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CULINARY RECOMMENDATION APPLICATION BASED ON USER PREFERENCES USING FUZZY TOPSIS

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ABSTRACT: Culinary tourism is the experience of finding and enjoying unique and impressive food and drinks in a new region. Each region has a unique food flavor and can be the right choice for culinary tourists who want to try new experiences regarding taste. Differences in tourist preferences in choosing culinary regions sometimes become obstacles in finding a suitable place. Price, distance, facilities, menu variations, and halalness are some of the things that tourists consider in choosing culinary locations. Therefore, it is essential to accommodate tourist preferences to produce appropriate recommendations because the characteristics of tourists in determining their favorite culinary places are very subjective and varied. This study aims to develop a culinary recommendation system based on user preferences using Fuzzy TOPSIS as a recommendation method. Ten criteria can be selected, and their weight value determined by the user. The final result of the recommendation system is an alternative culinary location ranking and map location, along with detailed culinary location information. Result evaluation shows that the system is suitable and useful for users. This study proposes some new criteria that have not been used in other research.

ABSTRAK: Pelancongan masakan merupakan pengalaman mencari dan menikmati makanan dan minuman yang unik dan menarik di sesebuah daerah. Setiap daerah mempunyai rasa unik makanan dan boleh menjadi pilihan tepat untuk pelancong yang ingin mencuba pengalaman baru mengenai rasa. Perbezaan pilihan pelancong dalam memilih tempat masakan kadang-kadang menjadi halangan dalam mencari tempat sesuai. Harga, jarak, kemudahan, variasi menu, dan makanan halal merupakan beberapa faktor yang dilihat pelancong dalam memilih lokasi kulinari. Oleh itu, sokongan cadangan untuk pelancong membuat pilihan adalah penting kerana pilihan makanan adalah sangat subjektif dan berbeza-beza. Kajian ini bertujuan bagi membangunkan sistem cadangan masakan mengikut pilihan pengguna dengan menggunakan kaedah Fuzzy TOPSIS. Sepuluh kriteria boleh dipilih mengikut keutamaan. Matlamat akhir sistem ini adalah sebagai pilihan lain bagi pilihan lokasi makanan dan lokasi peta bersama maklumat terperinci lokasi masakan. Keputusan menunjukkan sistem ini sesuai dan berguna untuk pengguna. Kajian ini mencadangkan beberapa kriteria baru yang tidak digunakan oleh penyelidik lain.

KEYWORDS: *recommender system; fuzzy TOPSIS; culinary ranking; user preferences; GIS*

1. INTRODUCTION

Tourism is a complex multidimensional sector that influences the relevance of other areas in tourism activities. Tourism is all activities related to the tourist, and its multidimensional and multidisciplinary nature emerges as a manifestation of the needs of every person and country as well as interactions between tourists and the local community, fellow tourists, the Government, Regional Government and entrepreneurs [1]

Indonesia is actively developing the tourism industry, especially for Surabaya, as one of the metropolitan cities in Indonesia, also focusing on increasing the visits of both local and foreign tourists. Various efforts have been made, starting from city park beautification, city corner cleaning, growing tourist destinations, and many other things. Surabaya is famous as a city with a variety of culinary destinations that present many colors and choices for tourists who want to enjoy culinary treasures in Surabaya. However, some obstacles are encountered by tourists, including lack of knowledge about culinary locations in Surabaya and different preferences in determining culinary location.

The selection of culinary destinations has many criteria, such as price, location, convenience, type of menu, and others [2]. The choice is also subjective, meaning that each tourist has different preferences in choosing culinary destinations. According to [3], if data attributes of an alternative are not adequately served, contain uncertainties or inconsistencies, the usual Multiple Attribute Decision Making (MADM) method cannot be used. Based on these problems, it is necessary to have a Decision Support System (DSS) with Geographic Information System (GIS), so that the system can provide automatic recommendations on culinary tourism. DSS allows users to make decisions more quickly and carefully by combining hardware, software, and decision processes [4].

There have been many studies discussing Decision Support Systems (DSS) culinary recommendations [2, 5, 7]. Web and mobile-based applications have also been made to facilitate culinary connoisseurs in finding the nearest culinary location. However, most web and mobile apps focus more on distance and rating, so other criteria such as convenience, a variety of menus, prices, and halalness were rarely used as filters or additional rules.

