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Application of Dijkstra's Algorithm to Determine the Shortest Route from City Center to Medan City Tourist Attractions

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ABSTRACT

Tourist attractions are very interesting things to visit in an area that we are living. It is no exception when visiting the city of Medan, the tourists will visit interesting tourist spots in the city of Medan. To optimize time so that you can visit all tourist attractions in Medan City, you need to map locations so that you can create the shortest route that can be used to take all the tourist sites you want to visit in Medan City. The shortest route of a trip will shorten the travel time. Likewise in terms of seeking experts. When requesting a route from one point (start point) to another location (destination point), usually the result that comes out is the "shortest path" from the starting point to the destination point. The shortest path is the problem of finding a path between two or more vertices in a minimum weighted graph. To simplify solving the shortest path problem, a search algorithm is needed. Dijkstra's algorithm solves the problem of finding the shortest path between two vertices in a weighted graph with the smallest total number, by finding the shortest distance between the initial vertex and other vertices, so that the path formed from the initial vertex to the destination vertex has the smallest total weight. In this study, Dijkstra's algorithm looks for the shortest path based on the smallest weight from one point to another, so that it can help provide a choice of paths. Based on the trials of Dijkstra's algorithm, it has the ability to find the shortest path, because in this algorithm each graph is selected an edge with a minimum weight that connects the selected vertices with other unselected vertices.

Keywords: Dijkstra's algorithm, shortest route

INTRODUCTION

Tourist Attractions are locations that are often visited by many people, especially people from out of town. Places where you can learn about cultural heritage or learn about the history that happened. There are so many benefits that can be obtained from tourist attractions, for example as concrete evidence of historical events that can be observed at this time, become insight and knowledge, help in the field of education and science, and so on. One city that has many tourist attractions is Medan. Medan has many kinds of tourist attractions that can be visited by the people of Medan or people from outside the city of Medan, including the Maimun Palace, Tjong A Fie Mansion Museum, Al-Mashun Grand Mosque, Tjong Yong Hian Gallery, Ucok Durian, MahaVihara Maitreya Cemara Asri, The Le hu Garden and others.

However, the problem that is often experienced by visitors is the difficulty in choosing the shortest route from the starting point (departure location) to the tourist location you want to visit. This resulted in traveling to these tourist sites taking up a lot of time on the road plus the density of road drivers in the city of Medan, so this also had an impact on the number of tourist sites you wanted to visit. It could be that a visitor or a group of visitors wants to visit many tourist sites at once in a day, but because they choose the wrong shortest route, they can only visit one or two locations. That is why the search for the shortest route is needed in this case, and the research that will be carried out is very useful and useful for the future. So this research will refer to finding the shortest route from downtown Medan to a number of tourist spots using the Dijksta Algorithm. It's not easy to choose the shortest route directly through maps, the situation can change drastically at this time.

Research related to determining the shortest route has been carried out with various algorithms including the A* algorithm (Ferdiansyah & Rizal, 2013),(Andayani & Perwitasari, 2014) ,(Wamiliana et al., 2013). Especially in this study will use Dijkstra's Algorithm. Dijkstra's algorithm is one of the most popular algorithms from graph theory for determining the shortest path. Dijkstra's algorithm looks for the shortest path by comparing the smallest weight from the initial node to the last node or destination, to find the most effective and efficient path to take. In 1950, determining the shortest path is a problem that has been widely discussed and studied. This shortest path search has been applied in various fields to optimize the performance of automatic transmissions. One of the most interesting shortest path searches to discuss is related to transportation. Dijkstra's algorithm was chosen for determining the shortest route because it can determine the shortest route from a weighted graph where the weight is greater than zero (positive), from the starting point of all the desired points, so that the shortest route can be found from the starting point to the destination point.(Wamiliana et al., 2013)

