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Djikstra algorithm for finding the shortest route to company addresses in industrial areas

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ABSTRACT

Electronic maps are an application that implements manual maps into a web-based system. Useful for optimizing data from manual maps into useful information. By using a geographic information system (GIS), users can search for the location of the desired company. In this research, the Dijkstra algorithm method was implemented to find the shortest path in GIS. GIS technology uses the Dijkstra algorithm to provide data information by visually displaying road location data, place locations and the shortest path from the origin to the destination location on a map. The shortest route search geographic information system displays spatial data visualization of industrial area maps that are integrated with GoogleMaps.

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1. INTRODUCTION

An industrial area is an area or strategic concentration of industrial activities by a company. Initially, industrial area management companies were run by the government (BUMN), but many private companies have also been given permission to open or manage industrial areas. Bekasi is one of the areas that has quite a lot of industrial areas, which makes Bekasi one of the destination areas for job seekers. Workers in the Bekasi area do not only come from the Bekasi area but from various regions. However, sometimes job seekers who come from outside the area often experience difficulties regarding the location of the factory. With the large area of industrial areas, information is needed to search for specific locations, in this case specifically searching for company locations (Rahim et al., 2018; Wayahdi et al., 2021). Through a web-based geographic information system, various kinds of information can be obtained. One of them is information about the location of a company (R. Chen, 2022; Soverenty & Krisnamurti, 2022). Problems that exist include the public's ignorance regarding the detailed location information of the company they are going to, lack of information about the location distance and travel time to the company, and the absence of a web-based application for finding the shortest route for company addresses in the MM2100 Cibitung industrial area.

A geographic information system (GIS) is a system that can support spatial decision making and is able to integrate location descriptions with the characteristics of phenomena found at the location (Arrumdany et al., 2019; Novelan et al., 2021). For this reason, GIS is expected to become a website that can provide information about the location of companies in the Bekasi area, especially the MM2100 industrial area. The geographic information system presented is a map (Abbas et al., 2020) which can display profiles. GIS is used to store, manipulate and analyze special geographic information that manages data that has spatial information (spatial reference). The difference between GIS and other information systems is its ability to combine spatial data and analyze data information (Piwowar et al., 1990; Wei et al., 2020) using a database management system (DBMS).

GIS supporting components consist of five components that work in an integrated manner, namely hardware, software, data, users and methods (Koritsoglou et al., 2022; Pramudita et al., 2019; Rodríguez-Puente & Lazo-Cortés, 2013). The hardware supports geographical analysis and mapping to present images with high resolution and speed and supports database operations with large data volumes quickly. Software for the process of storing, analyzing, visualizing spatial and non-spatial data. Spatial data depicting real images on the earth's surface are represented in the form of graphs, maps, images in digital format in the form of x,y coordinates (vector) or images (raster) which have certain values (Kai et al., 2014; Sebayang & Rosyida, 2022). Non-spatial data in the form of tables contains information held by objects from spatial data. GIS users have levels like other information systems, from specialist, technical levels who design and manage the system to users who use GIS.

There are five processes in GIS, namely a) Data input process, used to input spatial data and non-spatial data (Dewa et al., 2020). Spatial data usually takes the form of analog maps. GIS must use digital maps so the analog maps must be converted into digital maps using a digitizer. Apart from the digitization process, an overlay process can also be carried out by scanning an analog map. b) Data manipulation, the type of data required by GIS needs to be manipulated to suit the system used. Therefore, GIS performs editing functions for both spatial and non-spatial data (Rosyida et al., 2022). c) Data management, after spatial data is entered, the next process is non-spatial data processing. Non-spatial data processing includes the use of a DBMS to store large data (Erlström et al., 2022). d) Query, a tabular analysis process. GIS can carry out two types of analysis, namely: geographic proximity analysis which is based on the distance between layers, GIS uses a buffering process (building supporting layers around layers within a certain distance) to determine the closeness of relationships, and overlay analysis is the process of combining data from different layers. . In simple terms, overlay is a visual operation that requires more than one layer to be physically combined. e) Visualization of the final results is realized in a map or graph. Maps are very effective for storing and providing geographic information (Fitro et al., 2018).