The concept of combining DSS and GIS is now growing. The method in DSS is used to analyze the inputted data, and GIS is used to display location information in the form of mapping. The advantages of DSS in analyzing data and the advantages of GIS in delivering information are combined, making this system better when used [8].

This culinary selection problem requires the consideration of multiple factors and can be categorized as a multi-criteria decision-making problem. Fuzzy TOPSIS is one of the multi-criteria decision-making methods used to find optimal alternatives from several alternatives with certain criteria. Fuzzy is used in linguistic criteria that have uncertainty, while TOPSIS is used to get the best alternative. Fuzzy TOPSIS is easy to use, can take into account all types of criteria (subjective and objective), rational logic, and is easy to understand for practitioners. The calculation process is straightforward, the concept allows the pursuit of the best alternative criteria described in mathematics in a simple way, and essential weights can be entered easily [9, 10]. This study aims to design a mobile application that makes it easier for Surabaya tourists to choose the destination for culinary locations based on their preferences. Criteria to be selected include convenience, menu variation, price, distance, parking area, facilities, service, and halalness.

2. RELATED WORK

Several criteria were used to determine tourist destinations according to tourist considerations [11]. The Analytic Hierarchy Process (AHP) method is used as a method for analyzing data to determine the priority of tourist destinations in the Talaud Islands. Promotional patterns that are still traditional for tourism in the Talaud Islands are considered to be still inefficient. Therefore a web-based system is needed that can become an effective promotional media so that it can increase tourist enthusiasm.

Developing the concept of a combination of GIS with multi-criteria was also used to determine the location of the industry in the Vojvodina area [12]. The use of the idea can provide a location determination solution by analyzing several influential factors. GIS in this study is used as an approach to spatial decision making to determine the location of the industry.

Other research has applied the merge of Fuzzy Multi-Attribute Decision Making (FMADM) and Geographic Information System (GIS) [13]. The incorporation of FMADM and GIS is done to identify and evaluate the application of ecotechnology. The process carried out is to determine the use of ecotechnology methods that are suitable for riverbank walls. Feasibility evaluation refers to specific criteria provided by local area experts. The results of the study show that GIS can provide convenience for users to obtain information regarding geographical problems.

A research was conducted by Taroreh et al. [14] to determine the location of tourism development in the Poso region using feedback from the community (feedback). The Poso region has natural tourism that is attractive to tourists but still has not been developed; the development carried out by the government is based on feedback and input from the community. The results of this study indicate that this system can provide a solution for the government to develop tourism.

Some research [15] used location-based services (LBS) to help tourists find restaurant locations and specific culinary menus. LBS is a service that can send data and information that contains current location information about the user's presence or information that projects several locations of mobile users. LBS is applied as a part of architecture consisting of five components, such as mobile devices, communication networks, positioning components (GPS), provider services, applications, and data providers. Services delivered include map areas, weather conditions, traffic flow conditions, tour guides, shopping information, and so on. LBS requires a precise location to produce useful information.

Afnarius et al. [16] have built a culinary tourism search application in West Sumatra based on the mobile geographic information system. The development of this application aims to help tourists get information about culinary tours in West Sumatra. The app is built using the PHP programming language, Basic4Android, and Google Maps. The database used in the application is PostgreSQL. However, the application still needs to add additional features, such as uploading photos to social networks, accounts for users, and adding new culinary locations.

Geotagging is a procedure for adding geographic metadata information on different media such as adding geographic information on images, audiovisuals, internet sites, SMS messages, QR codes, and RSS in the form of geospatial metadata [17]. Generally, the information added consists of GPS geographic coordinates, location (address), description of data from the place.

The difference between previous research projects lies in the criteria, data analysis, and methods used. This study uses the concept of combining DSS with GIS to create an auto recommendation system, which applies the Fuzzy TOPSIS method. This application is expected to help tourists in Surabaya determine the location of a culinary destination and be able to display the route to the desired culinary tour.

3. METHOD

3.1 Data and Information Collection

Survey and literature studies are conducted to find out what criteria are considered by tourists when choosing culinary destinations. At this stage, 50 respondents would select and verify the criteria obtained from literature studies. This verification is used to determine the factors that influence based on user needs. After confirmation, criteria derived will be used as the criteria for selecting culinary destinations in the system. Furthermore, the results of data collection on culinary destinations are used as an alternative in the system. Five culinary experts will assess all of these alternatives.

