 2.

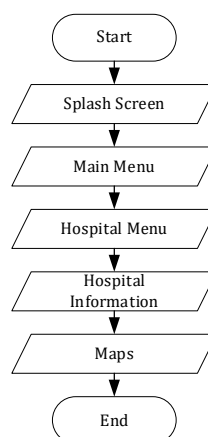


Figure 2. Application development

The object's location and the intended hospital act as input, with the route to the nearest hospital as output (Yuliantari & Musabbikhah, 2022).

The following steps were used in the study:

1. Formulating the problem in Kabupaten Tegal, namely how the shortest route starts from Slawi Square.
2. Formulate a mathematical model of the shortest distance problem that must be traversed with discrete mathematics with the Dijkstra Algorithm.
3. Creating the shortest route between locations with the Dijkstra algorithm is calculated manually.
4. Implementing the study results by determining the shortest route from the starting point of Slawi Square to 5 hospitals in Slawi Regency.

There are Some cases of shortest trajectory search solved using the Dijkstra Method are:

1. Search for the shortest path between two specific nodes (*a pair shortest path*),
2. Shortest path search between all pairs shortest *path*,
3. *Single-source shortest path*,
4. Search for the shortest path between two nodes through several nodes (*intermediate shortest path*).

This method aims to find the shortest path based on the most negligible weight from one point to another. Suppose a point depicts a building and a line describes a street; the Dijkstra Method calculates all possible smallest weights of each point. The picture of the Dijkstra Method is shown in Figure 1 as follows:

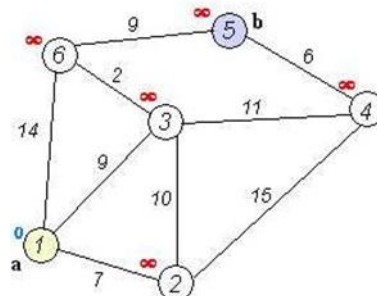


Figure 3. Dijkstra method

First, determine which point will be the starting node, then give weight to the distance of the first node to the nearest node one by one; Dijkstra will develop the search from one point to another and the next point step by step. Here is the logical sequence of the Dijkstra Method:

1. Give each point a weight (distance) value to each other point, then set the value 0 on the starting node and the value infinite against the other nodes (unfilled)
2. Set all nodes as "Untouched" and the initial node as "Departure node."
3. Consider the neighboring untouched node from the departure node and calculate its distance from the departure point. For example, if the departure point A to B has a distance weight of 6 and from B to node C is 2, then the distance to C passing through B becomes $6+2=8$. If this distance is smaller than the previous distance (previously recorded), delete the old data and resave the distance data with the new distance.
4. When we finish considering each distance to neighboring nodes, mark the touched nodes as "Touchable nodes." The touched node will never be rechecked; the distance stored is the last distance and the least weight. Set the "Untapped node" with the smallest distance (from the departure node) as the next "Departure Node" and continue by returning to step 3.

3. RESULTS AND DISCUSSIONS

In this Dijkstra algorithm analysis, the author took an example of finding the shortest route from STMIK Tegal to the location of Mitra Siaga Hospital, Tegal Regency. The following data on the name of the road traveled, nodes, and the distance between nodes from the house to Mitra Siaga Hospital Tegal Regency can be seen in Table 1.

Table 1. Nodes and distance between nodes

No.	Streets	Node	Distance (m)
1.	Pendidikan Street – Kol. Sugiono Street	A - B	200
2.	Kol. Sugiono Street – Gajah Mada/Sudirman Street	B - C	2.000
3.	Gajah Mada Street –Tegal Pemalang Street	C - D	2.000
4.	Tegal Pemalang Street – Pala Raya Street	D - E	2.300
5.	Pala Raya Street – Mitra Siaga Hospital	E - F	200
6.	Gajah Mada/Sudirman Street – AR Hakim Street	C - G	2.000
7.	AR. Hakim Street – Kartini Street	G - H	600
8.	Kartini Street – Perintis Kemerdekaan Street	H - I	1.000
9.	Perintis Kemerdekaan Street – Hanoman Street	I - J	400
10.	Hanoman Street –Pala Raya Street	J - K	1.200
11.	Pala Raya Street – Mitra Siaga Hospital	K - F	1.500