The methods used in GIS will be different for each problem. The practical implication of this research is the use of the Djikstra algorithm in determining the shortest route between the user's location and the target company in the industrial area. The GIS-based application provides spatial data visualization information on GoogleMaps maps which displays the locations of places, roads and shortest paths according to Djikstra's calculation results.

2. RESEARCH METHOD

Route search can use the Dijkstra algorithm to determine the shortest route (Y. Chen, 2020; Sipayung et al., 2023). Making this shortest route search application develops GIS with spatial data visualization which contains information on the location of PT blocks. The starting point for calculating the shortest route is the PT address where the person is located. Meanwhile, the destination point in searching for the shortest route is the address of the PT you want to go to in that area.

Dijkstra is an algorithm used to find the shortest path in a directed graph (Gunawan et al., 2019; Kai et al., 2014; Polakis & Tsouchlaraki, 2022). Dijkstra's algorithm requires parameters of origin and destination. The final result of this algorithm is the distance from the origin to the destination along with the route. G is a labeled directed graph with vertices V(G) = {V1, V2 ..., Vn} and the shortest path sought is from V1 to Vn. Dijkstra's algorithm starts from point V1. In its iteration, the algorithm will look for one point whose total weight from point 1 is the smallest (Amaliah et al., 2016; Lakshna et al., 2022; Pazil et al., 2020). The selected points are separated, and they are not considered again in the next iteration. Dijkstra's algorithm for finding the shortest path (Alam & Faruq, 2019; Amaliah et al., 2016; He, 2022):

1. L = { };
2. V = {V2, V3,..., Vn}.
   For i = 2,..., n, do D(i) = W(1, i)
3. As long as V n∉L do :
   a. Select the point Vk ϵ V-L with the smallest D (k). L = L ᴗ { Vk }
   b. For each Vj ϵ V-L do :
      If D (j) > D (k) + W (k, j) then replace D (j) dengan D (k) + W (k, j)
   c. For each Vj ϵ V, w*(1, j) = D (j)

The shortest path from point V1 to Vn is through the points in L sequentially (Jabbar et al., 2022; Rachmawati & Gustin, 2020), and the smallest number of path weights is D (n). In Figure 1, the location in the graph is illustrated as a point. In Figure 2, the point is converted to a value that can be calculated using the Djikstra algorithm.