3.2 Fuzzy TOPSIS As Ranking Method

The Recommendation System works by ranking culinary destinations according to user preferences using the Fuzzy TOPSIS method. Following are the ranking steps using the Fuzzy TOPSIS method [18]:

Step 1: Categorizing Positive and Negative Ideal Criteria: at this stage, predetermined selection criteria will be grouped in the categories of positive and negative ideal criteria.

Step 2: Determine fuzzy numbers for weighting criteria and assessment of culinary destinations: at this stage, linguistic variables and TFN (Triangular Fuzzy Number) are associated with establishing the importance weight matrix for each criterion and performance rating for each alternative culinary destination.

Step 3: Determine Importance Weights: at this stage, the importance of each of the criteria used in the system will be determined. The level of importance of the criteria will be denoted by the formula:

$$\tilde{w}_{ij} = (w_{j1}, w_{j2}, w_{j3}) \quad (1)$$

Step 4: Construction of Decision Matrix: at this stage, the performance rating of each alternative culinary destination will be determined. The decision matrix that is constructed contains alternative *m*, *n* criteria, and *k* experts. The decision matrix can be denoted by [10]:

$$\tilde{x}_{ij} = (l_{ij}, m_{ij}, u_{ij}) \quad (2)$$

where $$l_{ij} = min\{l_{ij}^k\}, m_{ij} = \frac{1}{K}\sum_{k=1}^{K} m_{ij}^k, u_{ij} = max\{u_{ij}^k\} \quad (3)$$

Step 5: Normalization of Decision Matrix: the decision matrix obtained in step 4 will be normalized. There is a difference in the normalization technique on the ideal positive criteria (benefit) and negative ideal (cost). Normalized decision matrices can be denoted by:

$$\tilde{R} = [\tilde{r}_{ij}]_{m \times n} \quad (4)$$

where

$$\tilde{r}_{ij} = \left(\frac{l_{ij}}{u_j^+}, \frac{m_{ij}}{u_j^+}, \frac{u_{ij}}{u_j^+}\right) \text{where } u_j^+ = max_i\, u_{ij} \quad (5)$$

for benefit criteria.

$$\tilde{r}_{ij} = \left(\frac{l_j^-}{u_{ij}}, \frac{l_j^-}{m_{ij}}, \frac{l_j^-}{l_{ij}}\right) \text{where } l_j^- = min_i\, l_{ij} \quad (6)$$

for cost criteria.

Step 6: Weighting Decision Matrix: a normalized decision matrix will be multiplied by the level of importance/weight of the criteria obtained in step 3. The weighted decision matrix can be denoted by:

$$\widetilde{v_{ij}} = \widetilde{r_{ij}} \otimes \widetilde{w_j} \qquad i = 1,2,\dots,m, j = 1,2,..,n \tag{7}$$

Step 7: Determining Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS): determine FPIS and FNIS for each criterion:

$$A^+ = \{\tilde{v}_1^+, \tilde{v}_2^+, \dots, \tilde{v}_n^+\} \text{ for FPIS.} \tag{8}$$

$$A^- = \{\tilde{v}_1^-, \tilde{v}_2^-, \dots, \tilde{v}_n^-\} \text{ for FNIS.} \tag{9}$$

where:

$$\tilde{v}_j^+ = (1,1,1) \text{and } \tilde{v}_j^- = (0,0,0) \tag{10}$$

Step 8: Calculating the distance of each alternative to FPIS and FNIS: at this stage, the distance of each alternative that will be ranked against FPIS and FNIS will be calculated using the formula:

$$d_i^+ = \sum_{j=1}^{n} d\left(\widetilde{v_{ij}} - \widetilde{v_j^+}\right) \tag{11}$$

$$d_i^- = \sum_{j=1}^{n} d\left(\widetilde{v_{ij}} - \widetilde{v_j^-}\right) \tag{12}$$

Step 9: Calculating the Relative Proximity to Ideal Solutions: Calculate the distance of the total criteria of each alternative to FPIS and FNIS so that *x* then calculate the proximity relative to the ideal solution with the formula:

$$S_i = \frac{d_i^-}{d_i^- + d_i^+} \tag{13}$$

Step 10: Ranking: Sort the results of closeness relative to the ideal solution obtained in the previous step from the largest to the smallest value; the higher the value, the better the alternative.

