Searching the shortest route to distribute disaster’s logistical assistance using Dijkstra method

K Hartomo¹, B Ismanto², A Nugraha², S Yulianto¹ and B Laksono¹

¹ Information Technology Faculty, Universitas Kristen Satya Wacana, Salatiga, Indonesia
² Faculty of Education Science, Universitas Kristen Satya Wacana, Salatiga, Indonesia

*kristoko@uksw.edu

Abstract. The logistical assistance’s distribution itself has problems in determining the shortest route which should be chosen properly. Dijkstra method can be applied in choosing the shortest route. Dijkstra method is a method that can determine the shortest route from the boarding point to the arrival point by the smallest weight, to display into a map, it needs Google Maps Api technology. It is a free service provided by google that can be accessed by a browser. This research resulted in application on logistical assistance’s distribution of natural disasters by applying dijkstra method on finding the shortest route.

1. Introduction
Indonesia is a country in the Asian continent located in the Southeast Asia region. Indonesia and 14 other countries are located in an area crossed by the equator, Indonesia is surrounded by two continents, such as Asia and Australia and two Oceans such as Pacific Ocean and the Indian Ocean. The territory of Indonesia itself is located between 6 ° N - 11 ° S and 95 ° East - 141 ° East. The location of the region makes Indonesia have a tropical climate and is divided into three time zones such as Eastern Indonesia Time (WIT), Central Indonesia Time (WITA), and West Indonesia Time (WIB).

According to the data from the Ministry of Home Affairs, there are several provinces in Indonesia, one of which is Central Java. Central Java is a province in Indonesia which has a capital city in the city of Semarang [1]. Central Java currently has several active volcanoes, besides that, Central Java has a fairly high rainfall and a long dry season, which can easily lead to a potential for flooding, landslides and fires.

Throughout 2016, in Indonesia, particularly in Central Java province, there has been many natural disasters such as tornadoes, floods, fires, and landslides. The disaster occurred in several points in 15 regions in Central Java [2]. The 15 regions are Purworejo, Banjarnegara, Kendal, Boyolali, Purbalingga, Banyumas, Temangung, Wonosobo, Semarang, Klaten, Magelang, Wonogiri, Cilacap, Karanganyar, and Solo City. People who are victims of natural disasters desperately need help such as logistics, clothing, and medicines. The parties who are willing to help such as volunteers or government humanitarian agencies are moved to provide assistance needed by victims of natural disasters. The problem that is often experienced by volunteers or related government agencies is on the distribution of logistical assistance, such as in determining which shortest route should be chosen correctly.
2. Research methodology

There has been a study titled “Utilization of Google Maps for Mapping and Searching Data of State Universities in Indonesia”. It discussed the problem of high school students who find it difficult to search for complete information about the location of State Universities in Indonesia that they are going to be visually heading to. This study explains how to solve problems in finding data and location, and mapping state universities in Indonesia with the use of google maps [3].

There has been a study titled “Optimization of Dijkstra's Algorithm in dealing with different path weights at different times”. It discussed how to overcome the changes in the path weight which is supposed to be traversed by utilizing the Dynamic Vehicle Routing Problem with Time Window (DVRPTW) in the Dijkstra algorithm. This research was made because the Industrial world has a problem with the information system of the goods’ distribution route which can change at any time, which affects the distribution cost [4].

The third study related to the rainfall forecasting are needed in order to support the development in different fields including agricultural areas. There is no one model or system integrating climatic classifications and the weather forecasting aiming at determination of the ideal cultivating season. This rainfall forecasting was developed by processing the previous rainfall data using the combination of Z-Score model, transformation function, and the Winters Triple Exponential Smoothing. The data resulted from the forecasting was used to determine the spatial based climatic classification in Boyolali, Central Java, Indonesia using Oldeman method. The proposed model is able to predict the weather using climatic classification. The rainfall data resulted from the proposed forecasting model can be used for climatic classification using Oldeman method in the research area [5].

The fourth study compares the first difference of this research to the previous researches is the use of combination of ZScore method, transformation function, and winters triple exponential method to increase the accuracy of forecasting model, meliorate data pattern and add forecasting time period. The second difference is this research integrated the climatic forecast model with the climatic classification model based on the resulted forecasting rainfall data. The third difference is the focus of the research that is on the algorithm design, method, and algorithm optimum testing. The accuracy level of resulted prediction was measured by MAD, the prediction middle error value using ME, and counting the resulted prediction data pattern [6].