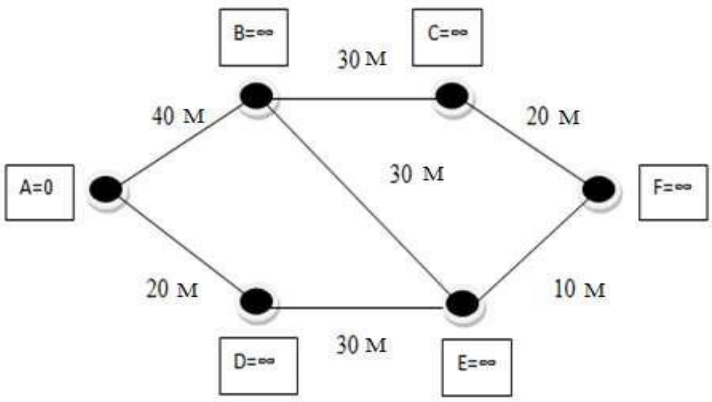

Figure 1. Route Point

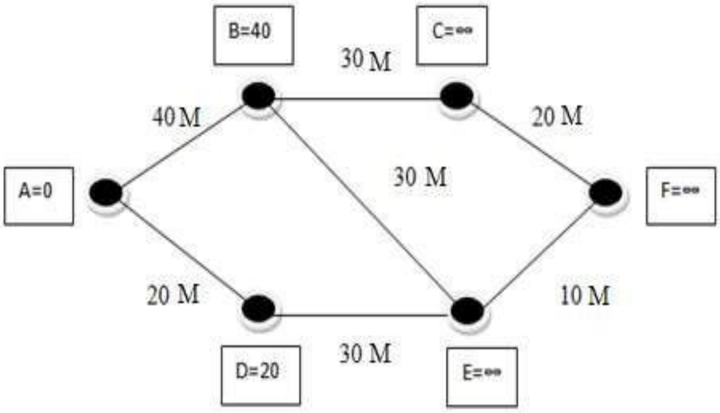

Figure 2. Route Value

3. RESULTS AND DISCUSSIONS

The shortest route is one of the graph theories for finding the distance from the starting point to the destination point by estimating the distance that will be traversed by choosing several routes that must be taken, the result that should be from finding the shortest route is the most efficient route to get to the destination so that it can save money. time. Figure 3 is a flowchart for determining the shortest route using the Dijkstra algorithm.

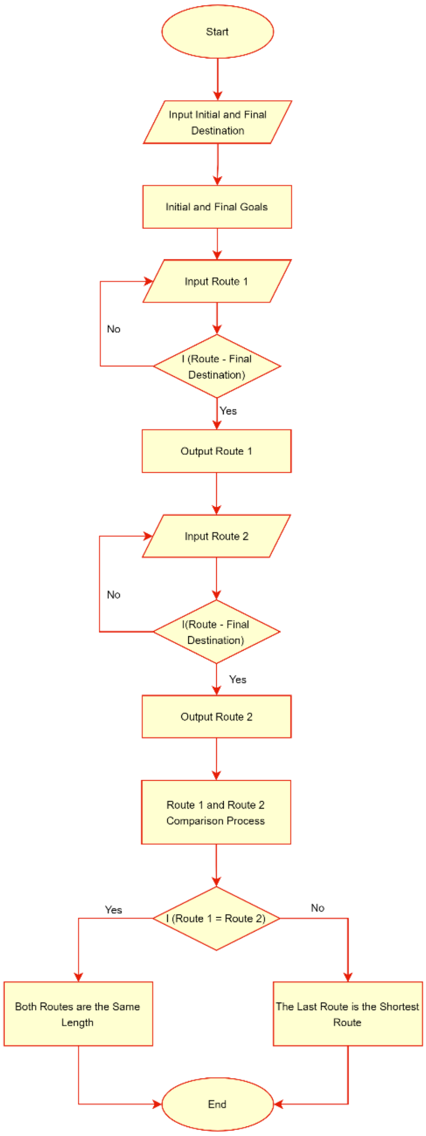

Figure 3. Shortest Route Flowchart

How Dijkstra's algorithm works: At each step, the edge with the smallest weight is selected which connects a node that has been selected with another node that has not been selected. Dijkstra's algorithm requires parameters of origin and destination. The final result of the Djikstra algorithm is the shortest distance from the origin to the destination along with the route.

In searching for the shortest route, there are several processes carried out on this website. In this process there is a User Use Case Diagram as in Figure 4. The use case consists of two actors, namely the Admin and User actors.

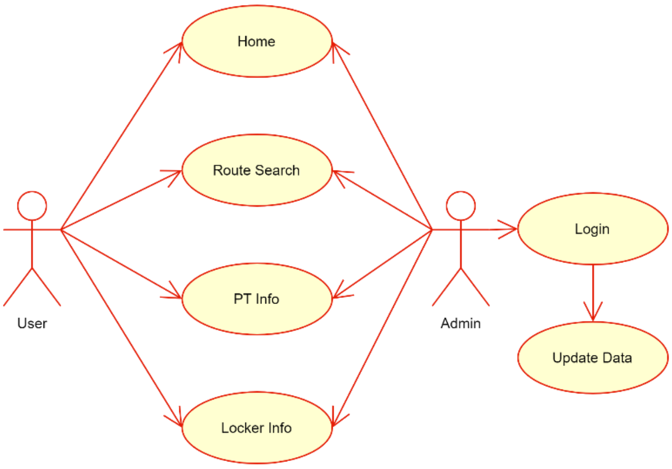

Figure 4. Use Case User Diagram

There are six activity diagrams, namely, Login Activity Diagram, Data Update Activity Diagram, Home Activity Diagram, Route Search Activity Diagram, PT Info Activity Diagram, and Loker Info Activity Diagram. Route search activity diagram, the process by which the user searches for a map by showing the shortest route, namely by entering the starting position and destination. Then the system displays a map according to what the user is looking for, as in Figure 5.