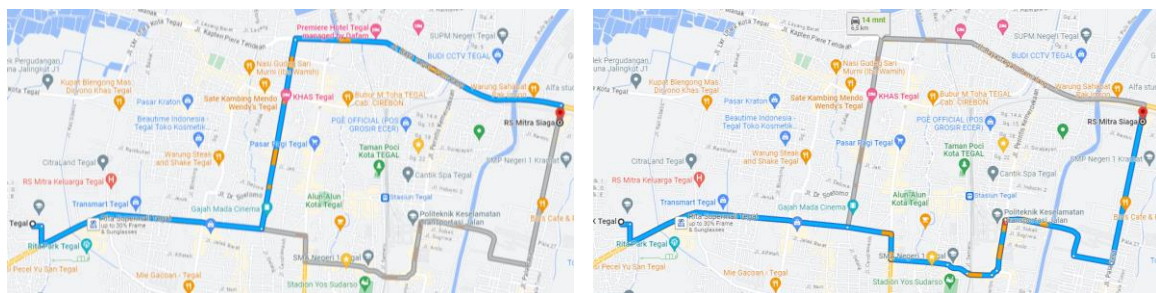


Figure 4. Route from STMIK Tegal to Mitra Siaga Hospital

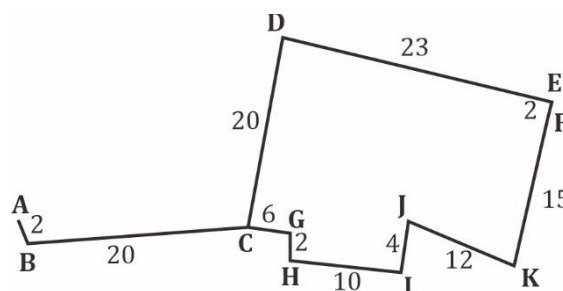


Figure 5. Route by Dijkstra method

Figure 4 shows the route from the initial location (STMIK Tegal) to the Mitra Keluarga Hospital house, where each distance between nodes has a different weight value. The distance between the vertices is used for calculations, resulting in the weight values' sum.

1. Application of Dijkstra Algorithm

The final stage is implementation, where the route in Figure 5 is calculated using the Dijkstra Algorithm method to find the shortest route. The following calculation results of the Dijkstra Algorithm can be seen in Table 2.

Table 2. Dijkstra algorithm calculation

Step	Node	Smallest	A	B	C	D	E	F	G	H	I	J	K
1	A	0A	0A	2A	∞	∞	∞	∞	∞	∞	∞	∞	∞
2	B	2A	0A	2A	22B	∞	∞	∞	∞	∞	∞	∞	∞
3	C	22B	0A	2A	22B	42C	∞	∞	28C	∞	∞	∞	∞

4	H	28C	0A	2A	22B	42C	∞	∞	28C	∞	40H	∞	∞
5	I	40H	0A	2A	22B	42C	∞	∞	∞	∞	∞	44I	∞
6	J	44I	0A	2A	22B	42C	∞	∞	∞	∞	∞	∞	56J
7	K	56J	0A	2A	22B	42C	∞	71K	∞	∞	∞	∞	56J

Table 2 is the calculation stage of the Dijkstra Algorithm, which results in 7 steps through several nodes and nodes to get the shortest route, A-B-C-H-I-J-K, with a total value of 7.1 km.

2. Implementation Application

This stage discusses the display of applications and tests carried out with initial locations (STMIK Tegal) with 10 hospital destinations in Tegal City and Tegal Regency.



Figure 6. Splash Screen Display



Figure 7. Initial Display



Figure 8. Display of Mitra Siaga Hospital



Figure 9. About view



Figure 10. Hospital Information Menu Display

3. Accuracy Testing

The results of this accuracy test directly compare the shortest route with the actual route found on Google Maps. Here are the test description results:

Table 3. Accuracy Testing

No.	Purpose	Information
1.	Dr. Soeselo Slawi Hospital	According to the route on Google Maps
2.	Harapan Sehat Slawi Hospital	According to the route on Google Maps
3.	Adella Hospital	According to the route on Google Maps
4.	Muhammadiyah Hospital	According to the route on Google Maps
5.	Suradadi Hospital	According to the route on Google Maps
6.	Mother And Child Pala Raya Hospital	According to the route on Google Maps
7.	Tk.IV Tegal Hospital	According to the route on Google Maps
8.	Mitra Keluarga Slawi Hospital	According to the route on Google Maps
9.	Kardinah Hospital	According to the route on Google Maps
10.	Islam Harapan Anda Hospital	According to the route on Google Maps

Based on Table 3, it is known that testing was carried out 10 times with the initial location, namely STMIK Tegal, with the aim of 10 hospitals producing 10 times the suitability of the actual route on Google Maps, then the accuracy was produced as follows:

$$accuracy = \frac{10 - 0}{10} * 100\% = 100\%$$

4. CONCLUSION

Based on the discussion and testing of the application of the Dijkstra method to improve the accessibility of health services in Kabupaten Tegal, it can be concluded that this method has great potential to increase the efficiency and availability of medical services. The Dijkstra method has proven effective in finding the shortest route to the nearest hospital, vital in emergencies and routine care. In addition, using the Dijkstra method can help optimize transportation resources, reduce travel time, and save transportation costs. The results of this study show that applying the Dijkstra method in finding routes to Mitra Siaga hospitals in Kabupaten Tegal can increase accessibility to health facilities. Future research can be more in-depth in analyzing the impact of the use of the Dijkstra method on public health. As well as a better understanding of how healthcare accessibility affects public health outcomes, it is also necessary to consider the integration of Dijkstra's method into the more comprehensive transport model in Kabupaten Tegal. This can involve cooperation with related parties in developing an integrated transportation system; this research is implemented as an application, and it is necessary to carry out advanced development to make the application more user-friendly and responsive. This will make it easier for people to use the application.

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