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The goal is to determine the directed graph representation for all road routes as well as to determine the shortest route from the city center to historic sites in Surabaya using the Djikstra Algorithm. Much research has been done on the shortest route, including that done by Masri, et al (Masri et al., 2019), using the Dijkstra Algorithm. This system is very useful for visitors because tourists can find out the shortest route that can be taken from and to a desired tourist spot in the tourism object area of Lake Toba and its surroundings by using this system. By researching the shortest route using the Djikstra Algorithm, tourists are expected to be able to add information about the fastest route and finally tourists choose the best route that can streamline all costs and find out all the information on tourist objects on Lake Toba.(Novandi, 2007)

Next is research conducted by Gautama, et al (Gautama & Hermanto, 2020), regarding Determining the Shortest Route Using Dijkstra's Algorithm on School Bus Lanes. One of the optimizations that can be done is to determine the shortest distance from the school bus lane. The shorter the distance traveled, of course, has an impact on costs and time. The results of this study are the total Denpasar School Bus route for the morning shift of 95.5 km. The school bus uses pertadex fuel, where 1 liter costs IDR 9,400 and can travel 12.8 km. So the total cost of fuel for the school bus is IDR 70,132. These results can provide an overview for the Denpasar City Transportation Agency regarding the application of mathematics in determining routes that can optimize fuel expenses. Subsequent research by Juniawan, et al (Gusmão et al., 2013), regarding Determining the Shortest Route for Tourist Destinations in Toboali City Using the Web-Based Dijkstra Algorithm. The difficulty experienced by these tourists is in terms of knowing and determining the path to be traversed to get to their tourist destination. For this reason, a web-based geographic information system was created and equipped with the function of determining the shortest distance using Dijkstra's Algorithm so that it can arrive at tourist destinations more quickly. The system is designed web-based so that more people can use it.(Pratiwi, 2022)

The results of the research are in the form of a Toboali City tourism information system that can determine the shortest distance to tourist sites. From the results of testing the algorithm, it can be proven that the system is able to determine the shortest distance from the starting point specified by the user to the destination point. From blackbox testing, the result is that the functional system has good performance. Furthermore, by Setiawan, et al (Setiawan et al., 2019), regarding Determining the Shortest Route to Shopping Centers in Jakarta Using Dijkstra's Algorithm. The problem of choosing a shopping center is what drives researchers to conduct this research.

The results obtained are an application to find the nearest shopping center using the Dijkstra algorithm which can be used on smartphones to make it easier to find and find shopping centers around the user.(Ahdan & Setiawansyah, 2020)

In this case, the path that must be passed from the city center to tourist attractions will be determined in order to find the desired destination with the shortest distance. Therefore, the shortest distance can be interpreted as the minimum weight of the path, which is the sum of the weights of all the arcs forming the path. Determining the shortest path is one of the problems to determine a path between two nodes with the minimum number of weights. In the case of searching for the shortest path between two locations on the map to travel between two locations, Dijkstra's Algorithm is suitable for determining the shortest route so that Dijkstra's Algorithm for Determining the Shortest Route in visiting tourist attractions in the city of Medan.

LITERATURE REVIEW

This research uses a method that is the study of literature and data collection. Literature studies were conducted to obtain the necessary data through references such as books, journals, articles, and internet site searches. Data collection was carried out to collect and analyze data such as information on tourist attractions in the city of Medan. There are five historical places which have now become museums and will be the samples in this study, with the starting point being the Medan City Train Station. These places are Maimun Palace, Tjong A Fie Mansion Museum, Masjid Raya Al-Mashun, Tjong Yong Hian Gallery, Ucok Durian, MahaVihara Maitreya Cemara Asri, The Le hu Garden.

