The shortest path search application based on the city transport route in Semarang using the Floyd-warshall algorithm

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Abstract. City transportation is a motorized vehicle with a fixed line that connects one area to another in one city. Information about the city transportation route in Semarang has been provided by the Department of Transportation of Semarang city which contains the code and route. The development of science regarding the route search algorithm method or the shortest path can be used to support the path search based on the city transportation route. A geographical information system is a system designed to work using data that has spatial reference spatial information. At this time the technology has not been applied optimally to support the search for the shortest route of urban transport based on the city transportation route. This study aims to develop the application of the shortest pathway determination based on the city transportation route in Semarang using the Floyd Warshall algorithm based on Geographic Information System. City transportation route data can be implemented in graph form. The process of establishing a path graph is based on the road protocol traversed by Semarang city transportation. In this research, Floyd-warshall algorithm was successfully implemented in the Shortest Path Determination Application based on the City Transport Route in Semarang. Based on the results of testing the Floyd Warshall algorithm calculation by comparing manual calculations and calculations generated by the application, producing the path with the shortest distance the same so that the application gives the correct results. The results of usability testing which include aspects of ease, efficiency, easy to remember, errors and satisfaction in this application get a percentage overall 92.9% with very good qualification results. This application displays route maps, codes and trip descriptions from the initial position and destination position that can be selected by city transport users in Semarang.

1. Introduction
The city of Semarang has a population of almost 2 million [1]. City transportation is a motorized vehicle with fixed lines that connect one area to another in one city. City transportation in Semarang City uses the code on one other route. Information can be delivered in various ways including using an information system. The information system that is currently developing is a Geographic Information System abbreviated as GIS. GIS is a computer-based information system, designed to work using data that has spatial reference spatial information. GIS is a computer-based system that is used to enter, store, manage, analyze and reactivate data that has spatial references for various purposes related to mapping and planning. The use of GIS can provide convenience in displaying information about city transportation that has been mapped. The information generated will be more easily understood by users, in this case, the prospective passengers of the public car with an attractive presentation without reducing the content and purpose [2]. The optimal route presentation, in this case, the determination of
the shortest route can be done by various methods. Using the right method can help produce information about the shortest route. A method that can be used in finding the shortest route using an algorithm. Some types of algorithms that can be used in finding the shortest route between Dijkstra algorithm, Greedy Algorithm, Floyd Warshall Algorithm, and others. Referring to the comparison study in each algorithm above, it can be concluded that "Floyd-Warshall algorithm that implements dynamic programming ensures the success of finding the optimal solution for the case of determining the shortest path (all pairs of shortest paths)" [3]. Floyd Warshall is an algorithm that can calculate the optimal weight that connects point pairs and does everything at once for all point pairs. In other words, when calculating the optimal route to be passed, first calculate all possible routes, then look for the optimal route by comparing each pair of routes. In this study will be built the shortest path application determination based on the city transportation route in Semarang using the Floyd Warshall algorithm. This application will display the shortest route based on the initial position and destination position chosen by the user. Restrictions on the problem in this study include the use of Geographical Information Systems that are not real time, the use of data on urban transport containing public facilities, namely 25 of 64 codes and the city transportation route in Semarang. The application determines the shortest path based on the input data code and route. Information about the city transportation route in Semarang has been provided by the Transportation Department of Semarang city which contains the code and route. The development of science regarding the route search algorithm method or the shortest path can be used to support the path search based on the city transportation route. A geographical information system is a system designed to work using data that has spatial reference spatial information. At this time the technology has not been applied optimally to support the search for the shortest route of urban transportation based on the city transportation route. This study aims to develop the application of the shortest pathway determination based on the city transportation route in Semarang using the Floyd Warshall algorithm based on Geographic Information System.

