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Analysis of Customer Satisfaction Survey on E-Wallets Using Simple Additive Weighting and TOPSIS Methods

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Abstract: Understanding customer's behaviors has an important role in business. The customer's behaviors dramatically change in line with technology development. In this modern era, customers buy goods no longer by cash payment but by electronic payment. E-wallet (electronic wallet) is a form of Fintech (Finance Technology) that utilizes internet and is used as an alternative payment method such as Funds, Shopeepay, Gopay, Ovo, Sakuku. In this study, the researchers examined which one had the high rate of the e-wallet customer satisfaction using the SAW and TOPSIS methods. Both methods were able to make more accurate assessments and predetermined preference weights. After the method implementation was done, it was concluded that the customer satisfaction surveys on e-wallet applications by using the SAW and TOPSIS methods showed the same results, that is, the first highest was DANA, the second was Shopeepay, the third was Gopay, the fourth was OVO, and the fith was Sakuku. Based on those results, the SAW and TOPSIS methods were recommended for use because they have relevant results.

Keywords: *e-wallet; customers; SAW, TOPSIS.*

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1 Introduction

Understanding customer's behaviors has an important role in business. The customer's behaviors dramatically change in line with technology development. In the past era, customers bought goods using cash payments. In this modern era or nowadays, customers buy goods no longer by cash payments. The payments are made electronically. The electronic payment system is an alternative payment system making it easier for consumers to make payments via the internet network [1].

Digital wallets or e-wallets are used for various things, particularly for money transfers. There are various uses of e-wallets, including e-wallets used to transfer funds between banks and between accounts, e-wallets used to pay various bills (for example, electric bills, telephone bills, etc.), e-wallets used to buy pulses or data packages, and those used as a place to save money known as savings. There are various types of e-wallets available in the community, that is, Dana, Shopeepay, Gopay, Ovo, and Sakuku.

The use of the Simple Additive Weighting (SAW) method is due to the fact that this method is able to provide more accurate estimates [2], [3], [4] and forecasts [5], [6], [7] assessment based on predetermined criteria values and preference weights. Besides, the Simple Additive Weighting (SAW) method can also determine the best alternative among several existing alternatives [8], [9], [10]. It does ranking process after determining the weight for each attribute. This study also used the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method for its higher accuracy in determining the results.

2 Literature Review

2.1 The simple additive weighting (SAW)

The SAW (Simple Additive Weighting) method is often called the weighted sum method. The basic concept of the SAW method is to find a weighted sum of performance ratings for each alternative on all attributes [11], [12]. The SAW method requires the process of normalizing the decision matrix (x) to a scale that can be compared with all existing alternative ratings.

2.2 The SAW method procedure

1. Determine the criteria to be used as a reference in decision making, namely C_i.
2. Determine the suitability rating of each alternative for each criterion.
3. Make a decision matrix formed from a match table, according to the given preference weights.
4. The final result is obtained from the ranking process, namely the sum of the multiplication of the normalized matrix R with the weight vector so that the largest value is selected as the best alternative (A_i) as a solution.

The formula for doing normalization is as follows:

$$r_{ij} \begin{cases} \frac{x_{ij}}{Max\ x_{ij}} \ if\ j : atribute\ of\ benefit, \\ \frac{Min\ x_{ij}}{x_{ij}} \ if\ j : atribute\ of\ cost, \end{cases} \tag{1}$$

where r_{ij} is the normalized performance rating of A_i alternative on the C_j atrribute, $i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n$. The preference value for each alternative (V_i) is given as

$$V_i = \sum_{j=1}^{n} w_j r_{ij}, \tag{2}$$

where V_i is the final value of the alternative, w_j is the predefined weight, r_{ij} is the normalised matrix. The higher value of V_i indicates that the alternative A_i is preferred.

2.3 Technique for order preference by similarity to ideal solution (TOPSIS) method

TOPSIS is based on the concept that the best chosen alternative not only has the shortest distance from the positive ideal solution but also has the longest distance from the negative ideal solution [13]. This concept is widely used in several MADM models to solve practical decision problems [13], [14], [15]. This is because the concept is simple and easy to understand, computation is efficient, and it has the ability to measure the relative performance of alternative decisions in a simple mathematical form.

2.4 The TOPSIS procedure

1. Make a normalized decision matrix.
2. Make the normalized decision matrix.
3. Determine the positive ideal solution matrix and the negative ideal solution matrix.
4. Determine the distance between the values of each alternative with the positive ideal solution matrix and the negative ideal solution one.
5. Determine the preference value for each alternative.

TOPSIS requires a performance rating for each alternative A_i on each normalized C_j criterion, that is,

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \tag{3}$$

$i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n$.

