REGIONAL LEADING POTENTIAL RECOMMENDATIONS: IMPLEMENTATION OF HAVERSINE FORMULA IN SIDOARJO ON HANDS MOBILE APPLICATIONS

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REGIONAL LEADING POTENTIAL RECOMMENDATIONS: IMPLEMENTATION OF HAVERSINE FORMULA IN SIDOARJO ON HANDS MOBILE APPLICATIONS

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Sidoarjo on Hands (SoH) is an android-based mobile application that can ease the public of Sidoarjo to get information about the potential area in Sidoarjo. SoH has gone through two stages of systems development. The deficiencies found in the earlier version include still not presenting information on the mileage of the current user site to potential desired areas that to land on. At the same time, the user also wants information about the route. The user must take this route if they would like to go to the potential area. This research tries to apply the Haversine formula as a method of estimation of the calculation of the distance between user's current location and the potential intended areas of SoH. Next, through Google Maps Library, the user will get information about the route. By applying the Haversine formula as a support system to offer the intended areas of potential recommendations, the SoH system may have better performance so that it is able to meet the needs of users of SoH itself.

Keywords: *Regional Leading Potential, Sidoarjo on Hands, Apriori Algorithm, Haversine Formula, Google Maps Library*.

INTRODUCTION

The Sidoarjo on Hands (SoH) is an android-based mobile application that can facilitate obtaining information about the potential of the area owned by Sidoarjo Regency. Sidoarjo is one of the districts in Indonesia. With an area of approximately 714,243 km2 [1], Sidoarjo holds a lot of regional superior potential. Some of the potential areas in Sidoarjo include industrial potential, agricultural potential, fisheries potential, craft potential, tourism potential and culinary potential. Public will easily learn all the information about this potential through this application.

In the earlier version 1.0 SoH prototype [2], SoH processes the data search by applying the joint matching query method. This method searches potential areas by combining user's potential data search with spatial data stored in the SoH application database. This method is ineffective as sometimes the search results that appear are not suitable with user's profile.

Furthermore, SoH optimizes data search method by applying Apriori TID algorithm [3]. As a result, the recommendations of the regional potential raised by the system are not only able to offer information which is relevant for the user, but also adjust to user's searching history. Therefore, the information on the search results of potential areas is improved due to the higher relevance for the user's profile. At this stage of the SoH development application, information about distance between user's current site and a potential area does not exist. The information about the routes to take if they want to reach the potential area does not exist as well for this stage of SoH applications. It is because both information are useful for users to decide where the potential areas they want to visit. This study attempts to apply the Haversine formula algorithm [4] as an estimation method for calculating the distance between SoH user's current site and the potential of the intended area. We choose Haversine formula because in some former studies [5–7] this method is used as an alternative solution of problems related to distance calculation. The information about the route will be resolved through the utilization of the Google Maps Library.

From the findings obtained after the earlier version of the SoH application development, it is deemed necessary to improve current SoH system performance in order to meet the shortcomings found in the former version of the SoH application. SoH application adds these two ancillary features directly. As such, it makes it easier and more convenient for users to run SoH. By implementing Haversine formula and Google Maps library as a system support to advance recommendations on intended potential areas, SoH provides better performance to meet the needs of SoH users.

Haversine Formula

We used the Haversine method to calculate the distance between points on the earth's surface using the longitude and latitude as input variables. Haversine formula is an important equation in navigation providing the distance information of a large circle between two points on the surface of the ball (earth) based on the longitude and latitude information. Assuming that the earth is perfectly round with radius R 6,367, 45 km, and the address of 2 points in the coordinate of the ball (latitude and longitude) are lat1, lon1 and lat2 lon2, the Haversine formula can be written with the equation as follows [5,6] :

$$d = 2R \sin^{-1} \sqrt{sin^2\left(\frac{ø_2 - ø_1}{2}\right) + \cos(ø_1)\cos(ø_2)\, sin^2\left(\frac{\psi_2 - \psi_1}{2}\right)} \quad (1)$$

Here, d is the distance between two points with latitude and longitude and (ø,ψ), and R is the radius of the Earth.