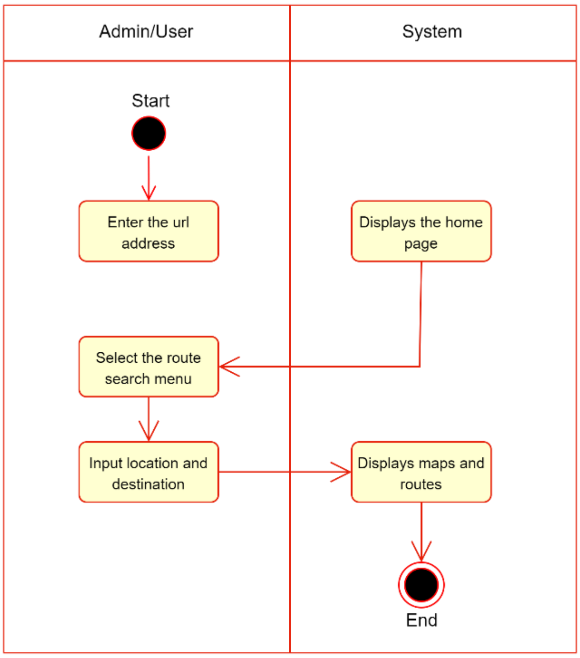

Figure 5. Route Search Activity Diagram

Route search sequence diagram, the user runs the program - the application will display the main menu - the user selects the Route Search menu - Input the initial route and destination - then the application will load into the database and immediately display the destination route in map form as shown in Figure 6.

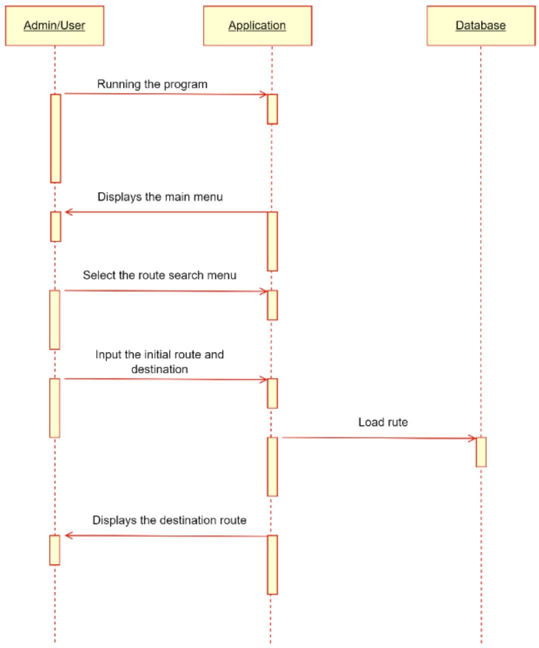

Figure 6. Route Search Sequence Diagram

The main web page consists of several menus including the Home Menu, Route Search Menu, Weather Forecast Menu, Wind Forecast Menu, Locker Info Menu, Login Menu. The Home menu contains the profile of the MM2100 Cibitung Industrial Area as in Figure 7.


Figure 7. Home View

The Route Search page consists of a map display form and a toolbox for route search. This form functions to make it easier for users to find the shortest route to the address of the company they want to go to, as in Figure 8.