The following are the dots ± dots marked in yellow using google earth which will be part of the research as well as data which is secondary data used to determine the distance of each point originating from google maps:

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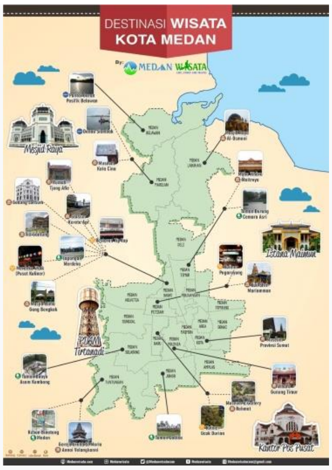

Source : (google Map ., 2022)
Figure 1. Tourist Sites

The shortest path finder in a graph is a problem to find the path between two or more vertices on. The graph used is a weighted graph, which is a graph where each side is assigned a value or weight. The weights on the sides of the graph can represent the distance between cities. In this case the weight must be positive, although in other cases it can be negative. The shortest path with initial vertex and destination vertex is defined as the shortest path with minimum weight and is a simple path. The shortest word in the shortest path problem means minimization of the weights on a path in the graph. There are several types of shortest path problems, including:
a. The shortest path between two given vertices.
b. The shortest path between all pairs of vertices.
c. The shortest path from a certain node to all other nodes.
d. The shortest path between two nodes that passes through certain nodes.

Dijkstra's algorithm, (according to its founder Edsger Dijkstra), is an algorithm used to solve the shortest path problem for a directed graph. This algorithm was published in the 1959 journal Numerische Mathematik entitled "A Note on Two Problems in Connexion with Graphs" and is considered a greedy algorithm.
The shortest route problem from one point to another is a classic optimization problem that is widely used to test a proposed algorithm. The shortest route problem is considered good enough to represent the optimization problem, because the problem is easy to understand (only adding up all the edges traversed) but has many choices of solutions.

According to Andrew Goldberg, a researcher at Microsoft Research Silicon Valley, there are many reasons why researchers continue to study the problem of finding the shortest path. "The shortest path is a relevant optimization problem for a wide variety of applications, such as network routing, gaming, circuit design, and mapping".

The mathematical description for the graph can be represented G = {V. E}, which means a graph (G) is defined by a set of vertices (Vertex = V) and a collection of edges (E).
Dijkstra's algorithm works by creating a path to one optimal node at each step. So in the nth step, there are at least n nodes where we already know the shortest path. Dijkstra's algorithm steps can be done with the following steps:

1. Determine which point will be the initial node, then weight the distance at the first node to the nearest node one by one, Dijkstra will carry out the search development from one point to another and to the next point step by step.
2. Give a weight value (distance) for each point to another point, then set a value of 0 at the initial node and an infinite value for other nodes (unfilled) 2.
3. Set all nodes that have not been traversed and set the initial node as "Departure node"
4. From the departure node, consider neighboring nodes that have not been traversed and calculate the distance from the departure point. If this distance is smaller than the previous distance (which was previously recorded) delete the old data, re-store the distance data with the new distance
5. When we have finished considering each distance to the neighboring nodes, mark the nodes that have been traversed as “Nodes skipped”. The node that is passed will never be checked again, the distance that is stored is the last distance and has the minimum weight.
6. Set "Node not passed" with the smallest distance (from the departure node) as the next "Departure Node" and repeat step e.

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For example, calculate the shortest distance from V1 to V7 in the following figure.

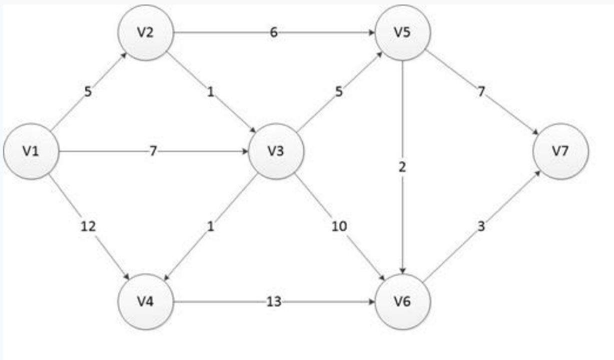

Figure 2. Vertex Chart

The results of each step can be seen in the following table.

