

Application of Haversine Formula in Education Game "Landmark Nusantara"

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ABSTRACT

Indonesia is the largest archipelago state is therefore also called Nusantara. Almost every region in Indonesia has a characteristic landmark that describes each area that has tremendous potential in form of lore and attraction. The tremendous potential of this must be backed up with a nice introduction. One medium that can be used is an educational game in which the process can be done with the concept of learning while playing. Therefore, designed and built an educational game titled "Landmark Nusantara", where the game is aimed to provide knowledge about landmarks that exist in Indonesia. The Game that was built has 30 landmark data sample regions in Indonesia. The game is based on Geographic Information System with the help of Google maps which also features geolocation that can be used to determine the location you want to tag based on latitude and longitude, and supported by a method of Haversine Formula.

Keywords: Game; Google Maps; Haversine Formula; Indonesia; Landmark.

1. INTRODUCTION

Indonesia is one of the largest archipelago countries, which consists of five major islands as Sumatra, Java, Kalimantan, Sulawesi, Papua, and thousands of other small islands, therefore Indonesia is also called Nusantara. Indonesia itself is a country that rich in historical places, culture, and travel. Almost every region in Indonesia has a landmark that illustrates the characteristic of each region.

Landmark itself is anything that makes it easier to be recognized, remembered, and admired that can be in the form of nature, buildings, monuments, and other structures. Indonesia consists of various areas to make Indonesia rich in landmarks that depict typical of each region. Landmark owned by each region making the region has tremendous potential in the form of lore and attraction. Nevertheless, the extraordinary potential of this must be supported by a nice introduction. A good introduction can be done through various media, one with a medium educational game.

Game is generally interpreted as a play activity undertaken by one or more persons where there is the

result intended by the player and has rules that determine the limits of the action taken by the player. Games can also be an educational application, which means they can be used as a medium of learning in which the process can be done with the concept of learning while playing [1][2]. The educational game is an alternative media to introduce the landmark each region [3][4][5] in Indonesia to the public one of them with the help of Google Maps.

Google Maps is a free service provided by Google and is very popular and commonly accessible through a browser. Google Maps is one of the applications of Google-based Geographic Information System to search for a location or region on earth. Google maps have a geolocation feature that can be used to determine the location you want to tag according to latitude and longitude [6][7]. A method to determine the distance between the two points to take into account that the earth is not a flat plane but is a field that has a degree of curvature which is the Haversine Formula.

Some journals using Formula Haversine [8][9][10], namely [11][12][13] which in this study using Haversine Formula method as the calculation in finding the shortest distance is a straight line from one point to the system

users. There was also a study [14] Haversine Formula used to calculate the distance and find the shortest distance in a straight line between the point coordinates of users with point coordinates of the nearest place according to calculations.

Based on the description that has been presented, an educational game titled "Landmark Nusantara" then built, where the game will give the knowledge to users about the landmarks of a region in Indonesia in Geographic Information System based which use the help of Google Maps and using Haversine formula that can be used to calculate the shortest distance is a straight line between two points.

2. HAVERSINE FORMULA

Haversine Formula is used to calculate the distance between two points on the earth's surface using latitude and longitude as input variables [15][16][17]. The haversine formula is an important equation in navigation, giving great circle distance between two points on the surface of a sphere (Earth) by longitude and latitude. The use of this formula assumes ignoring the effect of ellipsoidal, accurate enough for most calculations, also ignoring altitude hills and deep valleys on the surface of the earth [18][19].

Assuming that the earth is a perfect sphere with radius R 6367, 45 km, and the location of the second point in a coordinate ball (latitude and longitude), respectively lon_1 , lat_1 , and lon_2 , lat_2 , then the Haversine formula can be written by the equation (1). The angle of the latitude and longitude should be converted from degrees to radians before you can use trigonometric functions [13][20]. An explanation of the use of the Haversine method is in the results and discussion chapter

$$\Delta lat = lat_2 - lat_1$$

$$\Delta long = long_2 - long_1$$

$$a = \sin^2\left(\frac{\Delta lat}{2}\right) + \cos(lat_1) * \cos(lat_2) * \sin^2\left(\frac{\Delta long}{2}\right) \quad (1)$$

$$c = 2 * \text{atan}^2(\sqrt{a}, \sqrt{1-a})$$

$$d = R * c$$

Information:

R = radius of the earth by 6371 (km)

Δlat = amount of changes in latitude

$\Delta long$ = amount of changes in longitude

c = calculation axes intersect

d = distance (km)

1 degree = 0.0174532925 radians

3. RESULT AND DISCUSSION

3.1. Game Rules of "Landmark Nusantara"

This study uses landmark area data in Indonesia which is used to be the questions about the game Landmark Nusantara. The data sample used is as many as 30 data that becomes a mat the question in the game. Once the data are obtained then a draft rule is created for the game design of the system that will be implemented into the Landmark Nusantara game. Here's the game rule for the Landmark Nusantara game:

a. Win

- 1) Life point remains minimal ≥ 1 Km
- 2) Successfully passed 5 questions

b. Lose

- 1) Life point was left ≤ 0 Km
- 2) Did not make it past the five questions

c. The addition or subtraction Life Point

1) Life point reduced if:

- a). Players do not answer questions during the allotted time of 60 seconds. Life points are reduced by as many as 100 Km.

