Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Dijkstra's algorithm to find the nearest vaccine location

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Abstract

Since the start of Covid-19 pandemic has made many people look for vaccine locations. In general, Dijkstra algorithm is used to find the shortest path. The shortest path problem concentrates on finding the path with the minimum distance. The Dijkstra algorithm was chosen because it has several advantages other than advantageous in terms of running time to find the shortest path. This research focuses on calculation and implementation of Dijkstra algorithm that will result the shortest path with visual by Google Maps API. The project is tested with manual calculation first by using graph explanation. The graph is obtained based on route data obtained with the help of google maps then it is tested by implementing the Dijkstra algorithm using HTML, JavaScript and also Google Maps API to visualize the nearest vaccine location. From the research founded that there were shortcomings problem where program had to enter each road turn as a vertex and an edge, If not including the entire path that was formed, it would pass through buildings or structures that should not be passed. The results that will be displayed on the website based on the purpose of the research.

Keywords: COVID-19, Vaccination, Shortest path, Dijkstra Algorithm, Location.

1. Introduction

Coronavirus 2019 disease is an infectious disease caused by SARS-CoV-2, a type of coronavirus. This disease has caused a pandemic since 2019 until now. Patients with COVID-19 may experience fever, dry cough, and difficulty breathing. Sore throat, runny nose, or sneezing are less common. In the most susceptible patients, the disease can lead to pneumonia and multi-organ failure.

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The infection is spread from one person to another through respiratory droplets from the respiratory tract that are often produced when coughing or sneezing. The time from exposure to the virus to the onset of clinical symptoms ranged from 1–14 days with an average of 5 days. The standard method of diagnosis is the reverse-transcription polymerase chain reaction (rRT-PCR) assay of a nasopharyngeal swab or sputum sample with results within hours to 2 days. Antibody tests from blood serum samples can also be used with results within a few days. Infection can also be diagnosed from a combination of symptoms, risk factors, and a computed tomography scan of the chest that shows symptoms of pneumonia.

The spread of the Covid-19 virus is still rampant in Indonesia. While the spread of the vaccine is still hampered due to various things. One of them is the unclear location of the available vaccines. Therefore, this study is made with the aim of finding the closest vaccine location to the user.

The problem of finding the shortest route above can be solved by applying Dijkstra's algorithm. Dijkstra's algorithm uses the greedy principle, which is looking for the shortest path from one node (point / vertex) to another in the same direction (directed graph) starting from the origin node to the destination node. The calculated nodes are obtained from several strategic locations that can be known in general, such as offices, crossroads or public locations that are easily remembered by the public. The supporting data for the calculation of the Dijkstra's algorithm uses data derived from the user information regarding the user's name and location, while the location coordinate data is obtained from Google Maps.

2. Literature Review

Research related to the optimization of the vaccine process is ongoing. The study was conducted by Markhorst, B, Dijkstra, R, Otto, D., Malbasic, N., Zver, T., Van Der Mei, R., Moeke, D where they presented an optimization model that optimizes the performance measure of waiting per class. This is done by determining the optimal placement of medical hubs, such as: and distribution of vaccines and health workers among these centers [1].

The research carried out is related to implementing Dijkstra's algorithm in determining the shortest path to a goal. The research involved the use of Dijkstra's algorithm to solve various problems. Sunita and Deepak Garg conducted research by analyzing an algorithm by comparing the dynamic Dijkstra's algorithm with the algorithm given by Ramalingam and Demetrescu. The initiative to solve the single-source path dynamic problem [2].

Mikhail Urubkin, Vasiliy Galushka, Vladimir Fathi, Denis Fathi Sofya Petrenkova conducted research on Dijkstra's algorithm with the help of Microsoft SQL server DBMS to perform data processing, data manipulation with linear algebra operations to find the shortest path. The research resulted in a method to implement the algorithm with the help of Microsoft SQL DBMS to perform data processing assisted by relational algebra where the implementation of Dijkstra's algorithm will be used for graphs [3].