Haversine Formula Implementation in the SoH Application

The Haversine formula is used to calculate the distance between user's location and the point of intended destination. The calculation is carried out as follows:

1. The system will retrieve the coordinate data (lat 1 and lon1) of the current location of the user
2. From each potential group of selected areas, it will collect the coordinates' data (lat 2 and lon2) of the potential point
3. System will display the selected potential area in a sequence based on the value of the nearest distance

Google Map Library

The Google Maps library is used to place points of potential site areas in Sidoarjo Regency. In addition, it is also used to display information about the route, if user wants to visit the potential area. First, we divided each potential unit into 6 groups, namely industrial potential, agricultural potential, fisheries potential, craft potential, tourism potential and culinary potential. There are 3 sub categories for industrial potential which are home appliances industry, exhaust industry and iron industry. For craft potential category had 6 sub-potential categories, namely bags and suitcases, borders, batik, convection, hats and sandals. The tourism potential category is divided into natural tourism sub-categories and artificial tourism sub-categories. Whereas, the culinary potential category is divided into 7 sub-categories which are crackers, tofu, tempeh, salted eggs, petis, nuggets and sausages. On the map each potential unit will be given an icon according to the potential sub-category.

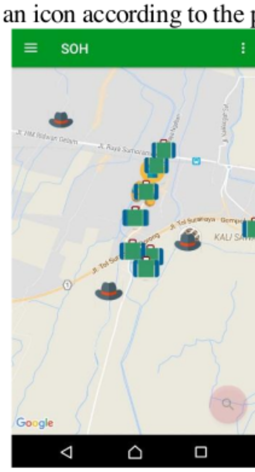

Figure 1. Unit marker point on the map

Apriori Tid Algorithm

Apriori Tid algorithm is one of the parts of association rule mining. Association mining rules is a technique in data mining that aims to get the rules of association or relationship between a set of items. Association rules are obtained from various data sources, including from transactional databases, data warehouses, as well as from other information storage areas. In general, the processed data is homogeneous. The first study of the search for association rules is obtained from an itemset which often appear together [8]. One algorithm that is often used for searching association rules is Apriori [9]. An association rule has two important parameters, namely support (value support) which is the percentage of item combination events or support count number of itemset that appear in acquire transactions and confidence (certainty value), namely the strong relationship between items in association rules [10].

The association analysis is defined as a process for finding all associative rules that meet the smallest requirements for support (lowest support) and smallest requirements for confidence (lowest confidence). In general, association rules are obtained as follows: For example, $I = \{i_1, i_2, i_3, ... i_n\}$ which are a set of items, while D is a set of transactions where each transaction has a set of items T,$T \subseteq I$. Each transaction will have a unique Tid (Transaction Identifier). Each transaction is said to contain X, a collection of items in I, if $X \subseteq T$. An association rule is formulated with the form $X \rightarrow Y$ where $X \subseteq I$; $Y \subseteq I$; and $X \cap Y = \Phi$. The $X \rightarrow Y$ rule has support s in transaction D if s% or the number of s in the transaction in D has $X \cup Y$. In other words, the support of a rule is a probability of occurrence of X and Y together or the number of events of X and Y together. The $X \rightarrow Y$ rule has a confidence value c if c% of transaction D that has X also has Y. Or in other words, the confidence of a rule is a conditional probability of Y being true if X is the antecedent. Support is the probability that an item or a set of items in a transactional database is as in (2).

$$\text{Support (X)} = (n(X))/n \quad (2)$$

where n is the total number of transactions in the database, n (X) is the number of transactions containing X itemset, or support count the number of items contained in the transaction. Confidence is a conditional probability for the $X \rightarrow Y$ association rule defined as in (3).

$$\text{Confidence } (X \rightarrow Y) = (\text{Support } (x \cup Y))/(\text{Support } (X)) \quad (3)$$

To measure the accuracy of a rule obtained, we used the Lift Ratio formula. Lift Ratio from the $X \rightarrow Y$ rule is defined as in (4).

$$\text{Lift Ratio } (X \rightarrow Y) = (\text{Confidence } (X \rightarrow Y))/(\text{Expected Confidence } (X \rightarrow Y)), \quad (4)$$

where Expected Confidence is defined as in (5).

$$\text{Expected Confidence } (X \rightarrow Y) = (\text{Support } (Y))/(\text{Support } (X \cup Y)) \quad (5)$$

If the lift ratio>1, the $X \rightarrow Y$ rules occur more often than expected, andX and Y are not independent. If lift ratio = 1, then the rule $X \rightarrow Y$ occurs as expected. But if the lift ratio is <1, then the rules $X \rightarrow Y$ occur less regularly than expected and X, Y are dependent.

