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Selection of the Shortest Path of Gamalama Eruption Evacuation Using the Astar Method

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Abstract. Natural disasters have no time limit and can happen anywhere at any moment. They put human life at risk and can result in both property loss and casualties. Like those at Gamalama volcano, volcanic eruption disasters are constant and incur enormous losses. There are numerous evacuation sites for self-rescue against volcanic eruptions, and knowing the distance to the evacuation sites is necessary to expedite the self-rescue process to reduce the number of victims. Naturally, the areas surrounding the disaster center must be kept clear. To solve this issue, a mechanism for choosing the shortest path via the astar method must be implemented. As part of the astar method, the shortest path is chosen by first figuring out the starting and destination locations, initializing intersections by turning each intersection into a node, adding the node to the open list, calculating it with weights, adding it to the closed list, figuring out potential nodes that lead to the destination, and saving the results. As a consequence of the master method's application, the shortest route—a distance of 3,560 meters—connects the starting point (the Tubo village head office) with the gathering point (the Salerno field). Bypassing every pre-planned path, which is as follows: No. 1 (Jl. Ake Tubo, Tubo) - Node 2 (Ake et al.) - Node 7 (Jl. Batu Angus No.1, Dufa Dufa) - Node 8 (North Sangaji) - Node 9 (Toboleu, Kec. Kota Ternate Utara) - Assembly Point (Salero Field). Keywords: Astar, Volcanic Disaster, and Geographic Information System.

Keywords: Algorithm, Geographic, Information System, Volcanic Disaster

INTRODUCTION

Natural disasters are phenomena that can occur at any time, anywhere, and at any time, causing risk or danger to human life, both property losses and human casualties. Indonesia is located on three of the world's active plates causing Indonesia to be very full of tectonic and volcanic activity. One of the disasters that is always present and causes huge losses is the volcanic eruption disaster. Volcanic eruptions are disasters that often occur in Indonesia because Indonesia is located on an active tectonic plate, and has active volcanoes from Sabang to Merauke which always have the possibility of erupting at an indefinite time.

Mount Gamalama, located in the Ternate archipelago, North Maluku, is a Strato-type volcano or type A layered volcano. Based on data from the Geological Agency, Gamalama Volcano has a peak with an altitude of about 1715 m, 1690 m above Ternate City.

When a disaster occurs, of course, the area around the center of the disaster must be kept away. Residents around the dangerous area must be immediately moved to a safe place to avoid the risk of the Gamalama Volcano disaster during an eruption. Geographical information systems play an important role in the safety of victims for the Selection of the Shortest Path for Evacuation of the Mount Gamalama Disaster Eruption.

To solve this problem, method distance is one of the solutions to create a shortest path selection system to get to its destination with minimized travel costs (eg time). Speeduse estimates the shortest distance to reach the point purpose and has value heuristic at the use as a basic tool for consideration.

METHOD

In 1968, Peter Hart, Nils Nilsson, and Bertram Raphael presented this algorithm's first public presentation. In computer science, one search algorithm that finds the least expensive path from a given beginning point to the desired destination point (from one or more destinations) is A*, sometimes known as "A star." With a heuristic value that serves as a foundation for consideration, Algorithm A* (Admissible Heuristic) is a best-first search technique that estimates the lowest cost option to go to a destination with the shortest distance. In order to choose among multiple options and efficiently accomplish objectives, heuristics are standards, procedures, or ideas. The heuristic value is utilized to make the search space more manageable. From the starting point and traveling through the graph to the goal, the A* search algorithm generates an ideal path.