4. RESULTS

4.1 Data and Information Collection

From the results of data collection and processing, the final results are in the form of criteria that are considered when tourists choose culinary destinations. The full criteria can be seen in Table 1.

All criteria will be used as calculation criteria in the Fuzzy TOPSIS method. Filter criteria are the criteria used to filter out alternative culinary destinations that will be recommended to suit the user's wishes. For the Halal criteria, if a user wants a halal culinary destination, then alternative culinary destinations that will be recommended are alternative culinary destinations with halal menus. The criteria for filters that are not selected will not be a filter for the system; for example, if the halal criteria are not chosen, then all the culinary destinations which have a halal menu and not will be an alternative culinary destination that will be recommended.

Table 1: Final result criteria

Code	Criteria	Type
C1	Comforts	Linguistic
C2	Menu variation	Linguistic
C3	Area of Place	*Crisp*
C4	Distance	*Crisp*
C5	Parking Area	Linguistic
C6	Facility	Linguistic
C7	Service	Linguistic
C8	Price	*Crisp*
C9	Halal	*Crisp, Filter*
C10	Menu	Linguistic

Linguistic criteria are non-exact criteria and will be used as criteria given by five experts. Criteria that have a type of crisp value will not be assessed again to facilitate the assessment of alternatives to be carried out by experts. Experts do not need to repeat the assessment of alternative culinary tourist destinations on specific criteria that already have exact numbers.

4.2 Fuzzy TOPSIS as Ranking Method

Step 1: Results that have been obtained from the assessment criteria will be grouped into two types of criteria, namely the criteria of benefit and cost. The criteria to be taken are five criteria, namely C1 (Convenience), C2 (Menu Variation), C3 (Place Area), C8 (Price), and C10 (Menu Type). For the calculation example, five criteria will be taken, namely C1 (Convenience), C2 (Menu Variation), C3 (Place Area), C8 (Price), and C10 (Menu Type). Categorizing the assessment criteria can be seen in table 2.

Table 2: Grouping of Positive and Negative Ideal Criteria

Criteria	Type
C1	Ideal Positive Solution
C2	Ideal Positive Solution
C3	Ideal Positive Solution
C8	Ideal Positive Solution
C10	Ideal Positive Solution

Step 2: Fuzzy Numbers that will be used for weighting criteria, and evaluating each alternative can be seen in Tables 3 and 4.

Table 3: Importance Rating

IMPORTANCE RATING			
Linguistic Variables	**TFNs**		
Very Low (VL)	0	0	0.1
Low (L)	0	0.1	0.3
Medium Low (ML)	0.1	0.3	0.5
Medium (M)	0.3	0.5	0.7
Medium High (MH)	0.5	0.7	0.9
High (H)	0.7	0.9	1
Very High (VH)	0.9	1	1

Table 4: Assessments Rating

ASSESSMENTS RATING			
Linguistic Variables	**TFNs**		
Very Poor (VP)	0	0	1
Poor (P)	0	1	3
Medium Poor (MP)	1	3	5
Fair (F)	3	5	7
Medium Good (MG)	5	7	9
Good (G)	7	9	10
Very Good (VG)	9	10	10

Step 3: The next step is to choose the importance level of the criteria. The level of importance of the criteria is in the form of linguistic variables that will be converted into fuzzy numbers. For example, this calculation will use the following criteria:
C1: "Very High"
C2: "Very High"
C3: "Very High"
C8: "Medium"
C10: "Medium-High"
So the results are as shown in Table 5.