Implementation of the Apriori Tid Algorithm in SoH Application

We used Apriori TID algorithm to optimize potential search results by the system with the following work stages:

a. Every time a SoH user makes use of the SoH application, the system will read the UUID data from the SoH user and keep a history of data search performed by that user. Later, the system will search the data into the SoH server by using the UUID from the SoH user as a data search key.

b. If user makes use of SoH application for the first time, the search for potential Sidoarjo Regency data will run join matching query method.

c. If the user has used the SoH application several times, the system will retrieve the data using the Apriori TID algorithm to read history of the SoH application. Based on history of the SoH application, the system will offer potential data recommendations for Sidoarjo Regency according to user history.

d. System would use the results of the data recommendations to search potential Sidoarjo Regency data on the SoH server.

e. The system will display information on potential of Sidoarjo Regency needed by SoH users.

Result and Discussion

The SoH architecture in general is not significantly different from the earlier version. Through the SoH application installed on the device, the user only needs to enter the Sidoarjo area's potential data that he wants to find. Thereafter, by combining several search methods (join matching query, Apriori TID algorithm and Haversine formula), the system will display search results according to what the user wants.

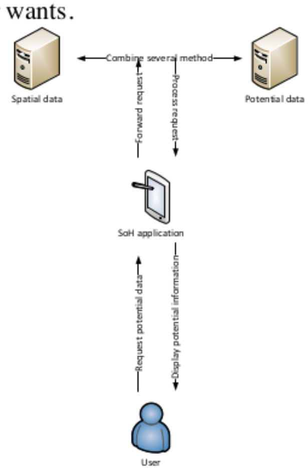

Figure 2. SoH Architecture

The SoH workflow description is as below:

1. SoH users enter the data they want to search for in the search box (fig 3). The search of keywordsin the form of potential unit names or potential types or other words is related to the potential search.

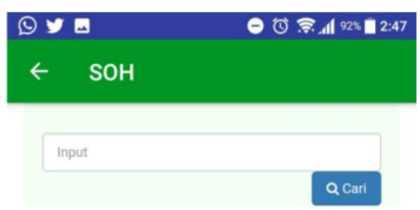

Figure 3. Search Box

2. By combining the query matching method and the Apriori algorithm, the system will get a group of datasets containing the results of the query command. (Figure 4)

3. The system will read each latitude and longitude coordinate from the resultset member and calculate each member distance of the dataset using the Haversine formula.

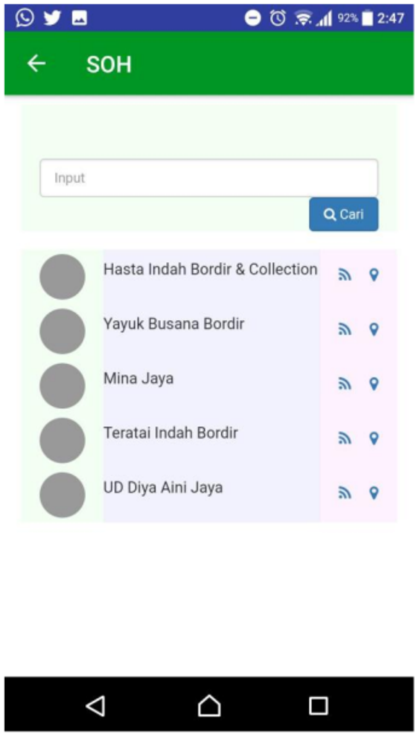

Figure 4. Optimize Search Result

4. From these calculations, a new result set is obtained as follows (fig 5). The system will display to the new dataset user sorted according to smallest distance calculation results.

