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Determination of The Shortest Route Based on BFS Algorithm for Purpose to Disaster Evacuation Shelter

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Abstract
Purpose: This study aims to determine the shortest route that can be taken by the user (community) during a disaster to reduce the risk of a greater number of victims by using the Breadth-first search algorithm, which is integrated into a web-based GIS application. By determining the starting point, which is the user's position when the disaster occurs, and then determining the endpoint, which is the location of the closest shelter, it will be possible to calculate the shortest distance that can be reached by the user at that time.
Methods: The method chosen in this study is a waterfall because each step of the research carried out must be sequential and structured to avoid the risk of errors in each sequence of processes carried out.
Result: The results of this study can be proven by doing manual calculations to determine the shortest distance, which will later be compared with the results of applications that have been designed using the BFS algorithm.
Novelty: The novelty of this research is the development of GIS as a disaster mitigation education. The function of this research can help the community in finding an evacuation route in the event of a tsunami disaster.

Keywords: Earthquake, Tsunami, Shelter, GIS, Breadth First Search Algorithm
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INTRODUCTION

Purus area of Padang Barat sub-district of Padang city is located at an altitude of only 5 M above sea level. The population in West Padang sub-district in 2017 was 46,010 according to data from Padang City in Angka (2018) [1]. With these conditions, the area of Purus village that will be affected most severely in the event of a tsunami because of both its relatively large and dense population and distance from the beach and the height of its territory. On the basis of this condition, it is necessary for an application capable of providing the shortest and safest route for Purus residents to reach the location of the shelter point. By implementing the Breadth First Search (BFS) algorithm integrated into this GIS web-based application, it can save travel time by knowing the shortest route to reach the shelter point. There are currently many activities in the field using a Global Positioning System (GPS), Laptop, and GIS software to perform mappings in real-time [2]. Breadth first search algorithm is an algorithm that performs a widened search that visits a vertex by preorder, which is to visit a node and then visit all the neighboring vertices on that node first. Furthermore, uns visited and neighboring vertices that were previously visited, so on. If the tree-shaped graph is rooted, then all vertices that are in direction d are visited first before the vertices in the direction of d+1 [3].

Currently, the Breadth First Search (BFS) algorithm is one of the algorithms for determining the closest path between the starting point and the endpoint in barrier-free conditions. Often used to determine the shortest path in gaming applications, the Breadth First Search (BFS) algorithm is widely used due to its simplicity and effectiveness [4, 5]. The use of breadth first search algorithm was also carried out by Santi in 2015 for the nearest and Android-based pharmacy location search app equipped with GPS facility, where users can get the nearest pharmacy location from its current position. This can certainly minimize time and save on mileage transportation costs [5]. Some previous studies have also used breadth first search

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algorithms in several types of applications [6]. Among them is in the form of a search tree application system as a result of the problem of defining the shortest city route. Research conducted by Ulza Alkindi on The Implementation of Breadth First Search Algorithm on Pacman To Regulate Character Movement. Can run according to expectations, where a ghost can determine the shortest path used in finding and chasing pac-man games [7].

The research conducted by Laylul Musabbichin optimum route search application on the map, Breadh first search algorithm (BFS) is better because it uses another heuristic algorithm because in terms of the distance of route results obtained and the total path cost/cost of route travel, breadh first search algorithm (BFS) provides better results [8]. Furthermore, research conducted by Edi Wijaya on Analysis of The Use of Breadth First Search Algorithm in Artificial Intelligence Concept. Where in time of searching does not always get a solution even though already all nodes on the tree are done tracking checks and developed. In this day, GIS Mobile Application has a lot of activities using Global Positioning System (GPS) and GIS software to do mapping in real-time [9]. Yunefri, Devega, and Kristanto developed a web-based GIS application with the aim of providing information about culinary in Pekanbaru based on the user's location. The development of the application is carried out by using the PHP programming language and the Haversine method to determine the closest distance of a restaurant. The results of the obtained data were tested by using a black box to show that a test by using this application is similar to the manual method [10]. Aulia Aulia, Zakir, Dafitri, Siregar, & Hasdiana conducted research that related to the situation in the restaurant. This study designed a system that can speed up ordering and food processing in restaurants. The results of this study also allow ordering data to be sent over a wireless network that connects smartphones to computers in the kitchen. As a result, the order can be directly read by the chef because it is shown on the LCD screen [2].