Plotting the most efficient path between points, or nodes, is the process of graphic forwarding (graph traversal) and path searching (pathfinding), and Algorithm A* (Star) is one of the most often used algorithms for these tasks. ProcedureBest first search is the foundational method that led to the development of the A* method. This approach calculates the approximate value of reaching the destination from that point n, h(n), and g(n), the value for reaching point n from the beginning point, to evaluate each point. This technique employs a function called distance–plus–cost, commonly represented by f(n)), to find the best visit order for finding nodes in a tree. A possible acceptance of an "approximate heuristic" for the distance to the destination point (denoted by h(n)) and path cost (always indicated by g(h), various heuristic values) add up to the total distance and cost. The function path cost that must be paid from the starting node to the destination node is the function path cost, or g(n). Before determining the most likely path to the destination, this algorithm calculates the distance (where the initial cost is represented by the g(n) part of heuristics).

Some of the basic terminology contained in this algorithm are starting point, nodes (nodes), A, open list, closed list, price (cost), and obstacles (unwalkable).

Formula:
$f(n) = g(n) + h(n)$

Information:
h(n) = Nilaiheuristicsbetween coordinates.
g(n) = Distance of node to point
(n). f(n) = Estimated solution with the shortest distance through n.

The term 'variable' can be understood as varying symptoms, variables can also be interpreted as research objects or what is defined as the point of focus in a study. The research variables are the focal points of the study. The variables in this study are as follows:

1. The number of gathering point locations (Asrama Haji, Lapangan Salero, Stadion Gelora, Dhuafa Center, Pelabuhan Nusantara).
2. The number of disaster-prone locations, namely (Disaster-Prone Area III (DPA III), Disaster-Prone Area II (DPA II), and Disaster-Prone Area I (DPA I).

System Development Method

The system development method used is the model waterfall. The model waterfall is a systematic and sequential information system development model. This method requires a systematic and sequential approach to software development, starting at the system level and progressing from analysis, coding, testing, and maintenance. It can be seen in Figure 1.

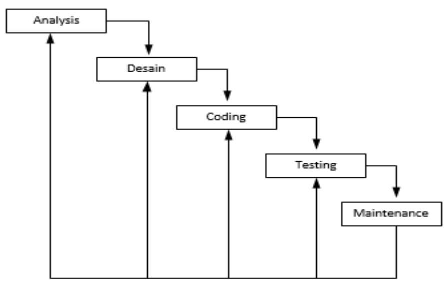

Figure 1. ModelingWaterfall (Abraham, 2015)

DISCUSSION

System Implementation

The implementation phase is carried out by collecting object data (coordinate points), creating interfaces, and writing program code. As for the results of the data collection, they can be seen in table 1.

Table 1. Coordinate Data

No	Object Name	Coordinate	
		Latitude	Longitude
1.	Lapangan Salero	0.8003857	127.3855010
2.	Duafa Center	0.7883154	127.3903613
3.	Lapangan Gelora	0.7859024	127.3826391
4.	Pelabuhan Nusantara	0.7713166	127.3782054
5.	Asrama Haji	0.7625575	127.3518349
6.	Kantor Lurah Tobu	0.8248016	127.3765301
7.	Kantor Lurah Akehuda	0.8246831	127.3812002
8.	Jalan Dufa-Dufa Belakang	0.8186769	127.3788631
9.	Indomaret Tafure	0.8324982	127.3857561
10.	SD N 49 Kota Ternate	0.8356757	127.3815844
11.	SD N 57 Kota Ternate	0.8399164	127.3771937
12.	MTS Pembangunan Kulaba	0.8473262	127.3608732
13.	Kantor Lurah Bula	0.8515574	127.3549869
14.	Kantor Lurah Tobololo	0.8538662	127.3514372
15.	Kantor Lurah Sulamadaha	0.8606910	127.3365252
16.	Masjid Takome	0.8464760	127.3123249

Calculation MethodSpeed

Use start and finish points to test algorithms while using the shortest path search method to the gathering point. Additionally, the testing star route was created using the Mapbox software. The original location and the agreed-upon meeting spot are tested initially. Testing the location this time: The original target was Salero Field, and the departure point was the Tubo Lurah office. Table 2 shows the labels assigned to each node to facilitate testing.