Based on the research that has been done related to the utilization of google maps to state universities data seekers along with mapping their territories and optimizing the Dijkstra method in dealing with changes in the path weight that is supposed to be traversed. Therefore this study is conducted aimed at designing geographic information system for distributing disaster logistics’ goods in Central Java by implementing the Dijkstra method into the program to determine the shortest route for optimization in determining which routes the local government will use correctly.

Google Maps is a free Google service that is quite popular. Google Maps is a map that can be seen by using a browser. We can add Google Maps API features in the web that we have created or on our blogs either paid or free. A stable internet connection is needed to use Google Maps API [7].

GIS (Geographic Information System) is one of the information data models regarding areas on earth surface. Therefore GIS is a system that emphasizes information about regions along with the attributes found in areas on the surface of the earth. Geographic Information System is part of computer-based Technical Geography which is used to store and manipulate data for specific needs or interests [8].

The research conducted in solving the problem is divided into four stages, such as: (1) Problem Identification, (2) System design, (3) System Implementation, (4) System Testing and Analysis of Test Results.

The stages of research in Figure 1 can be explained as follows: the first stage is an analysis of the existing problems, such as the system requirements that will be made to map which routes will be chosen. The second stage: namely to carry out a system design process which includes designing the process using the Unified Modelling Language (UML). The third stage: namely implementing the design that has been made in stage two into an application/program according to the system requirements. The fourth stage: that is testing the system that has been made, and analysing the results
of the test, to see whether the application that has been made is in accordance with what had been expected before or not, if it is not yet in line, improvements will be made.

![Diagram](image)

**Problem Identification**

**System Design**

**System Implementation**

**System Testing and Analysis of Test Results**

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3. **Results and discussion**

This research titled Searching the Shortest Route to Distribute Disaster’s Logistical Assistance using Dijkstra Method can be explained as follows, in which the use of the Dijkstra method is only applied to the shortest route menu. Menu page of the Central Java map, the map page has markers and nodes marked x, when the user selects one marker, then based on disaster data from the database will display information about the name of the city chosen and the victim’s data of occurrence. In this map there are some information on the affected cities such as Brebes, Tegal, Pemalang, Cilacap, Banyumas, Purbalingga, Batang, Pekalongan, Banjarnegara, Kebumen, Wonosobo, Purwokerto, Magelang, Temanggung, Kendal, Semarang, Boyolali, Klaten, Sukoharjo, Wonogiri, Karanganyar, Sragen, Grobogan, Kudus, Demak, Jepara, Pati, Rembang, and Blora. The program code to display google maps is in the program code 1.

### Table 1. Program Code 1 Function displays google maps.

|   |   |
|---|---|
| 1. | `$coord = new LatLng({'lat' => -7.2943546, 'lng' => 110.1000856});` |
| 2. | `$map = new Map([` |
| 3. | `'width' => 1000,` |
| 4. | `'height' => 500,` |
| 5. | `'mapTypeId' => 'roadmap',` |
| 6. | `'maxZoom' => 9,` |
| 7. | `'minZoom' => 8, ];` |

Program code 1 is a function to display maps from google maps. There is a $coord variable that functions to hold latitude and longitude maps from the Central Java map and the $map variable functions as a general setting of maps, such as width serves as a measure of the map’s width, height functions as a measure of the height of the map, mapTypeId functions as the type of map you want to display, maxZoom and minZoom function for zooming or shrinking the display in the folder.

Figure 3 is the shortest route search menu page, where user enters the initial city of Banyumas and the destination city of Tegal to be searched based on the shortest route using the Dijkstra method. The initial search with Dijkstra method shows the initial city Banyumas then there are 2 paths, such as Ajibarang and Banjarnegara. Calculating the shortest route, Ajibarang was chosen because the distance is closer than the path through Banjarnegara. After receiving the Ajibarang route then continuing the search and Jatibarang path was found because there was only one path to reach the city of Tegal. The results of the search from the initial city to the destination city, we obtained routes from Banyumas then
Ajibarang, Jatibarang and Tegal city. In searching for the shortest route from the city of Banyumas to the destination city of Tegal, the shortest distance is 113.3 km. Following is the calculation in Dijkstra with the weighting value based on the database, and V is always worth 0 because it is at the starting point.