Research conducted by Tamara Luarasi, Andi Domi, Tomi Thomo, Agim Kasaj, and Ergon Baboci explained that the latest technology had supported the latest business scenarios and the application of existing ones. Its application has been tested on the livestock market, which is in dire need of the presence of technology, especially in difficult rural zones. This study represents the method used in making digital brokers [11].

Adi Setiawan, Eko Sediyono developed a web-based GIS application to provide an overview of the calculation of the area of Indonesia based on the boundaries of sub-district/village, district, regency/city [12]. Supattra Puttinaovarat, Suwat Jutapruet, Aekarat Saeliw, Siwipa Pruitikanee, Jinda Kongcharoen, Watchara Jiamsawat, Suchakree Limpasamanon The capabilities of GIS, indoor map, and geospatial data visualization help speeding up facility maintenance management process and create benefits to all concerned parties, i.e., users can notify and follow the data of facility errors at the time; or officers in charge can operate quickly because they can access real-time data. Indoor map display makes it easier to access locations or places of damaged facilities [13].

Development of a mobile GIS Property mapping application for use by local authorities in developing countries [14]. Attempts to develop property mapping applications, especially in developing countries have mostly used GIS desktop productivity software tools that required the digitization of property maps by highly skilled GIS experts. In addition, these applications lacked real-time capture of an attribute, spatial and image data of properties. A survey was conducted in the Kafue local authority to gather systems requirements for the mobile application [15].

Research conducted by Christanti Nana Widiyati, Sudibyakto Sudibyakto with the title Application Of Us-Scs Curve Number Method And Gis For Determining Suitable Land Cover Of Small Watershed. This study aims to reveal the appropriate land cover which can reduce run-off using US-SCS Curve Number method with GIS. Four land cover scenarios are developed to reveal which one of the existing land cover types is appropriate for the area. To make a validation of the application US-SCS Curve Number Method, calculating observational run-off is required [16]. RakibulAhasana and Md MahbubHossainb conducted research that Leveraging GIS and spatial analysis for informed decision-making in COVID-19 pandemic [17].

METHODS

The flow of this research process can be seen in Figure 1.

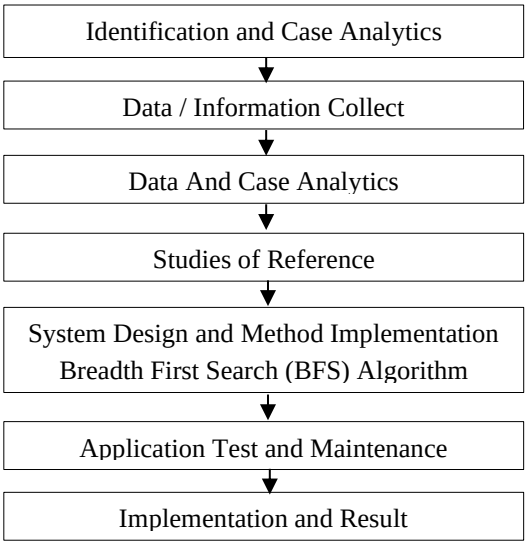

Figure 1. Stages of research

Identifying and Formulating Problems

After the previous two stages, it was only then that an identification of the problem was carried out as well as the formulation of the problem. The problem is that Bagaiamana utilizes the concepts of breadth first search algorithm into a geographical information system designed to help the people of purus district of Padang Barat Sub-district especially and from outside padang city to know the location of the nearest tsunami safe track point (Shelter).