Wijaya, A and Kurniawan, E conducted research related to the use of google maps to show routes and destinations. By combining the results displayed by google maps and Dijkstra's algorithm. Based on the survey results, the resulting applications were successfully developed. Based on the survey, a web-based application has been successfully developed with a positive response where 47% of the responses were very interesting, 45% interesting, and 8% unattractive [4].

Al Hakim, Purwono, Arief, Pangestu, Satria and Ariyanto conducted research related to the implementation of the Dijkstra algorithm using React Native to determine the distribution of covid. Based on the resulting research, Dijkstra's algorithm was successfully implemented on a system that was created where the system was able to display covid cases around the user in the form of the radius and closest distance from the user. where the closest distance is 41 meters and the radius is 147 meters. This system was developed with React Native Programming [5].

Some paper compares on algorithm performance by Wayahdi, M. R., Ginting, S. H. N., and Syahputra, D.to find the shortest path, namely greedy, A-Star and dijkstra algorithm where the analysis results get greedy fast but does not provide an optimal solution, A star itself is better than the shortest path than greedy algorithm but there are some cases where the goal is not found. Then for the dijkstra algorithm itself it is better to find the shortest path and tend to be better at offering the optimal path solution with the disadvantage that it tends to be slower [6].

3. Research Method

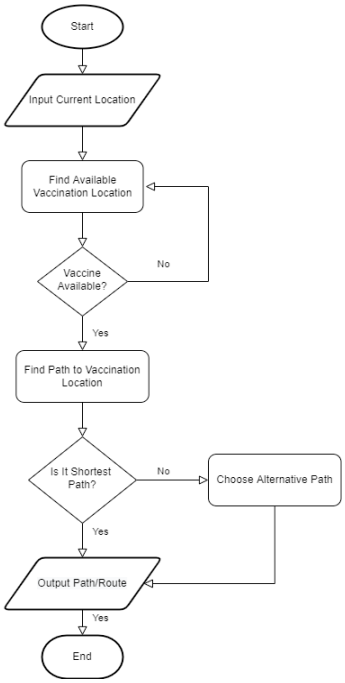

Fig. 1. Flowchart for the Algorithm Implementation

According to Figure 1, The First at the requirements stage is to find out what prospective users need from the program to be created. From this stage, it can be seen that what is needed from prospective users is the ease of finding the shortest path to the vaccination site. Then proceed to the design stage. From the requirements obtained previously, it can be concluded that finding the shortest path can be done by implementing the Dijkstra algorithm.

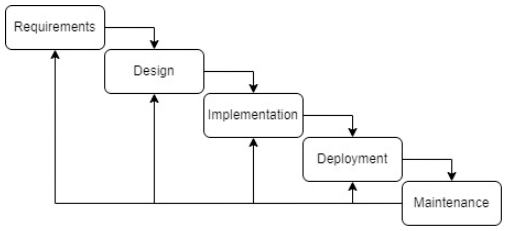

Fig. 2. Waterfall Method Process

In Figure 2, The implementation stage, the program is made in the form of a website using HTML, CSS, and JavaScript. Data from vaccination sites will be stored in the database. Then at the deployment stage, the program is tested by several potential users. From this deployment stage, inputs are obtained that can help develop this program in the future. At the maintenance stage, maintenance is carried out on the program that has been made. This is done to fix errors that were not detected in the previous stage.

3.1 *Algorithm*

Shortest path is a problem to find or find the shortest path between a point or what is called a vertex in a graph that has a number of values on the edge graph or a path that connects the points with the smallest value. There are several steps needed to find the shortest path including:

- Creates a table of distances between vertices / edges and gives the value of each of these edges, the previous vertex, the visited vertex, and the current visited vertex.
- The initial vertices are assigned a value of 0 as a starting point.
- Vertices that have been visited must be marked and cannot be visited again.
- Performs value calculations and updates the distance as well as the previous vertex list based on the vertex to be visited from the current vertex.
- Repeat the process that was done in the third step and so on until all the vertices have been visited.