Table1. Vertx

Iteration	Unvisited (Q)	Visited (S)	Current	Node : Min = (dist[node], prev[node])iteration						
				V1	V2	V3	V4	V5	V6	V7
	Initialization {V1,V2,V3,V4,V5,V6,V7}	{-}		(0, -)0	(∞, -)0	(∞, -)0	(∞, -)0	(∞, -)0	(∞, -)0	(∞, -)0
1	{V2,V3,V4,V5,V6,V7}	{V1}	V1		(5,V1)1	(7,V1)1	(12,V1)1	(∞,V1)1	(∞,V1)1	(∞,V1)1
2	{V3,V4,V5,V6,V7}	{V1,V2}	V2			(6,V2)2	(12,V1)1	(11,V2)2	(∞,V2)2	(∞,V2)2
3	{V4,V5,V6,V7}	{V1,V2, V3}	V3				(7,V3)3	(11,V3)3	(16,V3)3	(∞,V3)3
4	{V5,V6,V7}	{V1,V2, V3,V4}	V4					(11,V3)3	(16,V3)3	(∞,V3)3
5	{V6,V7}	{V1,V2, V3,V4,V5}	V5						(13,V5)5	(18,V5)5
6	{V7}	{V1,V2, V3,V4,V5.V6}	V6							(16,V6)6

Thus the shortest distance from V1 to V7 is 16 with the path V1->V2->V3->V5->V6->V7

METHOD

In this study, a graph was obtained from Figure 1. The points ± points used for research where the points will be assumed as the starting point and the tourist attractions and sides are the distance from each point. In this study we obtained several results, namely:

1. The graph used is a weighted graph where distance data from one point to another is taken from Google Maps, the distance from one point to another is expressed in km. The value at that distance is the weight of each edge so that the graph is declared a weighted graph.

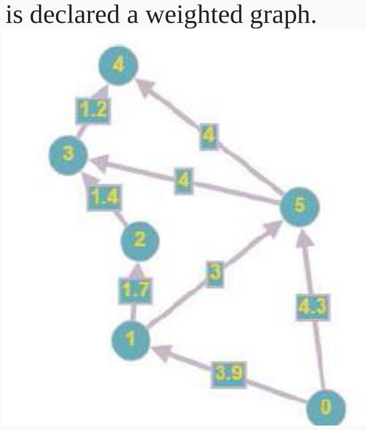

Figure.3 Weighted Graph

2. The following are the five tourist attractions along with the starting point and description of the place in this study, where the data on tourist attractions,

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Table 2. Place description of the marked point with numbers.

No	Tourist Attraction	Information
1	Istana Maimun	tourist attraction
2	Museum Tjong A Fie Mansion	tourist attraction
3	Masjid Raya Al-Mashun	tourist attraction
4	Tjong Yong Hian Gallery	tourist attraction
5	MahaVihara Maitreya Cemara Asri.	tourist attraction

3. Table of distances from connected graphs where the distance from one point to another is expressed in km, and the ∞ sign indicates if there are no edges between the points.

Table. 3 Interconnected distance

	0	1	2	3	4	5
0	0	3,9	∞	∞	∞	4,3
1	3,9	0	1,7	∞	∞	3
2	∞	1,7	0	1,4	∞	∞
3	∞	∞	1,4	0	1,2	4
4	∞	∞	∞	1,2	0	4
5	4,3	3	∞	4	4	0

Determine the shortest distance to a point to another point by calculating the shortest distance starting from the node with the smallest weight.
a. The distances to determine the shortest distance from the Medan City Railway Station to the Maimum palace and vice versa.

$$0 \rightarrow 1 = 3{,}9$$

$$0 \rightarrow 5 = 4{,}3$$

$$1 \rightarrow 2 = 1{,}7$$

$$1 \rightarrow 5 = 3$$

$$2 \rightarrow 3 = 1{,}4$$

$$5 \rightarrow 3 = 4$$

From the above distances, determine the distance that has the smallest weight, then add it up.