Collecting Data

At this stage will be done the collection of data and information obtained from communication in the form of interviews. The result of this stage is the obtaining of information about how the current system is in terms of presenting information about the nearest tsunami safe points and paths in the purus area of Padang Barat Sub-District of Padang city and the problems that exist in connection with it. The results of this stage serve as a cornerstone of thought in research.

Analyzing Data and Problems

The process of analyzing problems is done to obtain facts that can be used to solve the problem that is being researched. The result of this stage is the identification of several causes of problems in terms of the nearest tsunami safe points and paths in the purus area of padang city. Among others, the lack of facilities and infrastructure that has been provided by padang city government to present information quickly, precisely, and accurately.

Literature Studies

Once the problem is acquired and analyzed, a literature study will be conducted that is useful for obtaining references as well as literature in solving the problem. This library study is conducted by searching for references such as journals or books, either through internet media related to breadth first search algorithms and geographic information systems (GIS). The basic capabilities of GIS are to integrate various database operations such as queries, analyze them and display them in the form of mappings based on their geographic location. This is what distinguishes GIS and other information systems [2].

Designing systems and implementing algorithm breadth first search (BFS) methods
This process is an advanced process of data analysis. Once the problem to be analyzed is discovered, then the existing data is processed and analyzed. Once the data is complete, start designing and building the app. At this stage of design, researchers used Unified Modeling Language (UML) as a tool in explaining the program's analysis flow. UML is one of the most widely used language standards in the industry for defining requirements, making analysis and design, and describing architecture in object-oriented programming [18]. Conceptually stages of application design using waterfall method. From the results of the system analysis, the system to be created should be able to produce an output that is the shortest route to the tsunami shelter point by applying the BFS Algorithm [19].

Testing and Repairing
At this stage of testing aims to know how the system works well in processing data, as well as getting the desired results. If an error is found, a repair will be made. The testing mechanism that will be done is manual testing using the search of each point done with a neighboring node on that node (child node). Testing using the system. By creating a user interface in this case use the application of geographical information system route tsunami shelter point.

Concluding and Implementation
This stage is the final stage of research where it is expected that there is an appropriate solution and continued with the implementation of the system in the field. Drawing conclusions is done to compare the results that have been pre-reviewed at the implementation stage of the manually constructed system. The method is applied to solve problems, including procedures, measuring, and analytical methods. Methods should make the reader able to reproduce your experiment. Provide enough detail to allow the work to be reproduced. The published method should be indicated by a reference: only relevant modifications should be explained. Do not repeat details of existing methods, just refer it from the literature.

RESULT AND DISCUSSION

Implementing of BFS Algorithm

Here is a map of purus district of west padang in the form of grap for breadth first search is seen in Figure 2.

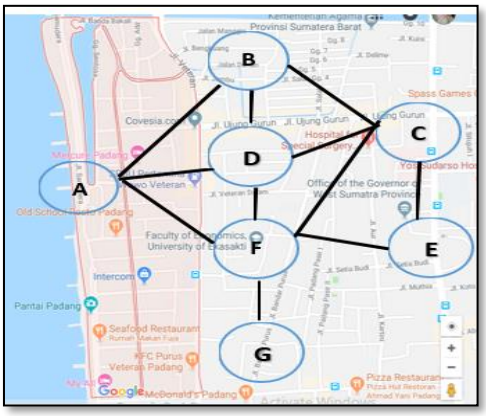

Figure 2. Location map in grap form for breadth first search

On this map, the starting point is the user and the endpoint is the shleter location point, for the starting point is converted into node A and the endpoint becomes node E. Breadth First Search (BFS) algorithm searches each point done with each neighboring node point on that node (child node), as shown in Figure 3.