Table 5: Importance of Weight Matrix

Criteria	**TFN**		
	l	***m***	***u***
C1	0.9	1	1
C2	0.9	1	1
C3	0.9	1	1
C8	0.3	0.5	0.7
C10	0.5	0.7	0.9

Step 4: In this stage, performance ratings are given by each expert (P) to each alternative to building a decision matrix. The performance rating given by each expert is a linguistic variable. The linguistic variable will then be converted into fuzzy numbers. Experts (P) only provide performance ratings against assessment criteria that are not crisp numbers. The performance

rating for criteria in the form of crisp numbers will be taken directly from the data specifications of culinary destinations. The performance rating given by experts will be aggregated because experts number more than one person. The aggregation calculations for A1 on C1 are as follows: For k = 3 in criterion C1 for alternative A1, for example, a = A1 and b = C1

$$\tilde{x}_{ab} = \left(min(l_{ab}^1, l_{ab}^2, l_{ab}^3), (m_{ab}^1 + m_{ab}^2 + m_{ab}^3)/3\,, max(u_{ab}^1, u_{ab}^2, u_{ab}^3)\right)$$

$$\tilde{x}_{ab} = \left(min(0.9{,}0.7{,}0.9), (0.9 + 0.9 + 0.9)/3\,, max(1{,}1{,}1)\right)$$

$$\tilde{x}_{ab} = (0.7{,}0.9{,}1)$$

For criteria that have crisp values, fuzzy numbers will not be used, but the form of the criteria value will be changed to TFN. For example, criterion C3 (Area of Place) has a value of 8; it will be converted into the form of TFN to (8,8,8). This is done to equalize crisp numbers into calculations using the TFN.

Step 5: At this stage, the normalization of the decision matrix will be carried out. The formula used to normalize depends on the type of criteria that have been grouped in step 1. Calculation of normalization of the decision matrix on positive ideal criteria is as follows:
For i = 5 on C1 belongs to the alternative A1, for example a = A1 and b = C1:

$u_b^+ = max_i(10{,}10{,}10{,}10{,}9)$ so that $u_b^+ = 10$

$$\tilde{r}_{ab} = \left(\frac{7}{10}, \frac{9}{10}, \frac{10}{10}\right)$$

$$\tilde{r}_{ab} = (0.7{,}0.9{,}1)$$

While for the negative ideal criteria, normalization of decision matrices can be calculated as follows:

For i = 5 on C8 belongs to alternative A1, for example a = A1 and b = C8:

$l_b^- = min_i(1.6{,}1.1{,}1.8{,}1.7{,}2)$ so that $l_b^- = 1.1$

$$\tilde{r}_{ab} = \left(\frac{1.1}{1.6}, \frac{1.1}{1.6}, \frac{1.1}{1.6}\right)$$

$$\tilde{r}_{ab} = (0.69{,}0.69{,}0.69)$$

Step 6: Then, the normalized decision matrix will be weighted multiplied by the importance of weights obtained in step 3. Weighting the decision matrix can be calculated as follows:

For criterion C1 in alternative A1, for example, a = A1 and b = C1:

$$\tilde{v}_{ab} = (0.7{,}0.9{,}1) \times (0.9{,}1{,}1)$$

$$\tilde{v}_{ab} = (0.63{,}0.9{,}1)$$

Step 7: FPIS and FNIS have their respective values: $FPIS = (1{,}1{,}1)$dan $FNIS = (0{,}0{,}0)$

Step 8: At this stage, each alternative in the weighted decision matrix will be calculated: the distance to the ideal fuzzy positive solution (FPIS) and the negative fuzzy ideal solution (FNIS). Alternative distances to FPIS and FNIS for positive ideal criteria can be calculated as follows:

For C1 and C2 on A1, suppose:

$$a = A1, x = C1, y = C2$$

$$d_a^+ = \sum\left((v_{ax1}, v_{ax2}, v_{ax3}) - (1,1,1)\right) + \sum\left((v_{ay1}, v_{ay2}, v_{ay3}) - (1,1,1)\right)$$

$$d_a^+ = \left|\left((v_{ax1} - 1) + (v_{ax2} - 1) + (v_{ax3} - 1) + (v_{ay1} - 1) + (v_{ay2} - 1)\right) + (v_{ay3} - 1)\right|$$

$$d_a^+ = \left|\left((0.69 - 1) + (0.9 - 1) + (1 - 1) + (0.63 - 1) + (0.93 - 1) + (1 - 1)\right)\right|$$

$$d_a^+ = 0.91$$

$$d_a^- = \sum\left((v_{ax1}, v_{ax2}, v_{ax3}) - (0,0,0)\right) + \sum\left((v_{ay1}, v_{ay2}, v_{ay3}) - (0,0,0)\right)$$

$$d_a^- = \left|\left((v_{ax1} - 0) + (v_{ax2} - 0) + (v_{ax3} - 0) + (v_{ay1} - 0) + (v_{ay2} - 0)\right)\right|$$

$$d_a^- = \left|\left((0.69 - 0) + (0.9 - 0) + (1 - 0) + (0.69 - 0) + (0.93 - 0) + (1 - 0)\right)\right|$$

$$d_a^- = 5.09$$

So that the distance between FPIS and FNIS can be seen in Tables 6 and 7.