2. Previous Research

Research using Geographic Information Systems and Floyd Warshall algorithm in displaying the shortest route information has been carried out. For example, research on geographic information systems searches the optimum route of Yogyakarta city tourism with Floyd Marshall algorithm. Geographical information system based on desktop and search for tourist locations is not real time, which directly knows the existence of the user. However, the user must enter the initial location (presence) and the final location (destination). The optimum route obtained is the fastest route/road that will be passed by four-wheeled vehicles. Data obtained from road surveys conducted by the Yogyakarta City Transportation Agency [4]. Other studies such as determining the shortest distance of the transmission route in Palembang City. Transmute data was obtained from the Transportation Agency of Palembang City. Transmission data consists of several points of interconnected bus stops. Compare each point in the search for the shortest route using the Floyd Warshall algorithm. The results of this study in the form of the closest distance information that can be traversed by transmitting passengers displayed in the form of GIS [5]. Other research In Nigeria for example, the main challenge is deciding the route to take from the point of origin to destination while minimizing costs, total mileage, fuel consumption and time. However, overcoming this challenge requires sophisticated knowledge about optimal society transportation network. Some algorithms can be used to determine the shortest distance and the shortest route between two nodes in a network, but this study uses classical, and Floyd - Warshall algorithm is recursive. This study will also explain hidden and some of the cases that ignore the shortest routes unknown to the transporter and the nation. The Floyd-Warshall algorithm has been efficient in finding the shortest route and distances in Nigeria. It can be concluded that network analysis is a tool capable of designing the best possible ways of enhancing our daily life problems [6]. Other research was conducted in the country of India. In this study, a comparison of Floyd Marshall algorithm and the rectangular algorithm was carried out. the performance of the Floyd Warshall algorithm is better than the Rectangular algorithm, especially for solid graphics. Therefore, in Rectangular algorithm theory, it may seem to provide better performance, its practical implementation is no better than the Floyd Warshall algorithm [7].
comparison research of algorithms and algorithms implemented in Microsoft visual studios in two cities in China. Dijkstra and Floyd algorithm to compare performance and provide an optimal solution for passengers. In a study not only use the Dijkstra algorithm to integrate National City traffic Advisory procedures that can meet different travel and customer needs provide some optimal decisions but also compare the Dijkstra and Floyd algorithms in practical cases. This paper compares two algorithms in the time cost of finding the shortest route. Using twenty examples to see the shortest direction. Measure the time-costs of the Dijkstra algorithm and the Floyd algorithm. Unit time is 'ns', 1 s = 109 ns. How can it be seen, the chart of Dijkstra’s performance is less than the Floyd algorithm. By compared charts and data from twenty groups of two algorithms, k discusses how much time the Dijkstra algorithm costs in finding the shortest route from the Floyd algorithm. This research has successfully collected and implemented people, across National Cities assignments that make the transportation network storage structure and find the shortest path from the network. National City Traffic discovery procedures meet the requirements. The cruise is different from travel. Users can choose two ways trains, trains and planes, providing a small portion of time and the lowest cost solution for users. Search for the shortest path by the Dijkstra algorithm and Floyd Algorithm. By Comparing the time of two algorithms, Dijkstra's algorithm is more effective than the Floyd algorithm [8].

3. Methodology
The optimum route presentation, in this case, the determination of the shortest route can be done by various methods. Using the right method can help produce information about the shortest route. The method that can be used in searching the shortest route is using an algorithm. Several kinds of algorithms can be used in finding the shortest route between Dijkstra's algorithm, Greedy Algorithm, Floyd Warshall Algorithm, and others. Referring to the research on the comparison in each algorithm above it can be concluded that "Floyd-Warshall Algorithm that implements dynamic programming guarantees the success of finding the optimum solution for the case of determining the all-pairs shortest path" [3]. Floyd Warshall is an algorithm that can calculate the optimum weight that connects a point pair and does it all at once for all point pairs. In other words, when calculating the optimum route that will be passed first calculates all possible routes to be traversed, then searches the optimum route by comparing each pair of routes.