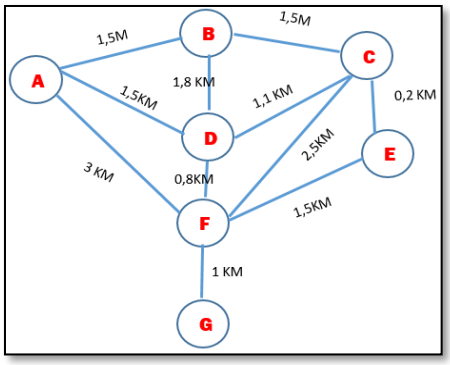

Figure 3. Graph for Breadth First Search

Here is a 3 image caption about the distance between nodes:
Point A = User

A –> B = 1.5 km	B –> C = 1.5 km
C –> D = 1.1 km	B –> D = 1.8 km
A –> D = 1.5 km	C –> E = 0.2 km
D –> F = 0.8 km	E –> F = 1.5 m
A –> F = 3 km	F –> G = 1 km

In Specifying the shortest path using the Breadth First Search (BFS) method from starting point A to endpoint E, the corresponding figure 3 can be implemented into Breadth First Search (BFS) to obtain the shortest path with the following steps:

Step 1

Take the initial state at point A, where point A has a choice of paths that are to B,D, and F so that it can represent the search tree.

Step 2

In performing, the shortest path search using the Breadth First Search (BFS) method. The main purpose of this search is to get point E. The main search begins by searching the starting point of point A, since the starting point A is the top level for it to be searched, followed by exploring the dots at the lower level or the neighboring vertices on that node (child node), as shown in Figure 4.

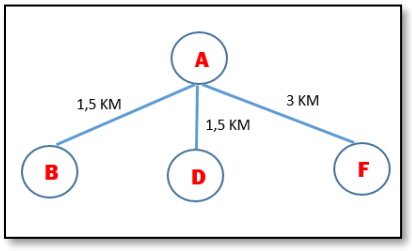

Figure 4. Shortest Path Search Process in Step 1

The shortest path search process as in figure 4 is not a solution for it to be re-searched to get a goal or solution, as in Figure 5.

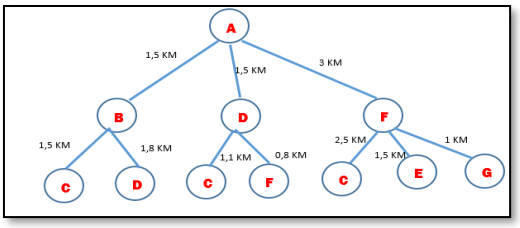

Figure 5. Shortest Path Search Process in Step 2

From Figure 5, get equation (1) search:

Point (A –> B) + (B –> C) = Distance traveled (1)

(A –> B) + (B –> C) = 1.5 + 1.5 = 3 km
(A –> B) + (B –> D) = 1.5 + 1.8 = 3.3 km
(A –> D) + (D –> C) = 1.5 + 1.1 = 2.6 km
(A –> D) + (D –> F) = 1.5 + 0.8 = 2.3 km
(A –> F) + (F –> C) = 3 + 2.5 = 5.5 km
(A –> F) + (F –> E) = 3 + 1.5 = 4.5 km
(A –> F) + (F –> G) = 3 + 1 = 4 km

Step 3

In step 2, The solution is obtained with a distance of 4,5 km, this goal is then saved, but this is not necessarily a nearby route, so another search is carried out to get the shortest path. Double-check the distance to see nodes that cannot resume their search because they exceed or equal the previous distance. Shortest Path Search Process is shown in Figure 6.

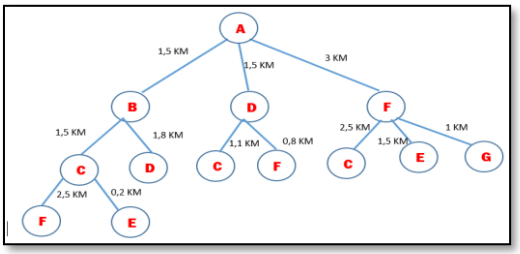

Figure 6. Shortest Path Search Process in Step 3

From the search as in Figure 6 get the following results:

(A –>B) +(B –> C) +(C –> F) =1.5 +1.5 + 2.5=5.5 km
(A –>B) + (B –> C) +(C –>E) =1.5 +1.5 +0.2=3.2 km

A solution was found with a distance of 3.2 km for which these results were stored and changed the distance previously, but this is not necessarily a nearby route for it to be carried out kambali search to find the nearest route path, as in Figure 7.

