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Recommendation System Coffee Shop using AHP and TOPSIS Methods

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***Abstract*— Indonesian people generally like to spend time with friends, family and business colleagues while drinking coffee. This habit of consuming coffee can not only be done at home, but can also be done in other places such as traditional and modern coffee shops. This has also significantly influenced the growth of coffee shops, especially in Tangerang. So people are faced with so many choices and alternative coffee shops to visit. This research was conducted to create a system that can recommend coffee shops in Tangerang based on priority criteria input by the user. Therefore, this recommendation system uses the Multi Criteria Decision Making (MCDM) method, where the process of making decisions is based on several criteria. This research uses the method Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). This research was tested using the Usefulness, Satisfaction, and Ease of Use (USE) Questionnaire and received a very good rating with an overall score of 87.6%, so the conclusion was that the average respondent felt helped by this recommendation system.**

***Index Terms*— AHP; Coffee Shops; Recomendation System; TOPSIS; USE Questionnaire**.

I. INTRODUCTION

Nowadays coffee is no longer considered just a commodity, but has become a lifestyle. The International Coffee Organization (ICO) released data that the amount of coffee consumption in Indonesia increased by 4.04% in the 2021 period to 5 million 60 kg bags from previously 4.81 million 60 kg bags [1]. The increase in the amount of coffee consumption of Indonesian people is also in line with the increase in the number of coffee shops. Toffin released research stating that there was an increase in the number of coffee shops in big cities in Indonesia almost 3 times, from 1000 in 2016 to 2950 in 2019 [2]. Coffee shop growth also occurred significantly in Tangerang in general and South Tangerang in particular. The Tourism Office states that at least 600 coffee shops have been registered [3].

Previous research was carried out by Bambang Hermanto who designed a coffee shop recommendation system in the city of Yogyakarta using the collaborative filtering method [4]. According to Laksana, the collaborative filtering method is more suitable for situations where data is not classified based on specified criteria, because this method obtains recommendation results based on different user preferences and is not limited by the specified criteria [5]. In this way, collaborative filtering does not work with explicit criteria input by the user, so it requires another algorithm that can accept user input in the form of priority criteria. Therefore, this recommendation system uses the Multi Criteria Decision Making (MCDM) method, where the process of making decisions is based on several criteria. Methods that use MCDM include Analythical Hierarchy Process (AHP), Elimination Et Choix TRaduisant la reality (ELECTRE), and Simple Additive Weighting (SAW) [6]. So when comparing the three methods, Fernandes stated that the electre method was easier to implement but could not provide results with high accuracy like the AHP method [7]. Meanwhile, according to Saputra, the AHP method makes it easier to find weighting values compared to the SAW method [8].

Therefore, the AHP method was chosen to identify the weights for each criterion combined with the TOPSIS algorithm. The TOPSIS algorithm was chosen because the selected alternative not only has the closest distance to the positive ideal solution, but also the furthest to the negative ideal solution [9]. TOPSIS calculations are also not complicated, easy to understand, and can determine the value of each alternative with easy calculations [10]. So this research was carried out using the AHP-TOPSIS method, a combination of the two methods was also chosen because AHP has advantages in pairwise comparison matrices and consistency analysis, while TOPSIS is able to make decisions effectively and efficiently, because it is simple in concept, computationally efficient, and has the ability to measure performance. relative to each decision alternative [11]. In this research, AHP was used to weight each criterion, while TOPSIS was used to find the preference value for each coffee shop alternative. Based on interviews with experts, there are 4 criteria used, namely taste, price, service and atmosphere.

The website created must also be ensured to have quality standard so several questionnaire methods were compared, such as System Usability Scale (SUS), End User Computing Satisfaction (EUCS) and Usefulness,

Satisfaction, and Ease of Use (USE) Questionnaire.The SUS method is useful and easy to learn and use products [12]. EUCS method focuses more on user satisfaction, such as accuracy and format [13]. USE Questionnaire can measure various aspects of usability, including usability, user satisfaction, ease of use, and ease of learning, which can provide a more comprehensive understanding of the user experience of the information system [14]. The USE questionnaire also covers the ISO 9241 standard, namely usability is relevant to effective, efficient and user satisfaction measurements [15]. So the USE Questionnaire is used as a method for system evaluation.