Table 2. Algorithm Testing Results A Star

No	Location Name	Estimatio n Distanc e/Heur istik	Label
1.	Tubo Village head office	3.561 m	A (point early)
2.	Jl. Ake Tubo	3.203 m	Node 1
3.	Ake Bridge Sugarcane	2.622 m	Node 2
4.	Campus Unkhair	3.235 m	Node 10
5.	Jl. Angus Stone No.1, Dufa Dufa	2.172 m	Node 7
6.	North Sanji, Mosque	1.588 m	Node 8
7.	Tobole,RS Islam	838 m	Node 9
8.	Oscar of Tolo	1.786 m	Node 3
9.	Sabia back	1.711 m	Node 4
10.	Lokomonit or SFR Ternate	1.126 m	Node 5
11.	Rear RRI	480 m	Node 6
12	Field salt shaker	0	WITH (point comp ul)

It is known that the starting point is A (tubo village head office) and the gathering point is Z (Salerno field). Each edge that is connected between nodes has been assigned a value (distance) as shown in Figure 2.

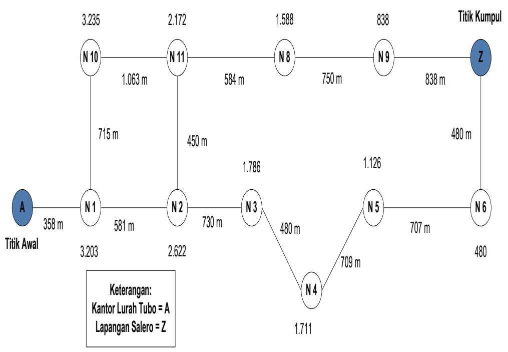

Figure 2 Testing GraphA Star

A star performs calculations on the nodes directly adjacent to the departure node (node A). Neighboring nodes that are directly connected to node A are node 1 (358 m), node 2 (581 m), and node 10 (715 m) then the three nodes are added together with the heuristic value of each node, namely node 2 (358 + 581 + 730 + 2,622 = 3,695 m) and node 10 (358 + 715 + 3,235 = 4,308 m). So getting the smallest value is node 2 with a weight of 3,695 m.

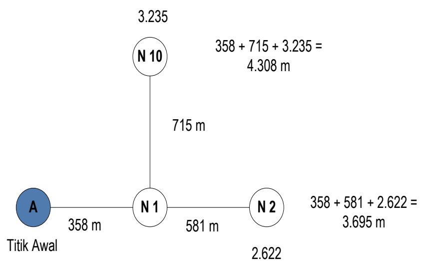

Figure 3 A Star Step 1

Node 1 is set to be the initial departure node and marked as the node that has been touched. A star re-calculates the next nodes and adds up again with the heuristic value.

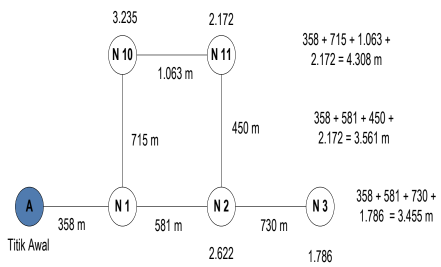

Figure 4 A Star Step 2

Node 1 is set to be the departure node and marked as the touched node. A star then does the calculation again with the same formula continuously so that the path with the smallest weight is obtained with a value of 3,560 m. Then it is declared completed with route A – node 1 – node 2 – node 3 – node 11 – node 8 – node 9 – Z with a distance of (358 + 581 + 450 + 584 + 750 + 838 = 3,560 m).

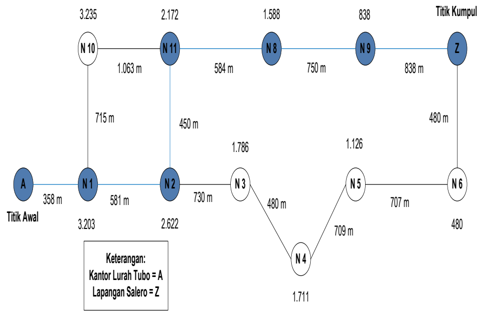

Figure 5 A Star Step 3

System View

Page Login

Page login is the initial appearance of the application user, to enter this page it is required to enter a username and password registered on the system. This page applies to levels administrator so admin can manage and test the system that has been made. The view logic can be seen in picture 6.

