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Android Based Restaurant Recommendation System Using the Simple Additive Weighting Method

Kevin Richie Yonathan[1]
[1](*Information management, Da-Yeh University, Taiwan)*

ABSTRACT : Culinary business is a very profitable industry that grows fast. In 2011, it has generated US$2.45 billion. Indonesian Franchise Association stated that the amount of restaurant in Indonesia has increased by a huge margin, including both franchise restaurant chains or independent ones. A problem starts to rise amidst the rapid and global growth of the culinary industry, consumers are having difficulties finding and deciding where to eat, especially when they are travelling far. To solve that problem, an application was built to help consumers to find restaurants. This application was built using the Simple Additive Weighting Method on Android. It has been tested using 30 samples who have used the application and filled questionnaires. The result of the questionnaire showed that the overall user satisfaction score is 87.9%.

Keywords: Android, recommendation system, restaurant, simple additive weighting, weighting.

I. INTRODUCTION

Culinary business is one of the most profitable and fastest-growing industries. It's estimated that that there are 16 million restaurants in the world [1]. King (2013) stated that the restaurant industry has generated US$2.45 trillion at the end of 2011. In Indonesia, restaurants have been coming out here and there, either private-owned restaurants or franchise-owned restaurants [3]. Franchise business also grows rapidly in Indonesia, this situation happens because Indonesia's huge population of 252.124.458 per 2014 census [3].Out of those 252.124.458, 63 million people are internet users. From that number, 95% use internet to access information online [4]. From a previous survey, 63% of the respondents said that restaurant finder applications play a big part in deciding where they will eat. 83% of the respondents also stated that restaurant finder applications are very helpful in finding places to eat when they are travelling [5] In this research, the recommendation of the restaurant will be made with the Simple Additive Weighting (SAW) method. This method is suitable to be used when the recommendation object has more than attribute to me weighted [6]. On top of that, the SAW method also can filter the best alternatives out of the several attributes because there's a sorting process that ranks the options from the most suitable one to the least, after the user has decided value of each attribute [7]. Previously, there has been a research about restaurant recommender system with the Slope One algorithm by Dharma Pratama (2015). The system used the database from the Google Places API. The Slope One algorithm calculates the recommendation using the distance and rating as the criteria. In that research, the it's also recommended to use the SAW method because the user preferences can also be used as a factor to decide the recommendation [8]. Based on the problems and advice from the previous research, and also the benefits of the SAW method, this research will create a restaurant recommender system using the Simple Additive Weighting method, based in Android and using the Zomato API and the criteria would be distance, price, rating, and the amount of upvotes.

II. LITERATURE REVIEW

Recommendation System: The recommendation system is a system that aims to calculate information that is of interest to its users and also helps prospective consumers decide what items to buy [9]. According to Chris Boylan, the recommendation system is a computer information system that helps make decisions for business and organizational activities [10]. Examples of using the recommendation system are book recommendations on Amazon and film recommendations on Netflix. The design of the recommendation system depends on the characteristics of the available data. For example on Netflix, data is given a rating scale from 1 to 5. The data supports the quality of interaction between users and items. In addition, the recommendation system can access specific data from users and items such as demographics and product descriptions. Recommendation systems have different methods for providing recommendations.

Simple Additive Weighting: Simple Additive Weighting (SAW) or often also called the weighted sum method is one of the most frequently used methods for Multi Attribute Decision Making [11]. The basic concept of this method is to find the average value obtained from calculations for each alternative by multiplying the scale value

given for the attributes of an alternative with the weighting importance of those attributes given by the decision maker which then sums the value of the object for all criteria [12].
The advantage of the SAW method is the accuracy of the assessment because it is based on a predetermined weight value for each attribute later will be followed by a ranking process that is in accordance with the best alternative obtained from a number of other alternatives [13].
According to previous research in 2013, there are eight stages of implementing the Simple Additive Weighting method [14]:

1. Determine the alternatives that exist, which is A_i.
2. Determine the criteria that will be used as a reference in making decisions, which is C_j.
3. Giving a match rating value of each alternative to each criterion.
4. Determine the weight of preference or level of importance (W) of each criterion.