The Floyd Warshall algorithm is one variant of dynamic programming, which is a method that solves problem-solving by looking at the solution to be obtained as an interrelated decision. That means these solutions are formed from solutions that come from the previous stage, and there are more than one possible solutions. Floyd Warshall algorithm for finding the shortest path is as follows.

\[
\begin{align*}
W &= W_0 \\
for k &= 1 \ to \ n, do: \\
for i &= 1 \ to \ n, do: \\
for j &= 1 \ to \ n, do: \\
if W[i,j] > W[i,k] + W[k,j] then \\
\text{change } W[i,j] \text{ to } W[i,k] + W[k,j] \\
W^* &= W
\end{align*}
\]

Information:
\[
\begin{align*}
W &= \text{matrix}; \ W_0 = \text{initial graph relationship matrix}; \ k &= \text{iteration 1 to n}; \ i &= \text{starting point in vi} \\
j &= \text{end point in vj}; \ W^* &= \text{matrix results after comparison}
\end{align*}
\]

The process of determining the minimum value of the Floyd Warshall algorithm can be written as follows:

a. In the 1st iteration, each matrix cell is checked whether the distance between the two starting points is greater than the sum between the distance of the origin to the destination (destination point = 1st iteration) with the distance of the original point (origin = 1st iteration) to the destination point. in other words whether \( W[i,j] > W[i,k] + W[k,j] \).
b. If so, then the distance between the two starting points is replaced by the sum between the distance of the origin to the destination (destination point = 1 iteration) by starting the origin (origin = 1st iteration) to the destination (W [i, k] + W [k, j]).
c. If not, then the distance used is the distance between the two starting points (W [i, j]).
d. The iteration process is carried out until the last iteration (number of iterations = total number of points).

4. Study and Result

The shortest distance calculation using the Floyd Warshall algorithm is done by determining the starting point and destination point. Each point has a value of coordinates longitude and latitude.

4.1. Sample of Research

In this study, we use nine nodes. After the location or coordinates are obtained, it will form a routing graph that shows the connection between the nodes (the position of each donor). With Google Maps API and Google service, each node symbolized with a marker will appear in the fragment folder. Each marker has a weighted distance to another marker in a different location.

For example, general users choose the starting position, that is JL Ngesrep Timur V, and the destination position is Pasar Rasamala. Table 1 describes zero iterations in distance calculations using the Floyd-warshall algorithm.

| From to                  | Ngesrep Timur V st | Pangeran Diponegoro’s statue | Setia Budi st | Sukun Raya st | Rasamala’s market | Karangrejo Raya st | Cemara st | Damar’s market | Accros of Hermina Banyumanik Hospital |
|--------------------------|--------------------|------------------------------|---------------|---------------|-------------------|-------------------|-----------|----------------|-------------------------------------|
| Ngesrep Timur V st       | 0                  | 0.73                         | ∞             | ∞             | ∞                 | ∞                 | ∞         | ∞              | ∞                                   |
| Pangeran Diponegoro’s statue | 0.73         | 0                            | 0.54          | ∞             | ∞                 | ∞                 | ∞         | 2.39           | ∞                                   |
| Setia Budi st            | ∞                  | 0.54                         | 0             | 1.41          | ∞                 | ∞                 | ∞         | ∞              | ∞                                   |
| Sukun Raya st            | ∞                  | ∞                            | 1.41          | 0             | 0.6               | ∞                 | ∞         | ∞              | ∞                                   |
| Rasamala’s market        | ∞                  | ∞                            | 0.55          | 0             | 0.59              | ∞                 | ∞         | ∞              | ∞                                   |
| Karangrejo Raya st       | ∞                  | ∞                            | ∞             | ∞             | 0.59              | 0                 | 0.76      | ∞              | 0.55                                |
| Cemara st                | ∞                  | ∞                            | ∞             | ∞             | ∞                 | 0.76              | 0         | 0.8            | 0                                   |
| Damar’s market           | ∞                  | ∞                            | ∞             | ∞             | ∞                 | ∞                 | 0         | ∞              | ∞                                   |
| Accros of Hermina Banyumanik Hospital | ∞              | 2.39                         | ∞             | ∞             | 0.55              | ∞                 | ∞         | ∞              | 0                                   |