II. LITERATURE REVIEW

A. Recommendation System for Coffe Shop

A recommendation system is a program that recommends the most suitable alternative by predicting a user's preference for an alternative based on information relating to the alternative, the user, and the interaction between the alternative and the user [16]. The way the recommendation system works is that user enters input which is then processed using a certain algorithm, and the results are returned to user as a recommendation of a particular alternative based on user preferences [17].

In general, Indonesian people who like to gather spend their time drinking coffee. Apart from being able to drink coffee at home, it can also be done in other places such as coffee shops, both traditional and modern [18]. Coffee shops are places that Indonesian people use to joke around, discuss together or just to soothe tired minds [19].

B. Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a method that works by weighting each criterion used. The criteria weight values are generated from calculations by comparing each criterion in pairs [20].

AHP has basic principles for solving a problem, namely[21]:

1) *Building a Hierarchy*
   Hierarchies are composed of criteria and alternatives which are fragments of a complex system.
2) *Make pairwise comparisons*
   Pairwise comparisons are made to assess criteria, the comparison scale can be seen in the table I.
3) *Synthesis*
   Several things are done at this stage, namely:
   a) Adds each value in a column in the matrix.
   b) Find the normalized value in the matrix by dividing each value in a column by the sum of all the values in that column.
   c) Adds up each value in each row, then divides by the total elements to produce an average value.

TABLE I. TABLE PAIRWISE COMPARISON SCALE

Scale	Description
1	Criterion X has the same effect as criterion Y
3	Criterion X is slightly more important than criterion Y
5	Criterion X is more important than criterion Y
7	Criterion X is clearly more important than criterion Y
9	Criterion X is absolutely more important than criterion Y
2, 4, 6, 8	For two adjacent values

4) *Measuring Consistency*
   The consistency value is measured by carrying out the following steps:
   a) Multiplies the value in the first column by the priority value of the first element, and continues until the last element.
   b) Sums each row and then divides by the priority value of that element.
   c) Add up the quotients in the previous point, then divide by the number of elements to get the value λ_{max}.
   d) Find the consistency index (CI) value based on the formula:

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (1)$$

   Where n is the size of the matrix.
   e) Calculate the consistency ratio (CR) value based on the formula:

$$CR = \frac{CI}{IR} \quad (2)$$

   With IR is Index Random Consistency
   f) Checking consistency in the hierarchy
   If the consistency ratio (CR) value obtained is less than 0.1 then the results of the calculation can be declared consistent and the weight values can be used [22].

C. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The TOPSIS method is used to determine the available alternatives, where the selected alternative must have the shortest distance from the positive ideal solution and the farthest from the negative ideal solution [9]. The solution algorithm used in the TOPSIS method is [23]:

a) Create a normalized decision matrix using the equation below:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (3)$$

With i=1,2,3,...,m and j=1,2,3,...,n.

b) Constructing a weighted normalized matrix The positive ideal solution (A+) and also the negative ideal solution (A−) are obtained based on the normalized weight value (yij) as in the formula below:

$$y_{ij} = w_i r_{ij} \quad (4)$$

With w=eigenvector; i=1,2,3,...,m and j=1,2,3,...,n.

c) Determining positive and negative ideal solutions The positive (A+) and negative (A−) ideal solution matrices are obtained based on the following equation:

$$A^+ = (y_1^+, y_2^+, y_3^+, .., y_n^+) \quad (5)$$

$$A^- = (y_1^-, y_2^-, y_3^-, .., y_n^-) \quad (6)$$

d) Find the distance from each decision alternative to the positive ideal solution and negative ideal solution. Calculation of the distance from alternative Ai to the positive ideal solution is carried out using the following formula:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_i^+ - y_{ij})^2} \quad (7)$$

With i = 1,2,3,..,m.
Calculation of the distance from alternative A_i to the negative ideal solution is carried out using the following formula:

$$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^-)^2} \quad (8)$$

With i = 1,2,...,m.

e) Find the preference value for each alternative To determine the preference value for each alternative (V_i) can be seen in the following formula:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (9)$$

With i = 1,2,3,..,m.