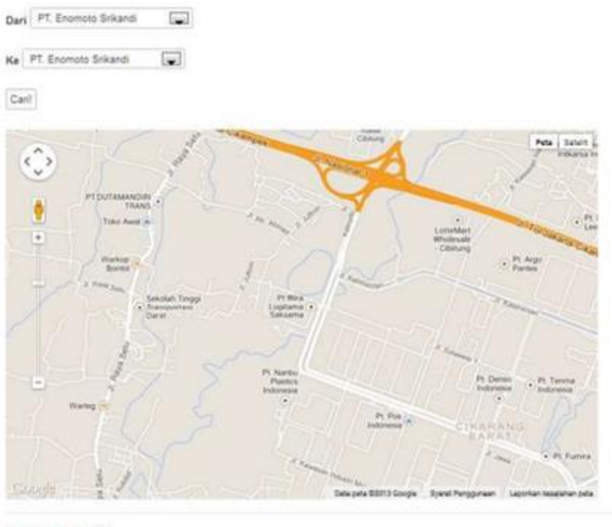

Figure 8. Route Search Display

Table 1 test cases of route search along with test results of the shortest route search system for company addresses using the Dijkstra algorithm in the MM2100 Cibitung industrial area.

Table 1. Route Search

	Kasus Data dan Hasil Uji (Data Normal)
Input Data	From: (Starting Point) To: (Destination Point). Description: (Describes the route along with the time and distance traveled).
Which are expected	Can display a map along with the shortest route.
Observation	Displays a map with the desired shortest route.
Conclusion	Accepted

First case, A is the starting point and D is the destination point, A = PT Wira Logitama, B = PT Riken, C = PT Pos Indonesia, D = PT Nok, E = PT Denso. The location from the starting point to the destination point in the first case is as in Figure 9.

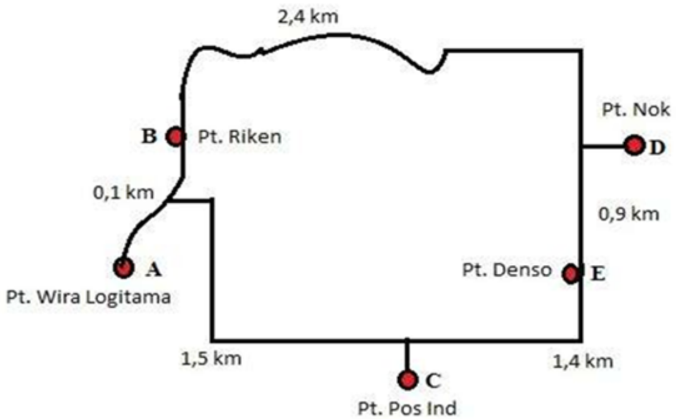

Figure 9. Location Points in the First Case Graph

Based on Figure 8, it is then translated into data as in Table 2. So the route that will be taken is: A – B – D with a distance of 2.5 km.

Table 2. First Case Location Point Table

Starting Point	Destination Point	Points Traveled	Distance Traveled
A	A	-	0 km
A	B	A – B	0.1 km
A	C	A – C	1.5 km
		A – B – D – E – C	4.8 km
A	D	A – B – D	2.5 km
		A – C – E – D	3.8 km
A	E	A – B – D – E	3.4 km
		A – C – E	2.9 km

The search results for the first case are as shown in Figure 10. So the route to be taken is: PT Wira Logitama – PT Riken – PT Nok with a distance of 2.5 km.

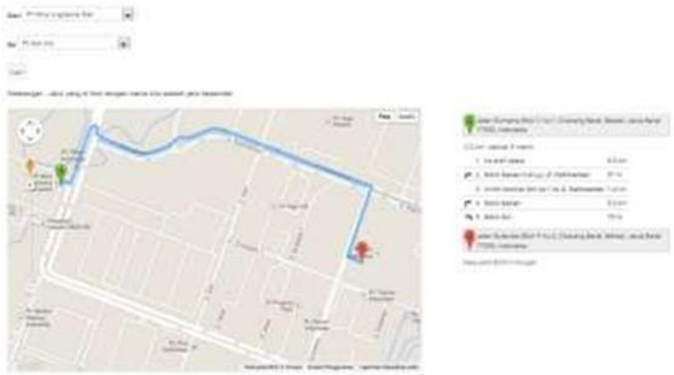

Figure 10. Search Results are displayed on the Website for the First Case

Second case, A is the starting point, G is the destination point, A = PT Fumira, B = PT Diamon Cold, C = PT Lotte Indonesia, D = PT Sukanda Jaya, E = PT Toyota Tsusho, F = PT Astra Otopart, G = PT Sumco. The location from the starting point to the destination point in the second case is as in Figure 11.