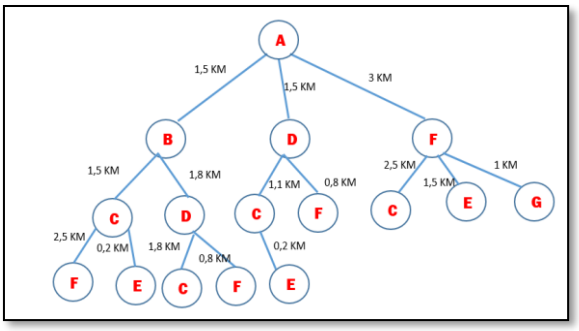

Figure 7. Shortest Path Search Process in Final

From the search results in Figure 7 get the following results:
(A –>B) + (B –>C)+ (C –>E)=1.5+1.5+0.2=3.2 km
(A –>D) +(D –>C) +(C –> E) = 1.5 +1.1+0.2=2.8 km
(A –>F) + (F –> E) = 3 + 1.5 = 4.5 km
In Figure 7 The solution can be found with a distance of 2.8 km then this result is saved again and replaces the previous distance, thus the search process is stopped because the distance to be traveled is already exceeded or equal to the previous distance. Based on the above search process with Breadth First Search method found the nearest line from point A to point E is with routes A, D, C and E with an estimated distance of 2.8 km. This it can be inferred from the data calculated manually, found the shortest route path, then will be done a comparison with the calculation results of the system to be built. Where the test of the analysis results, it is very useful to work because it will prove whether the results of the analysis are suitable.

Information System Design

System design is a necessary part of designing a new system to be created. In the design or in the design of the system is required tools where this research uses UML (Unified Modeling Language) in conducting the design. The design of use case diagram is shown in Figure 9.

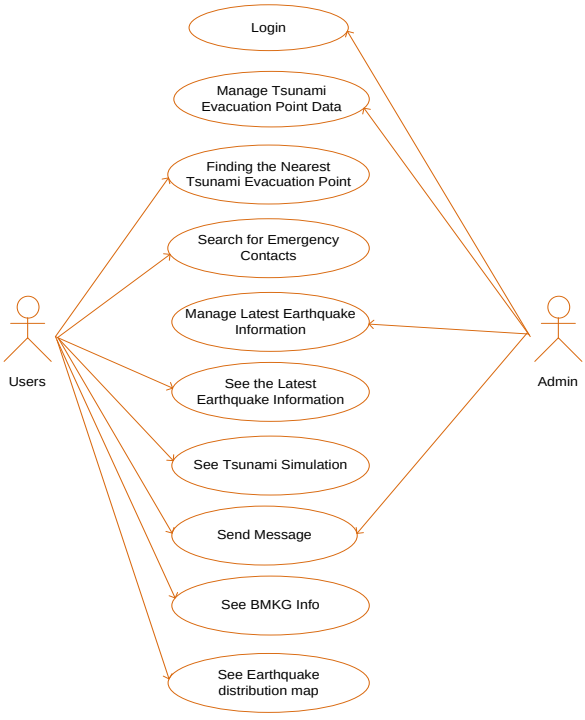

Figure 9. Use case diagram

In Figure 9, use case diagram explained that in order to be able to act as an admin, the user must be able to login into the. Sehas user successfully logged in, then the user who acts as admin. The admin can see all the information contained on the system and can perform the addition, editing, and deletion of data on the database. Then, the class diagram for a database can be shown in Figure 10.