III. RESEARCH METHODOLOGY

A. Requirement and Design

Coffee shop data needs from the pergikuliner website which contains names, pictures, list food and drink menus, locations and ratings. The assessment is in the form of a rating of taste, price, service and atmosphere. 50 coffee shop data were taken. This stage is the stage where all the results of the analysis and discussion of system specifications are applied into a system design.

1) *Flowchart Home User*: Flowchart Home User is on the home page/home that user sees when opening the Tangerang Coffee website.

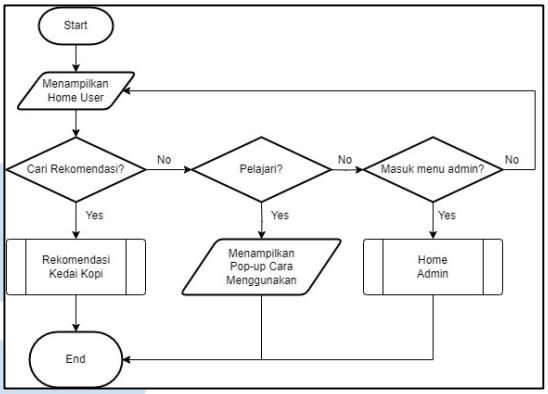

Fig 1. *Flowchart* Home User

2) *Flowchart Home Admin*: Flowchart Home Admin is on the home page which is seen when the admin successfully login using his account. On this page a list of coffee shops is displayed, search bar, search button, button delete search bar. 2.

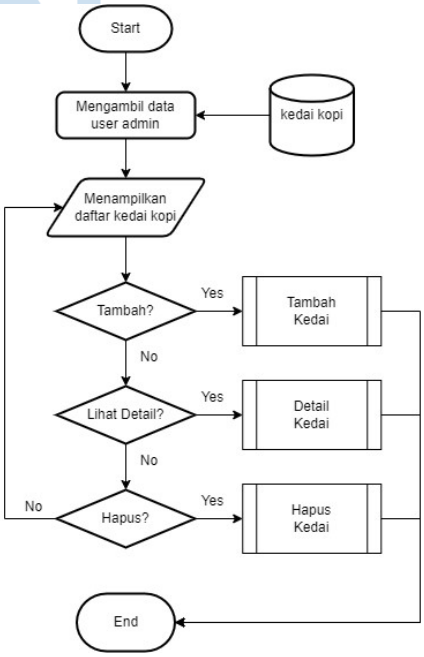

Fig 2. *Flowchart* Home Admin

IV. Results and Discussion

A. Interface Display

1) *Home User*: The image 3 is the result of implementing the display on the user's home page based on the mockup design that has been created. This page is the first page the user sees when opening the website. Displays an admin button to enter the admin menu, a start button to enter the criteria preferences menu and a learn button to display a pop-up on how to use the website.

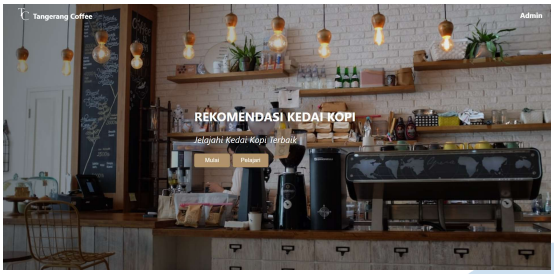

Fig 3. Home User

2) *Criteria Preference*: The image 4 is the result of implementing the display on the criteria preference page based on the mockup design that has been created. Displays a comparison of each criterion for users to input values based on their personal preferences and a search button to process user input.

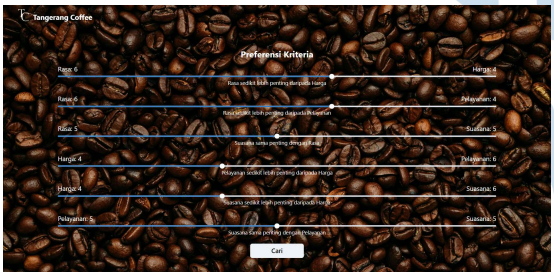

Fig 4. Criteria Preferences

B. AHP Method Calculation

1) *Creating a Criteria Pairwise Comparison Matrix:* The table II is a pairwise comparison of criteria entered by the user. Where each existing criterion is compared one by one. with calculation: Comparison of K1 with K2 = K1 − K2 + 1 = 3