$$W = [\, W_1, W_2, W_3, \dots, W_j \,]$$

5. Make a match rating table of each alternative to each of the existing criteria.
6. Make a decision matrix (X) formed from the match rating table of each alternative for each criterion. The value of X for each alternative (A_i) for each predetermined criterion (C_j) where i = 1, 2, ..., m and j = 1, 2, ..., n.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1j} \\ \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} \end{bmatrix}$$

7. Then calculate the normalized decision matrix by calculating the normalized performance rating value (n_{ij}) from alternative A_i on criterion C_j.
   For positive criteria:

$$n_{ij} = \frac{r_{ij}}{r_j^{max}} \; i = 1, \dots, m; j = 1, \dots, n$$

Figure 1

   For negative criteria:

$$n_{ij} = \frac{r_j^{min}}{r_{ij}} \; i = 1, \dots, m; j = 1, \dots, n$$

Figure 2

Information:

a. Profit criteria if the value provides benefits for decision making, on the contrary the cost criteria if it incurs costs for decision making.
b. If it is in the form of profit criteria, then the value is divided by the value of each column. As for the cost criteria, the value of each column is divided by the r_{ij} value.

8. The final preference value (V_i) is obtained from the sum of the multiplications of normalized matrix row elements (n) with preference weights (W) corresponding to the matrix column elements (W).

$$V_i = \sum_{j=1}^{n} w_j r_{ij}$$

Computer Usability Satisfaction Questionnaires: Computer Usability Satisfaction Questionnaires (CUSQ) is a questionnaire created to measure user satisfaction in using a computer system or application [15]. Lewis developed this questionnaire to find out the level of user satisfaction in non-laboratory situations. This questionnaire has 19 questions and is divided into four sections, each section evaluating applications from different aspects. Questions number 1 through 8 measure the usefulness of the application, questions number 9 to 15 measure the quality of information generated by the application, questions number 16 and 17 measure the quality of the application interface, and questions number 1 through 19 measure user satisfaction with the application in general.

Table 1. Table of CUSQ's Questions

No	Question	Aspect
1	Overall, I am satisfied with how easy it is to use this system.	System Usability & Overall Satisfaction
2	It is simple to use this system.	
3	I can effectively complete my work using this system.	
4	I am able to complete my work quickly using this system.	
5	I am able to efficiently complete my work using this system.	
6	I feel comfortable using this system.	
7	It was easy to learn to use this system.	
8	I believe I became productive quickly using this system.	
9	The system gives error messages that clearly tell me how to fix problems.	Information Quality & Overall Satisfaction
10	Whenever I make a mistake using the system, I recover easily and quickly.	
11	The information provided with this system is clear.	
12	It was easy to find the information I needed.	
13	The information provided with the system is easy to understand.	
14	The information is effective in helping me complete my work.	
15	The organization of information on the system screens is clear.	
16	The interface of this system is pleasant.	Interface Quality & Overall Satisfaction
17	I like using the interface of this system.	
18	This system has all the functions and capabilities I expect it to have.	Overall Satisfaction
19	Overall, I am satisfied with this system.	

2.4 Likert Scale

The Likert Scale is a measurement scale developed by Rensis Likert, a sociologist from the University of Michigan. According to Uebersax (2006), a Likert scale is a measurement scale for objects that have more than one attribute to be assessed [16].

Likert scale is one method that can map qualitative data into quantitative data, so that a qualitative study can be more easily processed and mapped into a conclusion [17].

III. METHODOLOGY AND SYSTEM DESIGN

Methodology: In designing a restaurant recommendation system with the Simple Additive Weighting (SAW) method, several stages are carried out in research and writing, those stages are as follows:

1. Literature Study
   At this stage, a study of the SAW method and the design of recommendation systems from various sources such as books, journals, as well as online or printed ones is carried out to deepen knowledge about the design of the recommendation system and the SAW method.
2. System Design
   The system design stage is by making a flowchart to determine the workflow of the system. After creating the flowchart, a mockup from the system view is created.
3. System Programming
   Based on the results of the design, programming will be done. The programming language used is Java. The features of a dining recommendation system and the application of the SAW method are also made at this stage. Making the appearance of the system (user interface) is based on the mockup that has been made.
4. Testing and Evaluation
   At this stage, testing the application is done to look for bugs and errors. Testing is also done to test the calculations with the SAW method carried out by the system by comparing the results of calculations from the system with manual calculations. System evaluation is done by distributing applications and questionnaires to users. After the user uses the application, the user is given a questionnaire to fill in as research evaluation material.
5. Documentation
   In the end the report writing is done at this stage with the aim of documenting all forms of research processes and concluding the final results obtained from this study.