- b) The player incorrectly answered questions. Life points reduced on the corresponding point on how far away the error the players marked with the correct answer, the distance calculation error marker using Haversine Formula

- 2) Life point increases if the player answers correctly and the players answered in less than 60 seconds. The calculation of life point increases is the remaining time multiplied by 5 km. The player answer would be considered true if the error within ≤ 15 km.

The Application of the Haversine Formula method on the game is used to calculate the distance of the player's answers points with the landmark answers point. By the time the players access the Landmark Nusantara game page then the player can see some parts include Life Point parts, answering time part questions to obtain additional point question part, part of the map is the part that becomes the input response from players and pins marker is used as the player input answers.

Players can enter answers using marker pins to areas where they feel is right. After the players answered the questions, the game will automatically calculate the distance between points on player answers with landmark marker pins point answer of the question in the game, using the Haversine Formula method. If the player answers a distance of not more than or equal to 15 km, the answer to the player is deemed correct and the game will automatically pop-up displaying information

to the player that the player answers correctly and provide educational information or knowledge about the landmark that became the question. If the player's answers distance is over 15 km, then the player answers are incorrectly and the game will automatically pop up the info to the player that the answer is incorrect by showing how far the incorrect point of players that have been calculated using the Haversine Formula method, and the game will still provide the info education or knowledge about a landmark that became the question. When the player gets the wrong answer, on a map where the input answers to the game will also feature a point marker landmarks area where the correct answer is and then the point marker will draw a straight line to the point answers to players who are used to illustrate that the distance calculated in a straight line, as can be seen in Fig. 1.



Figure 1. Map display when player incorrectly answering questions

After getting the user's location, then the user can choose the type of recreation desired. Three types of recreation, outdoor recreation, recreation buildings, and artificial recreational. When searching recreational locations, the Haversine method will process the user with multiple locations within the recreation. It will generate some recreational sites and has been ranked distance-based recreational sites closest to the location of the user. Besides, the game can also display information about tourist sites such as in Fig. 1.

4. DISCUSSION

The testing phase for the application of the Haversine Formula method is needed to evaluate the results of calculations carried out by the game with the results obtained manually to minimize errors in the game. At this stage, the players who answered questions using marker pins on the map has point coordinates are read in the game. The cardinal points of the player answer marker pins that are read in the game and then calculated the distance to the landmark point coordinates. The game automatically calculates the distance between the point using the Haversine Formula method with equation (1), which can be seen in Fig. 2.

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• Marker Pemain
Latitude 1 = -3.6888551431470353
Longitude 1 = 115.59814453125
• Landmark
Latitude 2 = 0.0010086
Longitude 2 = 109.3199945
• Perhitungan Titik Radian
latitude 1 = -0.0643826678770425 Radian
latitude 2 = 0.000017603390835614805 Radian
longitude 1 = 2.0175682312665897 Radian
longitude 2 = 1.9079938422870923 Radian
Δlat = Latitude 2 - Latitude 1 =0.06440027126787812;
Δlong = Longitude 2 - Longitude 1 = -0.10957438897949734;
• a= sin²(Δlat/2) + cos(Latitude Awal).cos(Latitude).sin²(Δlong/2)
a = sin(0.06440027126787812/2) * sin(0.06440027126787812/2) +
cos(-0.0643826678770425) * cos(0.000017603390835614805) *
sin(0.06440027126787812/2) * sin(-0.10957438897949734/2);
a = 0.00402891232412865;
• c = 2 * atan2 (√a, √(1-a))
c = 2 * atan2(√(0.00402891232412865), √(1-0.00402891232412865));
c = 0.12703282555491682;
• d = R * c
d = 6371 * 0.12703282555491682;
d = 809.3261316103751Km

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Figure 2. Haversine method calculation on game

Then from the calculations made in the game in Fig. 2, be tested also by manual calculation using the MS. Excel Haversine Formula method, in which the manual testing is done using MS. Excel aims to be able to see the calculations performed by the game whether by the calculation done using MS. Excel assistance. Manual calculations on MS. Excel with equation (1).

Based on the results of tests on the game, it was concluded that the application of the Haversine Formula method on the game already by the manual calculation is performed using MS. Excel aid, where the results of the game are the same as the results from Ms. Excel which have the same general area as far as 809.3261316 Km.

5. CONCLUSION

Based on the research, it has built an educational game called Landmark Nusantara that can give information knowledge and history of the landmarks in Indonesia, where the game is based on Geographic Information System using the help of Google Maps and the game is supported also by the Haversine Formula method which is used to calculate the shortest distance is a straight line between two points.

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