Table 6: Alternative Distance to FPIS

Criteria	A1	A2	A3	A4	A5
C1	0.47	0.44	0.79	0.79	1.51
C2	0.44	1.03	0.41	0.47	1.03
C10	1.1	1.27	1.1	0.95	1.12
C3	2	1.5	2.76	2	2
C8	1.56	0.9	1.44	1.65	1.86
Distance	5.57	5.14	6.5	5.86	7.52

Table 7: Alternative Distance to FNIS

Criteria	A1	A2	A3	A4	A5
C1	2.53	2.56	2.21	2.21	1.49
C2	2.56	1.97	2.59	2.53	1.97
C10	1.9	1.73	1.9	2.05	1.88
C3	1	1.5	0.24	1	1
C8	1.44	2.1	1.56	1.35	1.14
Distance	9.43	9.86	8.5	9.14	7.48

Step 9: The distance of each alternative to the ideal positive fuzzy solution and the ideal negative fuzzy solution will be calculated for the proximity of the ideal solution so that the results can be seen in Table 8. Alternative closeness to the ideal solution can be calculated as follows:

For alternative A1, where a = A1

$$S_i = \frac{d_i^-}{d_i^- + d_i^+}$$

$S_a = \frac{9.39}{9.39+5.61}$ so that $S_a = 0.626$

Table 8: Proximity to ideal solutions

Distance	A1	A2	A3	A4	A5
di+	5.57	5.14	6.5	5.86	7.52
di-	9.43	9.86	8.5	9.14	7.48
di- + di+	15	15	15	15	15
Si	0.629	0.657	0.567	0.609	0.499

Step 10:At this stage, an alternative closeness to the ideal solution will be ranked based on the values obtained to determine the best alternative. The higher the value obtained by the alternative, the better. Ranking results can be seen in Table 9.

Table 9: Alternative ranking results

Ranking	Alternative	Point
1	A1	0.657
2	A2	0.629
3	A4	0.609
4	A3	0.567
5	A5	0.499

4.3 Implementation

The user of this application can input directly into a text box on what kind of food they want; then they can choose such criteria that they prefer and its importance criteria. There are seven levels of importance criteria that can be selected (Very Low, Low, Medium Low, Medium, Medium High, High, and Very High). The application will display the culinary places that meet the condition and rank it from the highest to lowest; the rank image is displayed from left to right. The app will also view the map and how to reach that place when the picture is clicked. The application image can be seen in Fig. 1.

4.4 System Testing

To test the system, black-box testing was used to validate the system in making recommendations by comparing the results of expectations (expert judging) with system output. We used 20 different tests, that cover different criteria, and their weight and calculates the score value with the formula:

$$Score = \frac{Total\ passed\ case}{total\ case} \quad (14)$$

Table 10 shows number 1 of 20 test cases that have been done; overall result evaluation shows that this system scored 75%, meaning that there were 15 cases that had the same result between system output and expert judgment.