TABLE II. Criteria Pairwise Comparison

Kode	Kriteria	Nilai	Nilai	Kriteria	Kode
K1	Rasa	6	4	Harga	K2
K1	Rasa	6	4	Pelayanan	K3
K1	Rasa	5	5	Suasana	K4
K2	Harga	4	6	Pelayanan	K3
K2	Harga	4	6	Suasana	K4
K3	Pelayanan	5	5	Suasana	K4

Because K1 > K2, then the ratio K1/K2 = 3/1 and the ratio K2/K1=1/3 or 0.333. The process is continued until all criteria are compared. If all criteria have been compared, then the pairwise comparison matrix of criteria has been successfully formed as in Table III.

TABLE III. Criteria Pairwise Comparison Matrix

	K1	K2	K3	K4
K1	1	3	3	1
K2	0,333	1	0,333	0,333
K3	0,333	3	1	1
K4	1	3	1	1
Total	2,667	10	5,333	3,333

2) *Normalization of Criteria Pairwise Comparison Matrix:* The next step is to normalize the pairwise comparison matrix of criteria. The normalization process is carried out by:
r_{11} = 1/2.667 = 0.375
r_{21} = 0.333/2.667 = 0.125
r_{31} = 0.333/2.667 = 0.125
r_{41} = 1/2.667 = 0.375
This process is continued until all rows are normalized, so that the results are as in table IV

3) *Determining the Weight of Each Criteria:* The next step is to determine the weight or eigenvector for each criterion in the following way:

$$\text{eigenVector}_1 = \frac{0.375 + 0.3 + 0.563 + 0.3}{4} = 0.384$$

$$\text{eigenVector}_2 = \frac{0.125 + 1 + 0.063 + 0.1}{4} = 0.097$$

$$\text{eigenVector}_3 = \frac{0.125 + 0.3 + 0.188 + 0.3}{4} = 0.228$$

$$\text{eigenVector}_4 = \frac{0.375 + 0.3 + 0.188 + 0.3}{4} = 0.291$$

So the eigenvector values can be seen in the table V

TABLE IV. Normalization of Criteria Pairwise Comparison Matrix

	K1	K2	K3	K4
K1	1	3	3	1
K2	0,375	0,3	0,563	0,3
K3	0,125	1	0,063	0,1
K4	0,375	0,3	0,188	0,3
Total	1	1	1	1

TABLE V. Determining the Weight of Each Criteria

Alternative	Total	Eigen Vector
K1	1,538	0,384
K2	0,388	0,097
K3	0,913	0,228
K4	1,163	0,291

4) *Measuring Consistency:* Measuring the consistency value begins by finding the λMax value by adding up all the multiplication results between each value in the eigen vector with the total value of each criterion based on the pairwise comparison

matrix of criteria. The λMax value that has been obtained is then reduced by the number of existing criteria and the results of this reduction are divided by the difference between the number of existing criteria and 1 to get the consistency index (CI) value. The final step in measuring consistency is to divide the CI value by the random index value for a matrix of size 4 to get the consistency ratio value. All these calculations are explained in the following calculations:

$$\lambda Max = (0.384 * 2.667) + (0.097 * 10) + (0.228 * 5.333) + (0.291 * 3.333) = 4.179$$

$$CI = \frac{4.179 - 4}{4 - 1} = \frac{0.179}{3} = 0.060$$

$$CR = \frac{0.060}{0.9} = 0.066$$

CR ≤ 0.1 (consistent)

If the CR value obtained is considered consistent, then the calculation process can be continued using the TOPSIS method.

C. TOPSIS Method Calculation

1) *Creating a Decision Matrix:* The first step in TOPSIS is to create a decision matrix obtained from alternative coffee shops and the weight value of each predetermined criterion. The decision matrix can be seen in Table VI. The table VI displays 4 alternatives as a representation of the 50 alternatives in the database, for calculations the method still uses 50 alternatives.