3.2 *The process of finding the shortest path for the vaccine site*

The process of finding the shortest path to the location of the vaccine requires some data to search. The data in the form of starting point and destination or location of the vaccine, will then need distance related data for each point or vertex before reaching the destination. Then the shortest path will be checked using the Dijkstra algorithm. After finding the shortest path, the distance will be calculated to reach that location.

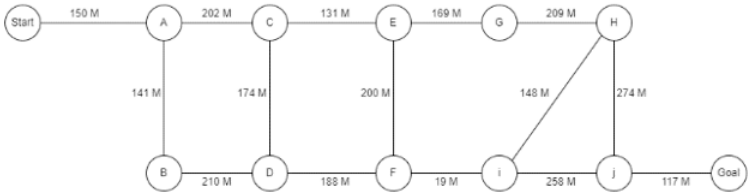

Fig. 3. Graph of the Implementation

3.3 *Graph Explanation*

The graph displayed in Figure 3, is obtained based on route data obtained with the help of google maps. by placing the starting point and Goal point as well as several vertices as an alternative and shortest path choice to reach the goal point/goal vertex. The value of each edge that connects the vertices is obtained based on measurements made by drawing a line from each associated vertex with the help of google maps. After calculating the distance and placing the existing points then it is implemented into a graph that will be used for calculations with the Dijkstra algorithm.

3.4 *Database*

The Sample Databases that used to calculate the result (in meter):

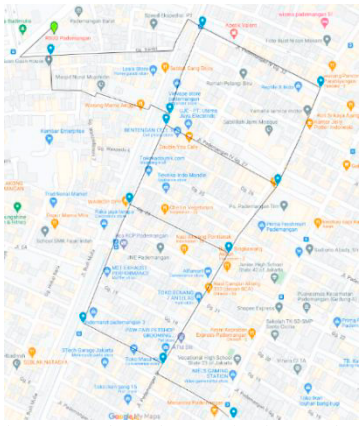

Fig. 4. Graph Implementation in Google Map

Based on Figure 4, The map from the Google Map above, the sample database list is obtained as follows along with the name of the node/vertex used in the calculation of the algorithm.

Table 1. Vertex Detail

Node	Place	Description
S	Pademangan II Gg 17 No 2	Starting Point
A	Jl. Pademangan Gg 17	Route
B	Jl. Pademangan V	Route
C	Jl. Pademangan IV Gg 23	Route
D	Jl. Pademangan V Gg 23	Route
E	Jl. Pademangan IV Gg 27	Route
F	Jl. Pademangan V Gg 27	Route
G	Jl. Pademangan IV Gg 32	Route
H	Pademangan Duta Kemayoran	Route
I	Pademangan V Intersection	Route
J	Santri Street	Route
Goal	RSUD Pademangan	Route

Table 2. Edges Detail

S-A	A-B	A - C	B - D	D - C	C - E	D - F	E - G
150	141	202	210	174	131	188	169
F - I	I - J	G - H	H - J	F - E	H - I	J - Goal	
19	258	209	274	200	148	117	

The database written in the table describes the distance from one point to another. The distance between these points is a road that can be traversed with the distance that has been calculated with the help of Google Maps.

Table 3. Dijkstra Calculation

	S	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**I**	**H**	**J**	**K**
1	0, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -
2		150, S	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -
3			291, A	352, B	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -
4				352, B	501, C	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -
5					501, C	483, D	∞, -	∞, -	∞, -	∞, -	∞, -	∞, -

	S	A	B	C	D	E	F	G	I	H	J	K
6					501, C		683, E	652, E	∞, -	∞, -	∞, -	∞, -
7							683, E	652, E	∞, -	∞, -	∞, -	∞, -
8							683, E		∞, -	861, G	∞, -	∞, -
9									702, F	861, G	∞, -	∞, -
10										850, H	960, H	∞, -
11											960, H	∞, -

based on the above calculations it will form a graph with the shortest path to reach the goal.