Flowchart: Flowcharts are diagrams with sequential steps to symbolize the flow of a process in a system using shapes or symbols. Flowchart is used in this to explain the algorithmic and systemic flow of the program.

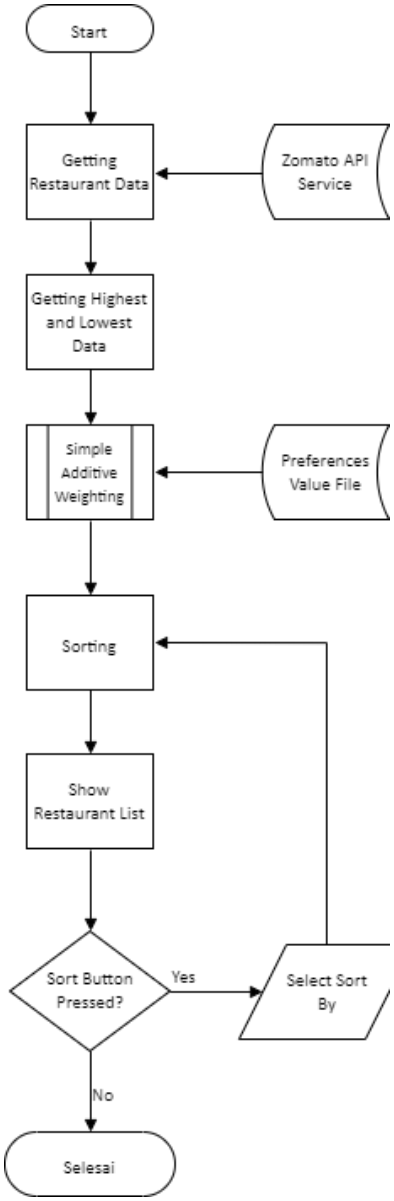

Figure 1. Flowchart of the Program.

Fig. 1 is a flowchart for the recommendation process. After the system gets the coordinates of a location, the system will send the coordinates to Zomato API Service to get the restaurant data that is around that location. After getting data from the existing restaurants, the system will look for the highest value (for rating and the number of upvotes) and the lowest value (for distance and price). The highest and lowest values will be used for calculations using the Simple Additive Weighting method. Weights for personal preferences of the user will also be used in calculations to determine the outcome of the final value. After the calculation is done, the system will sort the data based on the distance closest to the location desired by the user. Users can also sort by price, rating, number of votes, or personal preference values.

IV. IMPLEMENTATION AND TESTING

Implementation Result: For testing the algorithm, we set the location to be on: -6.2436638889, 106.6539222222. The preference value for each criterion are: 30% for distance, 50% for price, 10% for rating, and 10% for upvotes. Below is the list of the restaurants in that location:

Table 2. List of Restaurants

Restaurant Name	**Distance (km)**	**Price (Rupiah)**	**Rating**	**Amount of Upvotes**
The Premiere - XXI Living World	0.06	200000	1	1
Marugame Udon	0.06	120000	3.5	14
My Kopi-O!	0.07	120000	3.4	65
Tori Bento	0.08	100000	1	0
Pepper Lunch	0.09	200000	1	3
Oku Tei Japanese Food	0.09	40000	1	0
Donburi Ichiya	0.1	150000	3.9	110
HVALA	0.1	80000	1	3
I - ta Suki	0.11	200000	2.6	27
Gyu - Kaku Japanese BBQ	0.12	300000	3.8	34
Sushi Naga	0.2	160000	2.9	5
Ichiban Sushi	0.22	150000	2.8	58
Ikkudo Ichi	0.22	180000	4.1	173
HokBen	0.23	130000	3.2	12
Sushi Tei	0.27	250000	4.2	143
Zenbu	0.4	200000	4.2	188
Beatrice Quarters	0.4	200000	4.2	81
Shaburi Shabu Shabu	0.4	600000	3.7	45
Nama Sushi by Sushi Masa	0.4	400000	4	65
Sushi Tora	0.4	100000	2.9	5

TABLE 1 is a list of restaurants that were used to check the program's algorithm and mathematical process in the Simple Additive Weighting method.