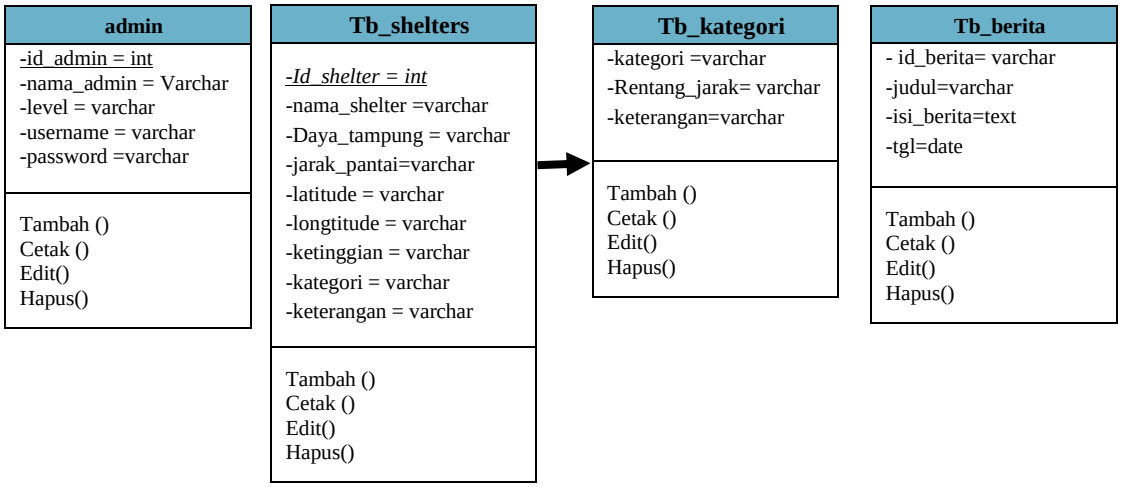

Figure 10. Class diagram

Based on Figure 10, the chart class is explained that there are four classes that are a set of objects of various attributes. Then, the Sequence Diagram of nearby shelters shown in Figure 11.

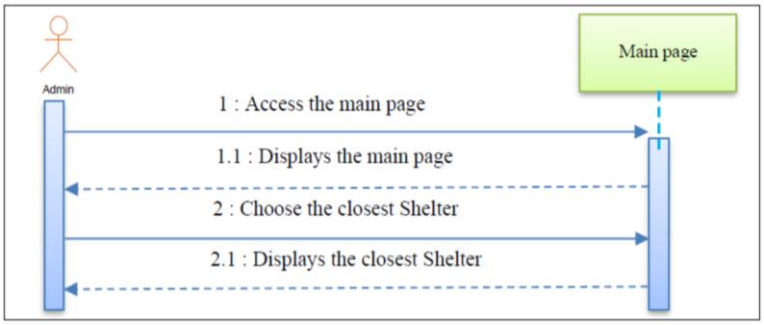

Figure 11. Sequence Diagram of nearby shelters

In Figure 11 is the sequence diagram of the nearest shelter, where people can access the main page. Then on the main page there is a map of the tsunami evacuation point (shelter), then the community chooses the nearest tsunami evacuation point (shelter). And the system displays the nearest tsunami evacuation point.

System Testing and Implementation

System testing and implementation aim to see whether the system design is in accordance with what is desired or not. After testing and implementation, the quality of a system will be seen. The following is - an implementation of the application design, as in Figure 12.