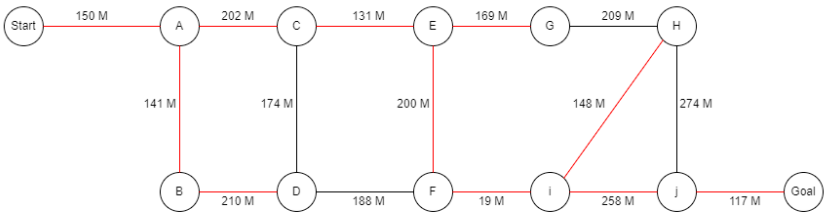

Fig. 5. Graph Routing Result

As we can see in figure 5, The resulting shortest path is S – A – B – C – E – D – G – F – I – H – J – Goal

4. Algorithm Implementation

For the implementation of the Dijkstra algorithm in determining the path to the nearest vaccine site, a program is produced in the form of a website that can display the closest path to the vaccine site according to the vertex data vertex and edges that have been entered and have been calculated. The implementation of this program uses html, JavaScript, and google maps API for implementation and visualization to solve the shortest path problem that is researched.

4.1 *Result and Analysis*

After observing the results and analysis, it was found that there were shortcomings where we had to enter each road turn as a vertex and an edge because if we didn't include the entire path that was formed, it would pass through buildings or structures that should not be passed.

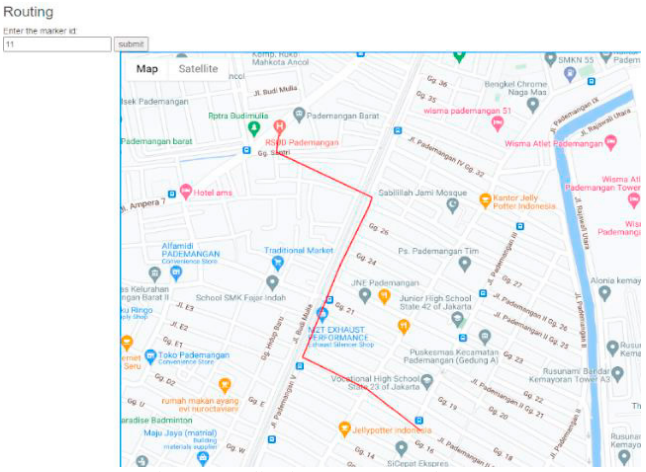

Fig. 6. Application Input Example 1

As shown in the Figure 6, when the destination node is inputted, the closest path to the vaccine will be displayed. In the program the path that is displayed is in accordance with the existing vertex coordinates. From each vertex, a calculation will be carried out on each existing path distance based on a google map which will then be calculated using the Dijkstra algorithm to find the fastest path to reach the destination point. The path used for calculations and traversed will be based on each vertex associated with the predefined starting point. The results that will be displayed on the website are based on the purpose of the node that has been written, in the picture above the destination node for the vaccine is located on the eleventh node so that the number eleven will be input in the search for the distance as the destination vertex.