Table 2 List of Restaurants after Normalization

Restaurant Names	**Normalized Value**			
	Distance	**Price**	**Rating**	**Amount of Upvotes**
The Premiere - XXI Living World	1	0.2	0.238095238	0.005319149
Marugame Udon	1	0.333333333	0.833333333	0.074468085
My Kopi-O!	0.857142857	0.333333333	0.80952381	0.345744681
Tori Bento	0.75	0.4	0.238095238	0
Pepper Lunch	0.666666667	0.2	0.238095238	0.015957447
Oku Tei Japanese Food	0.666666667	1	0.238095238	0
Donburi Ichiya	0.6	0.266666667	0.928571429	0.585106383
HVALA	0.6	0.5	0.238095238	0.015957447
I - ta Suki	0.545454545	0.2	0.619047619	0.143617021
Gyu - Kaku Japanese BBQ	0.5	0.133333333	0.904761905	0.180851064
Sushi Naga	0.3	0.25	0.69047619	0.026595745
Ichiban Sushi	0.272727273	0.266666667	0.666666667	0.308510638
Ikkudo Ichi	0.272727273	0.222222222	0.976190476	0.920212766
HokBen	0.260869565	0.307692308	0.761904762	0.063829787
Sushi Tei	0.222222222	0.16	1	0.760638298
Zenbu	0.15	0.2	1	1
Beatrice Quarters	0.15	0.2	1	0.430851064
Shaburi Shabu Shabu	0.15	0.066666667	0.880952381	0.239361702
Nama Sushi by Sushi Masa	0.15	0.1	0.952380952	0.345744681
Sushi Tora	0.15	0.4	0.69047619	0.026595745

TABLE 2's values were obtained from normalizing the values from TABLE 1 using Formula. 1 and Formula. 2. Distance and Price use Formula. 1 since they're profit criteria, meaning we're looking for the lowest data of

them (closest distance, lowest cost). Rating and upvotes uses Formula 2 since they're cost criteria, meaning we're looking for the highest data of them (highest rating, most upvoted).

Table 3. List of Restaurants after Weighting

Nama Restoran	Nilai Pembobotan			
	Jarak (30%)	Harga (50%)	Rating (10%)	Jumlah Upvote (10%)
The Premiere – XXI Living World	0.3	0.1	0.023809524	0.000531915
Marugame Udon	0.3	0.166666667	0.083333333	0.007446809
My Kopi-O!	0.257142857	0.166666667	0.080952381	0.034574468
Tori Bento	0.225	0.2	0.023809524	0
Pepper Lunch	0.2	0.1	0.023809524	0.001595745
Oku Tei Japanese Food	0.2	0.5	0.023809524	0
Donburi Ichiya	0.18	0.133333333	0.092857143	0.058510638
HVALA	0.18	0.25	0.023809524	0.001595745
I – ta Suki	0.163636364	0.1	0.061904762	0.014361702
Gyu – Kaku Japanese BBQ	0.15	0.066666667	0.09047619	0.018085106
Sushi Naga	0.09	0.125	0.069047619	0.002659574
Ichiban Sushi	0.081818182	0.133333333	0.066666667	0.030851064
Ikkudo Ichi	0.081818182	0.111111111	0.097619048	0.092021277
HokBen	0.07826087	0.153846154	0.076190476	0.006382979
Sushi Tei	0.066666667	0.08	0.1	0.07606383
Zenbu	0.045	0.1	0.1	0.1
Beatrice Quarters	0.045	0.1	0.1	0.043085106
Shaburi Shabu Shabu	0.045	0.033333333	0.088095238	0.02393617
Nama Sushi by Sushi Masa	0.045	0.05	0.095238095	0.034574468
Sushi Tora	0.045	0.2	0.069047619	0.002659574

TABLE 3 's values were obtained by weighting the values based the user's preferences. Each value is multiplied by their respective weight.