- $0 \rightarrow 3 = 0 \rightarrow 1 + 1 \rightarrow 2 + 2 \rightarrow 3 = 7$
- $0 \rightarrow 3 = 0 \rightarrow 1 + 1 \rightarrow 5 + 5 \rightarrow 3 = 10{,}9$
- $0 \rightarrow 3 = 0 \rightarrow 5 + 5 \rightarrow 3 = 8{,}3$

Of the three calculations above, the calculation used is the one that produces the smallest weight so that it will be used as the shortest distance. The distance obtained from these calculations is $0 \rightarrow 3 = 0 \rightarrow 1 + 1 \rightarrow 2 + 2 \rightarrow 3 = 7$
b. Perform a search calculation as above, then re-create the distance table as Table 3. Interconnected distances. Fill in each calculation result to obtain the shortest distance from one point to another.

Table 4. distance between points

	0	1	2	3	4	5
0	0	3,9	5,6	7	8,3	4,3
1	3,9	0	1,7	2,1	3,3	3
2	5,6	1,7	0	1,4	2,6	5,4

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3	7	2,1	1,4	0	1,2	4
4	8,3	3,3	2,6	1,2	0	4
5	4,3	3	5,4	4	4	0

c. After calculating each distance in determining the shortest route, a table will be made to determine the shortest route from the starting point, namely the Medan City Train Station.

RESULT

Based on the results of research in the search for the shortest route that has been carried out, obtained 5 shortest routes that can be passed when heading to historical sites with the starting point being the Medan City Train Station. After the results of the above calculations, the implementation of the design results will then be carried out, in this case the research will use a programming language. The implementation of the system aims to find out to what extent the results that have been developed take place. This study uses the C++ language, which is structured and can be used with various platforms. The following is the c++ code implemented from Dijkstra's Algorithm:

```
#include <iostream>
#include<stdio.h>
#include<conio.h>
 #include<ctype.h>
#include<string.h>
#include<math.h>
#define IN 99
#define N 6
    using namespace std;
    void dijkstra(float cost[][N], int source, inttujuan) {
        float dist[N],d;
    int prev[N], selected[N]={0},i, m, min,start, j;
        char path[N];
        //float total=0; for(i=1;i<N;i++) {
            dist[i] = IN;prev[i] = -1;
        }
selected[start]=1;
dist[start]=0;
while(selected[tujuan] == 0) {
min = IN;
m = 0;
for(i=1;i< dist[i]&&selected[i]== 0) {
dist[i] = d;
prev[i] = start; }
if (min> dist[i]&&selected[i]== 0) {
min = dist[i];
m = i; } }
 start = m;
selected[start] = 1; }
 start = tujuan;
j = 0;
while(start != -1) {
path[j++] start+64;
```

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```
start = prev[start]; }
 path[j] = '\0';
printf("\nPath : %s", path);
cout << "\nBobot yang dilalui: " <<dist[tujuan];
} int main() {
float cost[N][N];
int i, j;
float w;
 int source, tujuan, x, y;
 for (i=1;i< N;i++)
 for (j=1;j< N;j++)
cost[i][j] = IN;
 for (x=1;x< N; x++) {
 for (y=x+1;y<=n;y++){
} print ("\n");
} printf("\n Masukan asal simpul : ");
scanf("%d", &source);
 printf("\n Masukan tujuan simpul : ");
scanf("%d", &tujuan);
dijkstra(cost, source, tujuan);
return 0; }
```

The following results are the code above that has been executed:

```
Masukan nilai dari simpul 1 ke 3: 5.6
Masukan nilai dari simpul 1 ke 4: 7.0
Masukan nilai dari simpul 1 ke 5: 8.2

Masukan nilai dari simpul 2 ke 3: 1.7
Masukan nilai dari simpul 2 ke 4: 3.1
Masukan nilai dari simpul 2 ke 5: 4.3