TABLE VI. DECISION MATRIX

Alternative	K1	K2	K3	K4
A1	4,2	3,7	3,9	4,1
A2	3,7	3,7	3,8	4,2
A3	4,3	3,9	4,4	4,6
A4	4,4	4	4,2	4,4

2) *Decision Matrix Normalization:* The decision matrix is then normalized by dividing each value by the square root of the sum of all values in that column squared. The decision matrix normalization process is described in the following calculations:

$$r_{11} = \frac{4,2}{\sqrt{4,2^2 + 3,7^2 + 4,3^2 + 4,4^2 + .. n^2}} = 0.056$$

$$r_{21} = \frac{3,7}{\sqrt{4,2^2 + 3,7^2 + 4,3^2 + 4,4^2 + .. n^2}} = 0.049$$

$$r_{31} = \frac{4,3}{\sqrt{4,2^2 + 3,7^2 + 4,3^2 + 4,4^2 + .. n^2}} = 0.057$$

$$r_{41} = \frac{4,4}{\sqrt{4,2^2 + 3,7^2 + 4,3^2 + 4,4^2 + .. n^2}} = 0.059$$

The calculation is continued for each criterion/column in the matrix. The results of the Decision Matrix Normalization can be seen in Table VII. Table VII only displays 4 alternatives out of 50 alternatives in the database, for calculations the method still uses 50 alternatives.

TABLE VII. DECISION MATRIX NORMALIZATION

Alternative	K1	K2	K3	K4
A1	0.145	0.136	0.134	0.138
A2	0.128	0.136	0.130	0.142
A3	0.149	0.143	0.151	0.155
A4	0.152	0.147	0.144	0.149

3) *Normalization of Weighted Decision Matrix:* The next process is Normalization of the Weighted Decision Matrix. This is done by multiplying each criterion value of all alternatives in the normalized decision matrix by the eigenvector of that criterion which has been obtained from the AHP process as follows:

$$y_{11} = 0.145 * 0.384 = 0.056$$
$$y_{21} = 0.128 * 0.384 = 0.049$$
$$y_{31} = 0.149 * 0.384 = 0.057$$
$$y_{41} = 0.152 * 0.384 = 0.059$$

The calculation is continued for each criterion / column in the matrix so that the normalization results of the weighted decision matrix are obtained as in Table VIII. Table VIII only displays 4 alternatives out of 50 alternatives in the database, for calculations the method still uses 50 alternatives.

TABLE VIII. NORMALIZATION OF WEIGHTED DECISION MATRIX

Alternative	K1	K2	K3	K4
A1	0.056	0.013	0.031	0.040
A2	0.049	0.013	0.030	0.041
A3	0.057	0.014	0.034	0.045
A4	0.059	0.014	0.033	0.045

4) *Searching for Positive and Negative Ideal Solutions:* After normalizing the weighted decision matrix, the next step is to look for positive and negative ideal solutions. The positive ideal solution is obtained from the largest value for each criterion from all alternatives, while the negative ideal solution is obtained from the smallest value for each criterion from all alternatives. The process is as follows:

$$A_1^+ = max(0.056,0.049,0.057,0.059, n5, n6, \dots, n50) = 0.061$$
$$A_1^- = min(0.056,0.049,0.057,0.059, n5, n6, \dots, n50) = 0.048$$

n50 in this process is intended as the 50th data because calculations are carried out on 50 alternative data. This process is continued for each criterion in the matrix. The results can be seen in Table IX.

TABLE IX. POSITIVE AND NEGATIVE IDEAL SOLUTIONS

Ideal Solution	K1	K2	K3	K4
A+	0.061	0.016	0.036	0.046
A-	0.048	0.011	0.027	0.035

5) *Finding the Distance between Positive and Negative Ideal Solutions:* Finding the distance to a positive ideal solution is done by adding up the difference between the criteria values for the alternative and the positive ideal solution squared, the results are then rooted. Meanwhile, the negative ideal solution is obtained by adding up the difference between the criteria values for the alternative and the negative ideal solution squared, then the results are then rooted. The calculation process can be seen as follows:

$$D_1^+ = \sqrt{(0.056-0.061)^2+(0.013-0.016)^2} + (0.031-0.036)^2+(0.040-0.046)^2$$
$$= \sqrt{0.000025+0.000009+0.000025+0.000036}$$
$$= \sqrt{0.000095}$$
$$= 0.010$$

$$D_1^- = \sqrt{(0.056-0.048)^2+(0.013-0.011)^2} + (0.031-0.027)^2+(0.040-0.035)^2$$
$$= \sqrt{0.000064+0.000004+0.000016+0.000025}$$
$$= \sqrt{0.000109}$$
$$= 0.010$$

The calculation is continued for each alternative, so that the distance results for positive and negative ideal solutions are obtained in Table X. Table X shows 4 alternatives out of 50 alternatives that were calculated.