Table 4. List of the Restaurants, sorted from the most suitable

Nama Restoran	Nilai Hasil Akhir
Oku Tei Japanese Food	0.723809524
Marugame Udon	0.557446809
My Kopi-O!	0.539336373
Donburi Ichiya	0.464701114
HVALA	0.455405268
Tori Bento	0.448809524
The Premiere - XXI Living World	0.424341439
Ikkudo Ichi	0.382569617
Zenbu	0.345
I - ta Suki	0.339902828
Gyu - Kaku Japanese BBQ	0.325405268
Pepper Lunch	0.325227964
Sushi Tei	0.322730496
Sushi Tora	0.316707194
HokBen	0.314680478
Ichiban Sushi	0.312669246
Beatrice Quarters	0.288085106
Sushi Naga	0.286707194
Nama Sushi by Sushi Masa	0.224812563
Shaburi Shabu Shabu	0.190364742

TABLE 4's values were obtained by adding all the values after they went through the weighting process, we can see that Oku Tei Japanese Food is the highest; it means suits the user's preferences the most.

User Study: After the application is built, the next step is testing the application. According to Diehl (1992), at least 30 samples are needed in conducting research. Based on this theory, 30 samples were selected and asked to use the application and fill out a questionnaire as an evaluation of the application.

Table 5. Result of the Questionnaire

Question Number	Answer				
	Really Disagree	**Disagree**	**Neutral**	**Agree**	**Really Agree**
1	0	0	1	12	17
2	0	0	1	12	17
3	0	0	4	16	10
4	0	0	1	8	21
5	0	0	3	13	14
6	0	0	1	17	12
7	0	0	3	7	20
8	0	0	6	12	12
9	0	0	1	9	20
10	0	0	0	8	22
11	0	0	2	12	16
12	0	0	4	14	12
13	0	0	1	11	18
14	0	0	1	10	19
15	0	0	5	15	10
16	0	2	9	13	6
17	0	2	10	9	9
18	0	0	1	12	17
19	0	0	2	11	17

Calculation of the application's System Usability
Result = (Result 1 + Result 2 + Result 3 + Result 4 + Result 5 + Result 6 + Result 7 + Result 8) / total of questions
= (0.907 + 0.907 + 0.84 + 0.933 + 0.873 + 0.873 + 0.913 + 0.84) / 8
= 7.087 / 8
= 0.886 (88.6%)

Calculation of the application's *Information Quality*
Result = (Result 9 + Result 10 + Result 11 + Result 12 + Result 13 + Result 14 + Result 15) / total of questions
= (0.927 + 0.947 + 0.893 + 0.853 + 0.913 + 0.92 + 0.833) / 7
= 6.287 / 7
= 0.898 (89.8%)

Calculation of the application's *Interface Quality*
Result = (Result 16 + Result 17) / total of questions
= (0.753 + 0.767) / 2
= 1.52 / 2
= 0.76 (76%)

Calculation of the application's *Overall Satisfaction*
Result = ∑(Result of all questions) / total of questions
= (0.907 + 0.907 + 0.84 + 0.933 + 0.873 + 0.873 + 0.913 + 0.84 + 0.927 + 0.947 + 0.893 + 0.853 + 0.913 + 0.92 + 0.833 + 0.753 + 0.767 + 0.907 + 0.9) / 19
= 16.7 / 19
= 0.879 (87.9%)

The questions in the questionnaire relate to the usefulness of the application, the quality of information generated by the application, the application interface, and satisfaction with the application in general.

V. CONCLUSION

The conclusion drawn from the research that has been done is a restaurant recommendation system using the Simple Additive Weighting method on the Android platform successfully designed and built. The application uses the Zomato API service to get available dining and landmark data. From the results of the application testing questionnaire, it can be concluded that general user satisfaction with the application calculated by the Likert Scale calculation reached 87.9% or very strong.

Future research: Based on the restaurant recommendation system using the Simple Additive Weighting method on the Android platform that was built during the research, the following are suggestions for developing the system in the future.

1. Application development on other mobile application platforms, such as iOS or Windows Phone.
2. Can use an API service other than Zomato if anyone offers more complete information about where to eat.
3. Applications can also be developed with other algorithms or methods for different types of recommendations.

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