Table 2. Final iterations in distance calculations using the Floyd-warshall algorithm

| From to                  | Ngesrep Timur V st | Pangeran Diponegoro’s statue | Setia Budi st | Sukun Raya st | Rasamala’s market | Karangrejo Raya st | Cemara st | Damar’s market | Accros of Hermina Banyumanik Hospital |
|--------------------------|--------------------|------------------------------|---------------|---------------|-------------------|-------------------|-----------|----------------|-------------------------------------|
| Ngesrep Timur V st       | 0                  | 0.73                         | 1.27          | 2.68          | 3.28              | 3.87              | 4.63      | 5.43           | 3.66                                |
| Pangeran Diponegoro’s statue | 0.73         | 0                            | 0.54          | 1.95          | 2.55              | 3.14              | 3.9       | 4.7            | 2.93                                |
| Setia Budi st            | 1.27              | 0.54                         | 0             | 1.41          | 2.01              | 2.6               | 3.36      | 4.16           | 2.39                                |
| Sukun Raya st            | ∞                  | ∞                            | 1.15          | 0             | 0.6               | 1.19              | 1.95      | 2.75           | 1.74                                |
| Rasamala’s market        | ∞                  | ∞                            | 0.55          | 0.6           | 0                 | 0.59              | 1.35      | 2.15           | 1.14                                |
| Karangrejo Raya st       | ∞                  | ∞                            | 1.14          | 1.19          | 0.59              | 0                 | 0.76      | 1.56           | 0.55                                |
| Cemara st                | ∞                  | ∞                            | 1.9           | 1.95          | 1.35              | 0.76              | 0         | 0.8            | 1.31                                |
| Damar’s market           | ∞                  | ∞                            | 2.7           | 2.75          | 2.15              | 1.56              | 0.8       | 0              | 2.11                                |
| Accros of Hermina        | ∞                  | ∞                            | 1.69          | 1.74          | 1.14              | 0.55              | 1.31      | 2.11           | 0                                   |
Tabel 2 describes final iterations in distance calculations using the Floyd-warshall algorithm. Using google maps API, the data is displayed simply, because basically, the weights displayed between nodes exist for the calculation of the shortest distance.

After doing the Floyd Warshall Algorithm calculation with Ngesrep Timur V st initial position and Rasamala’s market destination position, the distance is 3.28 km

4.2. Application Results
To search for city transport lines, general users can choose the starting position and destination position in the dropdown menu. By entering Tomobol search, the application will start calculating the shortest path from the initial position to the destination chosen by the general user. Semarang city transportation application interface can be seen in Figure 1.

Figure 1 Shortest Path Search Results

In Figure 2 is the route search results with the initial position of Ngesrep Timur V st and the destination position of Rasamala’s market. The application displays route maps, city transport codes and travel descriptions. General users can zoom in on the map so that they can see the path that will be passed clearly.

Figure 2 Route Map
Table 3 is the result of calculating the distance generated by the application. You can see the distance from Ngesrep Timur V st to Rasamala’s market resulting in a distance of 3.28 km. Distance calculation on the application has the same results as manual calculation.

5. Conclusion
This study produced an application that can be used to search for the shortest paths based on city transport routes in Semarang. The Floyd Warshall algorithm is used to find the shortest path by processing maps using the GoogleMaps API and data processing using the MySql DBMS. The results of testing Floyd Warshall algorithm calculations by comparing manual calculations and calculations generated by the application, resulting in the path with the shortest distance the same so that the application gives the correct results. For further research, it can be developed into a real-time application and additional information on city transport tariffs used by public users. Research implements a different shortest path algorithm to compare the shortest path results.

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