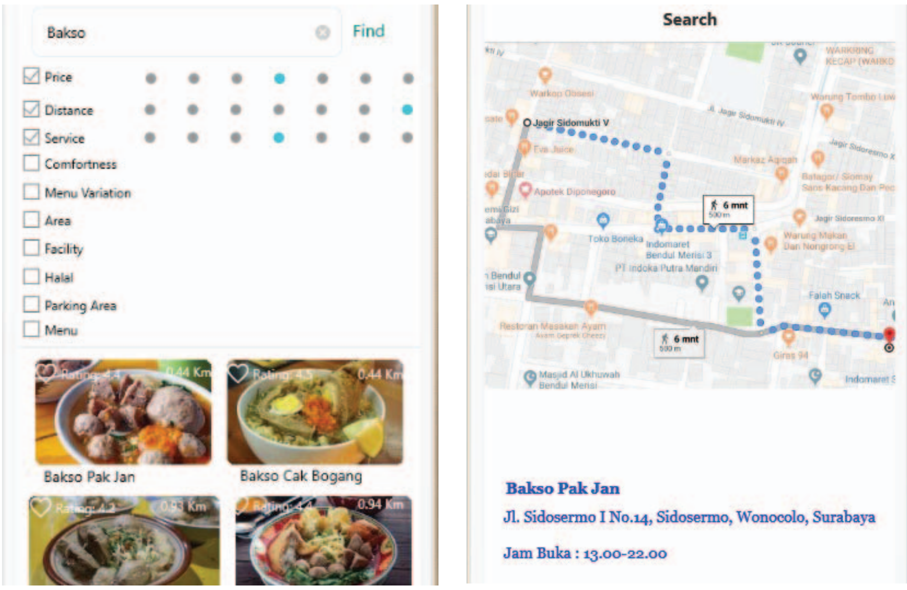

Fig. 1: The Application.

Table 10: Recommendation results

Test Case	Criteria	Weight	System Output	Experts
1	Price	Medium	Rank:	Rank:
	Distance	Very High	1.Bakso P.Jan	1.Bakso P.Jan
	Service	Medium	2.Bakso Cak Bagong	2.Bakso Cak Bagong
			3.Bakso Jenggot	3.Bakso Jenggot
			4.Bakso Bringas	4.Bakso Bringas
			5.Bakso Cak Man	5.Bakso Cak Man

4.5 System Evaluation

The system evaluation aims to determine the performance accuracy of the Fuzzy TOPSIS method as a decision support system for selecting culinary locations. System evaluation will be carried out by measuring user satisfaction with the system. The users were application users and experts who conduct culinary location selection. The categories used in the evaluation questionnaire are usability, accuracy, functional completeness, performance, and subjective assessment of users of the system as a whole (overall). Each category asked in the questionnaire will calculate the MOS (Mean Opinion Score) value. MOS calculations are used to conclude the ratings given by the user. The application is said to be useful if it has a value of 3 to 4. MOS formula can be seen below:

$$MOS = \frac{\sum_{n=0}^{N} R_n}{N} \quad (15)$$

where R is the individual rating of subject *N* for stimulus or *n* related factor.

This application was evaluated by twenty end-users and five experts; evaluation results show that usability, completeness, accuracy, performance, and overall category each scored 3.5, 3.5, 3.5, 3.65, and 3.6. The MOS results for each category are then calculated with MOS so that the overall system score is obtained. The calculation for the overall system score is as follows:

$$System\ score = \frac{3.5 + 3.5 + 3.5 + 3.65 + 3.6}{5} = 3.55$$

From the results of the system score calculation, it was found that twenty-five system users gave a value of 3.55 from the total value of 4. Therefore, it can be concluded that the system is useful.

5. CONCLUSION

The decision support system with the Fuzzy TOPSIS method helps users by identifying the essential criteria in the process of selecting culinary destinations. These criteria were the convenience, a variety of menu, price, distance, parking area, facilities, services, area, halal, and type of menu. In these criteria, there are three types of values, namely linguistic, crisp, and filter. Linguistic use for criteria that are not exact values, crisp values use for criteria in the form of exact values, while filter values use for optional type criteria, which serve as an alternative filter for culinary destinations. The user's level of importance then determines the non-filter criteria. The level of importance of the criteria and assessment of alternative culinary destinations is processed by the Fuzzy TOPSIS method, and the system will display five culinary destinations with the best ranking as recommendations to users as the best culinary destination choice according to their preferences.

Decision support systems that are built have a high impact on solving the problem of choosing culinary destinations by providing recommendations on culinary destinations that suit the needs and preferences of users. This is evidenced by the results of a system testing and evaluation, which shows that 75% of system output has the same result as expected result, and the user considers the features provided in the decision support system with the TOPSIS Fuzzy method worth 3.55 out of 4.

In this study, the app is built with minimal features for end-users so that for further development, it is recommended that this application also has a user-based community where all users can post a review, comments, and also rate so that the performance rating of each alternative can be determined. This feedback can be related to culinary destinations so that this application can be an effective and unbiased platform for people who need culinary destinations recommendation.

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