Masukan nilai dari simpul 3 ke 4: 1.4
Masukan nilai dari simpul 3 ke 5: 2.6

Masukan nilai dari simpul 4 ke 5: 1.2


 Masukan asal simpul : 1

 Masukan tujuan simpul : 5

Path : EA
Jalur yang dilalui: 8.2
```

Figure 3. Program Execution Results

DISCUSSIONS

From the research and implementation results of Dijkstra's Algorithm based on the trajectory, it can be concluded that: Obtained the 5 shortest routes that can be passed when heading to historical sites from the beginning was the Medan City Train Station. The problem of finding the shortest route to visit tourist attractions can be solved with Dijkstra's Algorithm. By using Dijkstra's method, the shortest path from a travel path can be determined by determining the initial vertex and the destination vertex and comparing the values of each vertex.

REFERENCES

Ahdan, S., & Setiawansyah. (2020). Pengembangan sistem informasi geografis untuk pendonor darah dengan algoritma dijkstra berbasis android. *Jurnal Sains Dan Informatika*, *6*(2), 67–77. http://doi.org/10.22216/jsi.v6i2.5573

Andayani, S., & Perwitasari, E. W. (2014). Penentuan Rute Terpendek Pengambilan Sampah di Kota Merauke Menggunakan Algoritma Dijkstra. *Aeminar Nasional Teknologi Informasi & Komunikasi Terapan (SEMANTIK)*, 164–170.

Ferdiansyah, & Rizal, A. (2013). *Penerapan Algoritma Dijkstra untuk Menentukan Rute Terpendek Pembacaan*

* Corresponding author

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Published : Aug 14, 2023

Water Meter Induk PDAM Tirta Kerta Raharja Kabupaten Tangerang. Jurnal TICOM.

Gautama, I. P. W., & Hermanto, K. (2020). Penentuan Rute Terpendek dengan Menggunakan Algoritma Dijkstra pada Jalur Bus Sekolah. *Jurnal Matematika*, *10*(2), 116. https://doi.org/10.24843/JMAT.2020.v10.i02.p128

Gusmão, A., Pramono, S. H., & Sunaryo. (2013). Sistem Informasi Geografis Pariwisata Berbasis Web Dan Pencarian Jalur Terpendek Dengan Algoritma Dijkstra. *Department of Electrical Engineering, Faculty of Engineering, Universitas Brawijaya*, *7*(2), 125–130.

Masri, M., Kiswanto, A. P., & Kusuma, B. S. (2019). *IMPLEMENTASI ALGORITMA DIJKSTRA DALAM PERANCANGAN APLIKASI PENENTUAN RUTE TERPENDEK PADA OBJEK PARIWISATA DANAU TOBA DAN SEKITARNYA*. Prosiding Seminar Nasional Teknik SEMNASTEK UISU 2019 : Teknologi Berkelanjutan Berbasis Industri 4.0.

Novandi, R. A. D. (2007). Perbandingan Algoritma Djikstra dan Algoritma Floyd-Warshall Dalam Penentuan Lintasan Terpendek (Single Pair Shortest Path). *Makalah IF2251 Strategi Algoritmik*, 1–5.

Pratiwi, H. (2022, January 29). *Application Of The Dijkstra Algorithm To Determine The Shortest Route From City Center Surabaya To Historical Places*. Jurnal Teknologi Dan Sistem Informasi Bisnis. https://doi.org/10.47233/jteksis.v4i1.407

Setiawan, J., Prakoso, R. S. P., & Margi, S. K. (2019). *PENENTUAN RUTE TERPENDEK MENUJU PUSAT PERBELANJAAN DI JAKARTA MENGGUNAKAN ALGORITMA DIJKSTRA*. Binadarma. https://journal.binadarma.ac.id/index.php/jurnalmatrik/article/view/715/412

Wamiliana, Kurniasari, D., & Rokhman, F. (2013). *Implementasi Metode Dynamic Programming pada Aplikasi Penentuan Jarak Minimum*. Ilmu Komputer Unila Publishing Network.

* Corresponding author