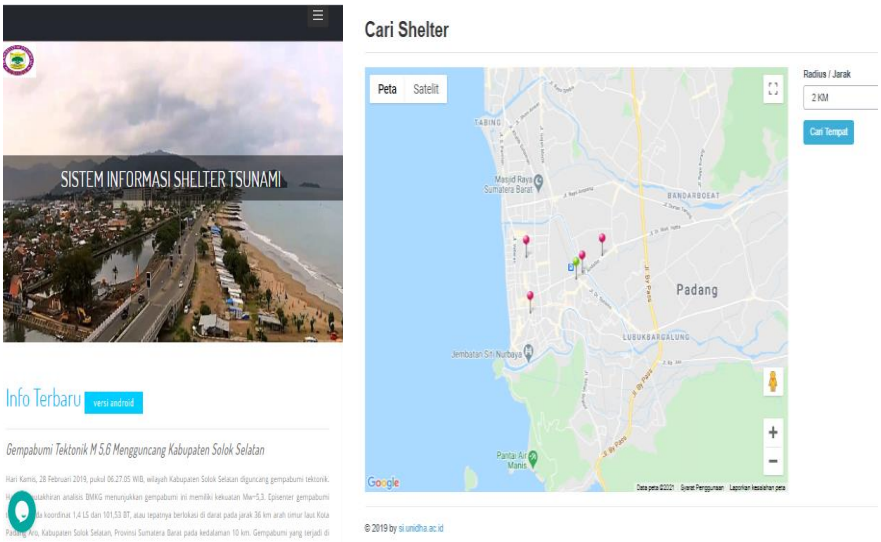

Figure 12. App home page view and Search shelter view

Figure 12 was the app's home page when it was first opened. On this page, people can select the menus at the top. Figure 12 is the nearest shelter search page using the algorithm concept of Breadth First Search. On this page, people can see shelter and information about shelter by choosing the nearest shelter based on the radius distance, as in Figure 13.

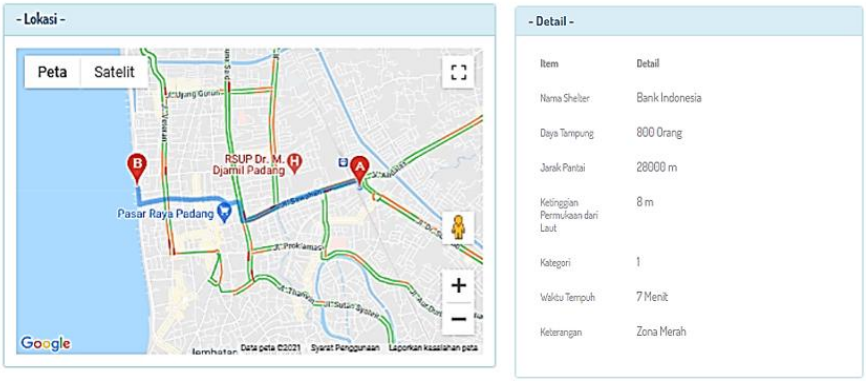

Figure 13. Shelter route page

Figure 13 is the nearest shelter route page. On this page, people can see the nearest shelter route and information about the shelter such as shelter capacity, distance to shelter point seen in figure 13, there is more than one route to get to point B, based on the search results using *breadth first search algorithm*, then the route that has the shortest distance is 2.8 KM which is via ocean road and Jl Jenderal Ahmad Yani with an estimated distance of 7 minutes. After testing using the app to track the shortest path as in figure 13. So it can be concluded that the system built by *implementing breadth first search algorithm that* is run is very precisely used to find and determine the shortest route path with a larger number. The use *of Breadth First Search algorithm* can not only be implemented in a game or game, but this algorithm can also be implemented in the search for the shortest route of tsunami evacuation shelter pointinPurus area of Padang city. The novelty of this research is the development of GIS as a disaster mitigation education. Where the function of this research can help the community in finding an evacuation route in the event of a tsunami disaster.

CONCLUSION

Based on the results of the implementation of the design of the use of Breadth First Search method for determining the shortest route of Tsunami evacuation shelter point, it can be concluded that the shortest track search application using Breadth First Search algorithm can be used and used in Purus area of Padang city to assist purus people in finding the most optimal path to reach the nearest and safest shelter when a tsunami disaster occurs, thus reducing the risk of more casualties. This can be proven by doing some testing when the app is completed. Through this research is expected to be the basis of development for the next application so that in the future, there will be a better system and able to meet the needs of the community for a guide in the face of tsunami disasters, especially for Padang city area.

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