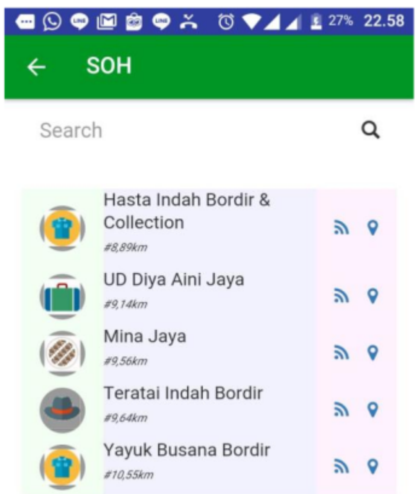

Figure 5. System Recommendation Result Set

5. The user selects one of the desired result set members. By utilizing the Google Maps library, the system will display guidance on taken directions / routes to get to that potential area.

Conclusion

The SoH application is a mobile-based application used to support and promote regional potential, in particular in Sidoarjo. This application has gone through several stages of development. At the first stage, the search for regional potential based on the join matching query method. This method combines text-based search methods and spatial data. At the second stage, data search is enhanced with the application of the Apriori method. Here, the search results are adjusted to the search history that the user has ever done. As a result, the search results displayed by the system are more relevant to user's profile. At the next stage, features of the recommended potential area added based on consideration of the closest distance to the user's current location. By implementing the Haversine Formula as a method of calculating distances and utilizing the Google Maps Library as a guide to the taken route, SoH 3.0 version has better features compared to the earlier version. This added feature is also able to help SoH users in choosing the potential of the Sidoarjo Regency more precisely.

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Regional aparıcı potensial tövsiyələr: Havershine formulasının Sidarjo on Hands (SoH) mobil proqramlarında tətbiqi

Sidoarjo on Hands (SoH), Sidarjo ictimaiyyətinə Sidoarjo'da potensial sahə haqqında məlumat almağı asanlaşdırmaq üçün android tipli mobil proqramıdır. SoH sistemi iki inkişaf mərhələsindən keçib. Əvvəlki versiyada tapılan çatışmazlıqlar hazırkı istifadəçi saytının tələblərinə cavab vermirdi. İstifadəçi marşrut haqqında məlumat istəyir, müəyyən potensial sahəyə düşmək üçün istifadəçi hansı marşrutdan istifdə etməlidir. Bu tədqiqatda Havershine formulasının istifadəçinin hazırkı yeri ilə və SoH-un potensial nəzərdə tutulmuş sahələr arasında məsafənin qiymətləndirilməsi üçün Havershine tətbiqinə çalışılır. Bundan sonra, istifadəçi Google Xəritə Kitabxanası vasitəsilə marşrut barədə məlumat alacaqdır. Nəzərdə tutulmuş sahələrlə bağlı potensial tövsiyələri dəstəkləyən Havershine formulasını tətbiq etməklə təklif etmək üçün SoH sistemi istifadəçilərinin tələblərini ödəməklə daha yüksək məhsuldarlığa nail olur.

Açar sözlər: *Regional aparıcı potensial tövsiyələr, Sidarjo on Hands, Apriori alqoritmi, Haversine formulası, Google Xəritə Kitabxanası.*

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Региональные ведущие потенциальные рекомендации: применение формулы Havershine для мобильных программ Sidoarjo on Hands (SoH)

Sidoarjo on Hands (SoH) – мобильное приложение на базе Android, которое может облегчить общественности Sidoarjo получение информации о потенциальной области в Sidoarjo. SoH прошел два этапа развития системы. Недостатки, обнаруженные в более ранней версии, включают в себя еще непредоставление информации о пробеге текущего сайта пользователя потенциальным желаемым областям, на которые можно приземлиться. В то же время пользователь также хочет получить информацию о маршруте. Пользователь должен выбрать этот маршрут, если он хочет попасть в потенциальную зону. В этом исследовании делается попытка применить формулу Хаверсайна в качестве метода оценки расстояния между текущим местоположением пользователя и потенциальными предполагаемыми областями SoH. Далее через библиотеку Google Maps пользователь получит информацию о маршруте. Применяя формулу Хаверсайна в качестве системы поддержки, чтобы предложить предполагаемые области потенциальных рекомендаций, система SoH может иметь более высокую производительность, чтобы удовлетворить потребности пользователей самой SoH.

Ключевые слова*: региональный лидерский потенциал, Sidoarjo on Hands, алгоритм Apriori, формула Haversine, библиотека Google Maps.*

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