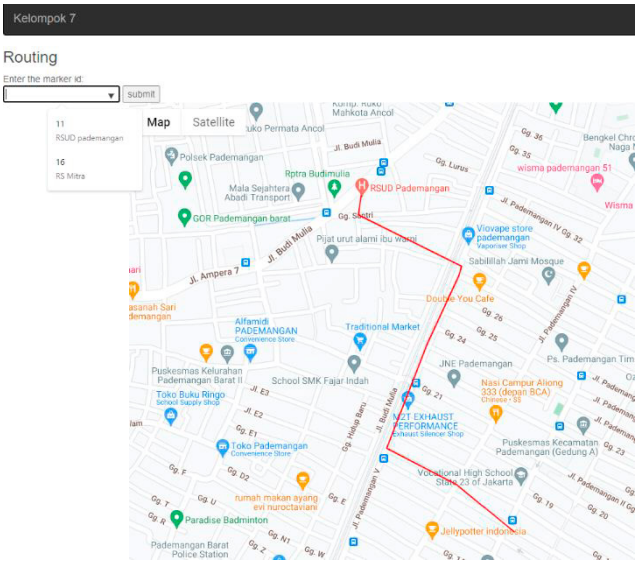

Fig. 7. Dropdown Feature

As we can see in figure 7, In addition to entering the destination vertex input, the application website is given a dropdown option containing the destination vertex and the name of the existing vaccine location to make it easier to search for the location.

5. Conclusion

The shortest path problem concentrates on finding the path with the minimum distance. To find the shortest path from the source node to another node, we can use the Dijkstra algorithm. The Dijkstra algorithm was chosen because it has several advantages other than advantageous in terms of running time, Dijkstra can solve several cases of finding the shortest path.

Based on discussion and testing in the search for the shortest path, the use of this Dijkstra algorithm can help the community to find the closest location for the Covid-19 vaccine. Based on the results of the test, the results of the shortest route from the initial location to the location of the Covid-19 vaccine were obtained. In this study, the initial location is limited to the location that has been inputted. For program development, the initial location can be developed into a *"current location"* so that the program runs optimally.

References

[1] Markhorst, B., Dijkstra, R., Otto, D., Malbasic, N., Zver, T., van der Mei, R., & Moeke, D. A data-driven digital application to support the capacity planning of the COVID-19 vaccination process. 2021.

[2] Sunita, Garg D. Dynamizing Dijkstra: A solution to dynamic shortest path problem through retroactive priority queue. Journal of King Saud University - Computer and Information Sciences. 2021 Mar 1;33(3):364–73.

[3] Urubkin M, Galushka V, Fathi V, Fathi D, Petrenkova S. Programmatic implementation of the Dijkstra algorithm in the Transact-SQL language using relational algebra. In: E3S Web of Conferences. 2020.

[4] Wijaya A, Kurniawan E. Implementasi Algorithma Dijkstra Dalam Pencarian Rute Terpendek Fasilitas Kesehatan Tingkat I (Studi Kasus BPJS Kesehatan Kota Bengkulu). Jurnal Media Infotama. 2019;15(2).

[5] Al Hakim, R. R., Purwono, P., Arief, Y. Z., Pangestu, A., Satria, M. H., & Ariyanto, E. Implementation of Dijkstra Algorithm with React Native to Determine Covid-19 Distribution. Sistemasi: Jurnal Sistem Informasi, 2022;11(1), 160-170.

[6] Wayahdi, M. R., Ginting, S. H. N., & Syahputra, D. Greedy, A-Star, and Dijkstra's Algorithms in Finding Shortest Path. International Journal of Advances in Data and Information Systems, 2021;2(1): 45-52.

[7] Noto, M., & Sato, H. Method for the shortest path search by extended Dijkstra algorithm. Proceedings of the IEEE International Conference on Systems, Man and Cybernetics. 2000; 3.

[8] Huang, Y. Research on the improvement of Dijkstra algorithm in the shortest path calculation. In Proceedings of the 2017 4th International Conference on Machinery, Materials and Computer (MACMC 2017), Atlantis Press. 2018 January;745-749.

[9] Deepa, G., Kumar, P., Manimaran, A., Rajakumar, K., & Krishnamoorthy, V. Dijkstra Algorithm Application: Shortest Distance between Buildings. International Journal of Engineering & Technology. 2018;7(4.10):974-976.

[10] Sari, I. P.,Fahroza, M. F., Mufit, M. I., & Qathrunad, I. F.Implementation of Dijkstra's Algorithm to Determine the Shortest Route in a City. Journal of Computer Science, Information Technology and Telecommunication Engineering. 2021;2(1), 134-138

[11] Aria, M. New algorithm for digital way-finding map. IOP Conference Series: Materials Science and Engineering. 2018;407(1).