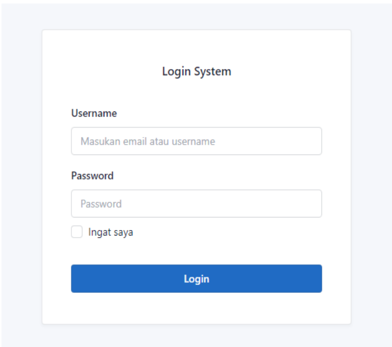

Figure 6 Display Login Admin

Home Page Admin

This main page is the start when the admin is successfully login. On this main page, there is a welcome to the geographic information system for selecting the shortest path for the evacuation of the Gamalama volcano. Can be seen in Figure 7.

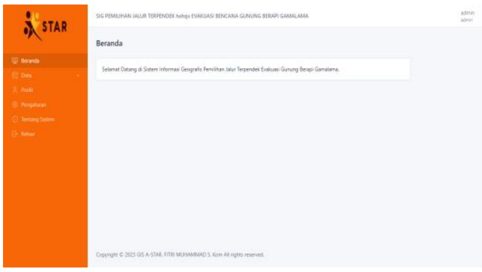

Figure 7 Home View Admin

Route Page

This page works for determining the route of the Gamalama volcano hazard evaluation path. The route data display can be seen in the picture Figure 8.

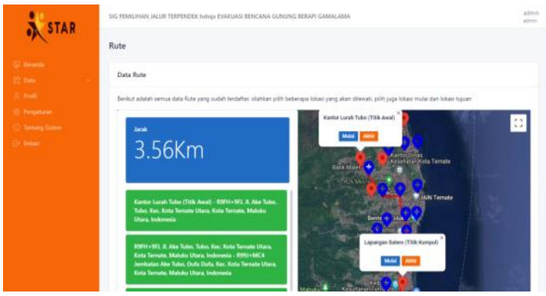

Figure 8 View of the Route Page

The following is the route data that has been registered, on the route data page the admin can select several routes to be passed, and also select the starting location (starting point) and ending location (gathering point).

Location Page

This page functions to determine the location of gathering points and disaster-prone locations that will be used as the starting location and ending location. The display location can be seen in Figure 9.

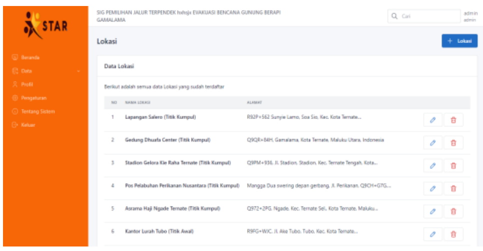

Figure 9 Location Page Display

In this menu admin can add or edit existing locations, and data that has been added or edited will be displayed again in the location menu view.

Paged Graf

On this page, it acts as a link between one node and another node so that it can be used as a path to get to the destination point. The graph data display can be seen in Figure 10.

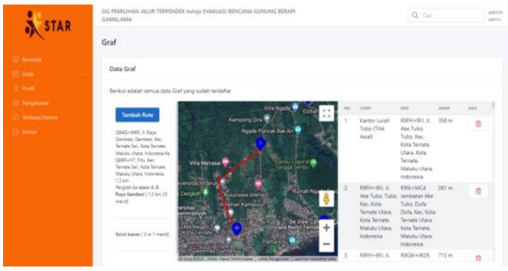

Figure 10 Pages Graf

On this page, the admin uses a graph as a link between one vertex to another, and from that graph, the admin can find out the distance from one point to another.

User Pages

This page displays all registered user data. You can see the user page image in Figure 11.