\[ G = (V,E) \]
\[ G = 0 + 23.8 + 67.1 + 22.3 \]
\[ G = 113.2 \text{ km} \]

To get the shortest route from one city to another one, Dijkstra’s algorithm is used. It can be seen in algorithm 1. Algorithm 1 is Dijkstra’s algorithm. In the initial phase of the algorithm there is an initialization from vertex (line 2), all distance nodes from the initial vertex that have not been optimized yet will be accommodated in graph Q (lines 6 and line 7), as long as Q is not empty, then the distance node at the vertex with the closest distance is accommodated at array dist[], if the connecting distance node is not optimal it will be removed from graph Q (line 8 - line 10), the vertex value or the last node removed in dist(u) will be the benchmark for each to calculate the next city distance (line 14), the last stage displays the optimal distance value based on the return value in the array dist.

Table 2. Algorithm 1: Dijkstra method.

| Line | Code |
|------|------|
| 1.   | function Dijkstra(Graph, source): |
| 2.   | for each vertex v in Graph: |
| 3.   | dist[v] := infinity ; |
| 4.   | previous[v] := undefined ; |
| 5.   | end for |
| 6.   | dist[source] := 0 ; |
| 7.   | Q := the set of all nodes in Graph ; |
Table 2. Cont.

8. while Q is not empty:
9.     u := vertex in Q with smallest distance in dist[];
10.    remove u from Q;
11.    if dist[u] = infinity:
12.        break;
13.    end if
14.    for each neighbor v of u:
15.        alt := dist[u] + dist_between(u, v);
16.        if alt < dist[v]:
17.            dist[v] := alt;
18.            previous[v] := u;
19.            decrease-key v in Q;
20.    end if
21. end for
22. end while
23. return dist;

Table 3 is the result of testing using the Dijkstra method based on the difference in distance from the initial city to the destination city, the test was conducted to determine whether the Dijkstra method has worked on the problems in determining the shortest route according to user’s needs. In Table 2, the tests were carried out in several cities, for example the initial city of Banjarnegara and the destination city of Cilacap in Dijkstra’s calculation, the shortest distance was 92.4 km and at the normal distance suggested by Google 96.38 km. There is difference as much as 3.98 km in which based on the distance, Dijkstra is closer than normal distance. From the testing in 10 cities, the average distance difference was -3.34%.

Combination of ZScore method, transformation function, and winters triple exponential method to increase the accuracy of forecasting model, meliorate data pattern and add forecasting time period the average distance difference was -6.15% [6].

Table 3. The testing results of the shortest route.

| No | Initial City  | Destination City | Dijkstra Distance (km) | Google Normal Distance (km) | Distance Gap (km) |
|----|---------------|------------------|------------------------|---------------------------|------------------|
| 1  | Banjarnegara  | Cilacap           | 92.4                   | 96.38                     | -3.98            |
| 2  | Banyumas      | Tegal             | 113.2                  | 118.68                    | -5.48            |
| 3  | Batang        | Banjarnegara      | 84.03                  | 84.10                     | -0.07            |
| 4  | Boyolali      | Grobogan          | 81.87                  | 82.10                     | -0.23            |
| 5  | Demak         | Rembang           | 88.26                  | 88.30                     | -0.04            |
| 6  | Karanganyar   | Magelang          | 100.26                 | 117.00                    | -16.74           |
| 7  | Kendal        | Klaten            | 128.07                 | 129.00                    | -0.93            |
| 8  | Pati          | Karanganyar       | 118.18                 | 119.00                    | -0.82            |
| 9  | Semarang      | Pati              | 78                     | 79.49                     | -1.49            |
| 10 | Wonosobo      | Sukoharjo         | 151.37                 | 155.00                    | -3.63            |

4. Conclusion

Dijkstra’s algorithm testing on the implementation into a geographic information system, it can be concluded that the Dijkstra method has worked at the problem level in finding the shortest route with the smallest distance value. Based on the data (can be seen in Table 2) in the distance gap column there are results that show how optimal this Dijkstra method is applied to the shortest distance search between the initial city to the destination city rather than using the normal distance (which is farther) based on Google recommendations. Suggestions in this application, in testing the city, some more cities can be added to the list of cities. Further, in the application, the city points can be added with more connectedness at distance between points, and in further research, the type of disaster and the level of disaster experienced can be discussed.
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