TABLE X. DISTANCE OF POSITIVE AND NEGATIVE IDEAL SOLUTIONS

Alternative	D+	D-
A1	0.010	0.010
A2	0.015	0.007
A3	0.005	0.016
A4	0.005	0.015

6) *Searching for Preference Values:* The preference value is obtained from the distance to the negative ideal solution divided by the sum of the distances to the positive and negative ideal solutions. The preference values are then sorted from highest to lowest. The calculation process is as follows:

$$V_1 = \frac{0.010}{0.010+0.010} = 0.499$$
$$V_2 = \frac{0.007}{0.007+0.015} = 0.316$$
$$V_3 = \frac{0.016}{0.016+0.005} = 0.754$$
$$V_4 = \frac{0.015}{0.015+0.005} = 0.728$$

From this process, the preference value and ranking of each alternative is obtained in Table XI. The table XI shows 4 alternatives out of 50 alternatives in the database.

TABLE XI. PREFERENCE VALUES AND RATINGS

Alternatives	Preferences	Ratings
A1	0.499	29
A2	0.316	48
A3	0.754	1
A4	0.728	2

From Table XI, the data can be sorted from highest to lowest preferences as in Table XII. Based on Table XII it can be concluded that the G8 Coffee & Eatery coffee shop is the coffee shop that best suits user preferences, followed by Kopi Aah in second position and Black Campaign Coffee in third position. Table XII shows 4 alternatives out of 50 alternatives in the database.

TABLE XII. LIST OF COFFEE SHOPS BASED ON ORDER OF PREFERENCE VALUE

Alternatives	Coffee Shops	Preferences
A3	G8 Coffee & Eatery	0.754
A4	Aah Coffee	0.728
A6	Black Campaign Coffee	0.717
A11	Volks Coffee	0.705

The list of coffee shops based on manual calculation preference order in Table XII can be compared with Figure 5 which is the result of system calculations. It can be seen that both lists show accurate store order and preference values.

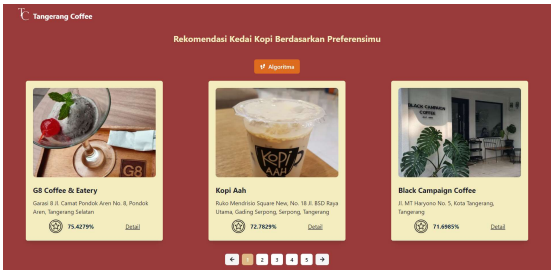

Fig. 5. Display of System Calculation Results

D. Evaluation System

The USE Questionnaire method which is divided into 4 parts, namely usefulness, ease of use, ease of learning, and satisfaction. The results of the questionnaire were filled in by 31 respondents, overall value are displayed:

TABLE XIII. CALCULATION PERCENTAGE CONVERSION RESULTS

Section	Percentage Calculation Results	Remarks
Usability	86.5%	Very Good
Convenience	87.3%	Very Good
Ease of Learning	88.7%	Very Good
Satisfaction	87.7%	Very Good
Overall	**87.6%**	**Very Good**

V. CONCLUSION

A recommendation system that uses the AHP method for weighting criteria and TOPSIS to find preference values to display recommendations for coffee shops in the Tangerang area according to user preferences and priorities was successfully built. questionnaires distributed for age start from 17-35 years old and have experienced come to coffe shop in Tangerang area. Testing and evaluation of the system was carried out by distributing questionnaires made based on the USE Questionnaire method to 31 respondents with a percentage of usefulness values of 86.5%, ease of use values of 87.3%, ease of learning values of 88.7%, and a satisfaction score of 87.7%, resulting in an overall score percentage of 87.6% with a very good predicate.

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