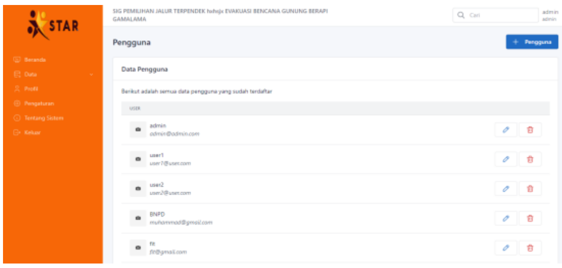

Figure 11 Display of User Pages

Profile Page

The following page is information about your profile, the admin can update your profile, please enter the settings. The profile view can be seen in Figure 12.

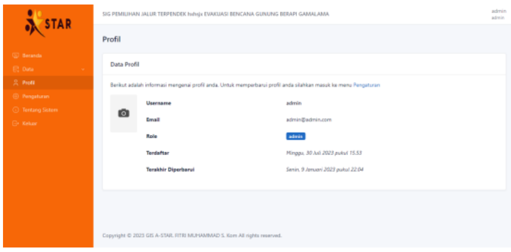

Figure 12 Profile Page Display

Settings Page

On the admin settings page, you can change the profile you want, to change the profile data you have to fill in several questions in the following page view. Can be seen in Figure 13.

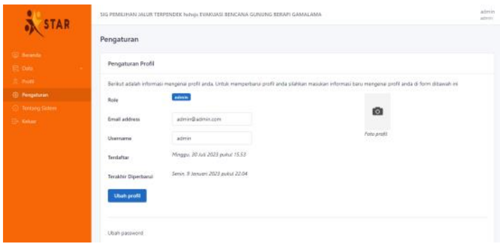

Figure 13 Settings Page Display

About System Page

On the page, there is a speech that is "SIG Selection Of The Shortest Path Evacuation Of Gamalama Volume" which is an application for finding the shortest route using an algorithm Can be seen in Figure 14.

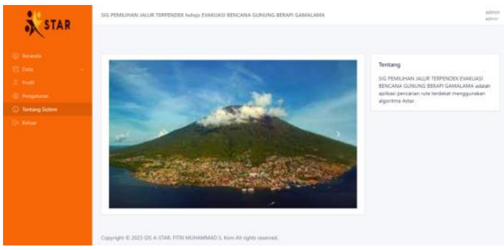

Figure 14 Display About System Page

Results Analysis

The system created consists of nine menus on the admin view, including the settings, about the system, logout, route data, location data, graph data, user data, profile data, and home menu. These results are based on the tests conducted, explicitly testing the system using the black box method.

The black box approach of software testingWith this approach, the intended software's particular features are tested. When a black box is tested, each menu's functionality within the system is tested, unlike the designed algorithm. The program modules tested are routine testing, location data, graph data, user, and login admin. Afterward, every run test produced valid results, indicating that the functional system on the menu that was put to the test produced accurate findings.

A database server can be connected to the system to store and retrieve data. Because the locations of gathering points and disaster-prone areas are helpful map boxes, the system can also operate as intended. So, everything is operating in the system's intended manner.

This system can use a star to show the closest route to the gathering point. This allows for the implementation of algorithms to discover the locations of gathering sites and find the quickest route there using an algorithm. Simply put, a database has been used to predetermine the starting and gathering points' locations.

CONCLUSION

The following conclusions can be made in light of the research's findings:

1. Based on the decision to evacuate the Gamalama volcano tragedy as soon as possible,
2. The shortest path is 3,560 m, which can be found by using the formula f (n) = g (n) + h (n) with the calculation stages. This distance results from the method's implementation from the tubo lurch office starting place to the sales field gathering point.
3. The algorithm that can be used to show or calculate the nearest path to the gathering point location in this system is being implemented. All that needs to be added is the ability for this system to show the initial and destination locations, trip time, and state of any necessary access roads.

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