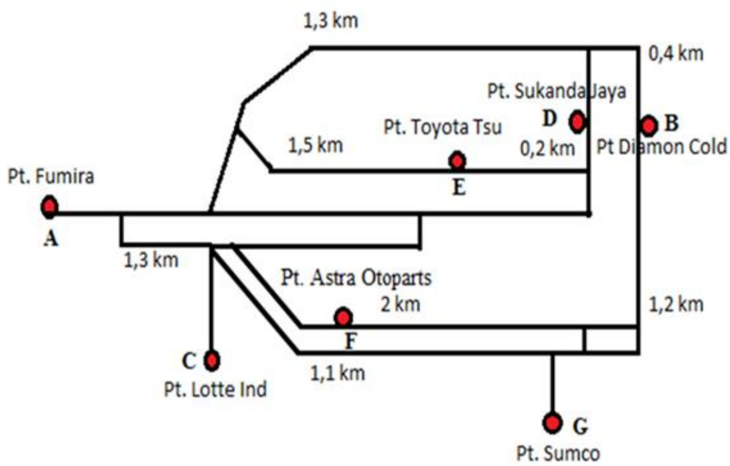

Figure 11. Location Points in the Second Case Graph

Based on Figure 10, it is then translated into data as in Table 3. So the route that will be taken is: A – C - G with a distance of 24 km.

Table 3. Second Case Location Point Table

Starting Point	Destination Point	Points Traveled	Distance Traveled
A	G	A – B – G	2.9 km
		A – E – D – B – G	3.3 km
		A – C - G	2.4 km
		A – F - G	3.3 km
A	G	A – B – G	2.9 km
		A – E – D – B – G	3.3 km

The search results for the second case are as shown in Figure 12. So the route to be taken is: PT Fumira – PT Lotte Indonesia - PT Sumco with a distance of 24 km.

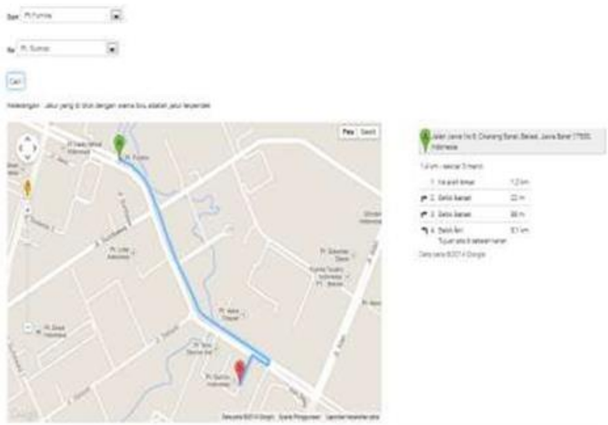

Figure 12. Search Results are displayed on the Website for the Second Case

4. CONCLUSION

After going through the GIS implementation and testing stages, it was concluded that the web-based GIS application succeeded in finding the shortest route between company addresses in the MM2100 Cibitung industrial area using the Dijkstra algorithm, the output produced from the algorithm approached the optimum value in a fairly fast time. The shortest route search geographic information system displays spatial data visualization of industrial area maps that are integrated with GoogleMaps. This research was tested in an industrial area with a common route without obstacles such as traffic jams, so that calculating the starting point to the destination point by looking for the shortest route can reflect the actual situation, the time to get to the target company is faster. It is recommended that future research search for the shortest route by comparing the Djikstra algorithm with other optimization algorithms such as A* (A-Star) or Bellman-Ford.

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