The positive ideal solution A^+ and the negative ideal solution A^- can be determined based on the normalized weight rating (y_{ij}) as follows:

$$y_{ij} = w_i r_{ij}, \tag{4}$$

$i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n$.

$$A^+ = \left(y_1^+, y_2^+, \ldots, y_n^+\right), \tag{5}$$

$$A^- = \left(y_1^-, y_2^-, \ldots, y_n^-\right) \tag{6}$$

with

$$y_j^+ \begin{cases} max\ y_{ij}; if\ j : atribute\ of\ benefit, \\ min\ y_{ij}; if\ j : atribute\ of\ cost, \end{cases}$$

$$y_j^- \begin{cases} max\ y_{ij}; if\ j : atribute\ of\ benefit, \\ min\ y_{ij}; if\ j : atribute\ of\ cost. \end{cases}$$

The distance between the alternative A_i and the positive ideal solution is formulated as follows:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_i^+ - y_{ij}\right)^2}; i = 1, 2, \ldots, m. \tag{7}$$

The distance between the alternative A_i and the negative ideal solution is formulated as follows:

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(y_{ij} - y_i^-\right)^2}; i = 1, 2, \ldots, m. \tag{8}$$

The preference value of each alternative (V_i) is given as

$$V_i = \frac{D_i^-}{D_i^- + D_i^+}; i = 1, 2, \ldots, m. \tag{9}$$

The higher value of V_i indicates that A_i is the preferred value.

2.5 E-wallet (digital wallet)

In Indonesia, an online-based payment system using electronic money (e-money) has been widely used. E-wallet (digital wallet) is a form of Fintech (Finance Technology) utilizing internet media and used as an alternative payment method such as Shopeepay, Funds, OVO, GoPsy, Sakuku. The E-wallet structure is as follows:

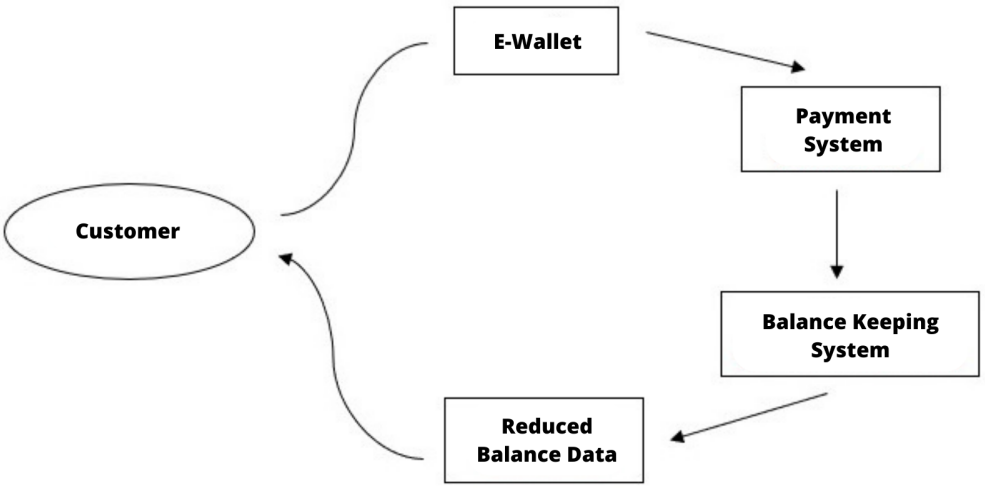

Figure 1: Source: niagahoster.co.id.

Based on the picture above, each customer has an e-wallet (digital wallet). After that, in the e-wallet feature, there is a payment system when a customer buys something. The e-wallet also has a balance storage system feature if the customer wants to save,

and the e-wallet can also view customer reduced balance data. The customer profile information is very meaningful for the company in relation to improving customer service and satisfaction.

3 Research Methodology

In this research, the Fuzzy Multiple Attribute Decision Making (FMADM) method was used by applying the Simple Additive Weighting (SAW) method and the Technique-for-Preference-by- Similarity-to-Ideal-Solution (TOPSIS) method.

In the SAW method, criteria and weights are required to do the calculations so as to obtain the best alternative. Simple Additive Weighting (SAW) is a weighted addition method. The basic concept of SAW is to find the weighted sum of the performance ratings for each alternative and criteria. The SAW method requires the process of normalizing the decision matrix (x) to a scale that can be compared with all existing alternative ratings. The SAW method recognizes the existence of 2 (two) attributes, that is, the criteria for benefits and the criteria for costs. The basic difference between these criteria is in the selection of decision-making criteria.

Meanwhile, the TOPSIS method requires a performance rating for each alternative A_i on each normalized C_j criterion. TOPSIS is based on the concept that the best chosen alternative is not only the shortest distance from the positive ideal solution, but also has the longest distance from the negative ideal solution.

In determining customer satisfaction with the e-wallets under study, criteria and weights are required to do the calculation so as to obtain alternatives. The following are the criteria needed for decision making, based on parameters in determining customer satisfaction with e-wallets.

Criteria	Description
C_1	Admin charge
C_2	Display
C_3	Accessibility
C_4	Topup Ease
C_5	Amount of Ballance Limit
C_6	Number of Payment functions

Table 1: Criteria.

Using these criteria, a level of importance of the criteria is determined based on the weight values that have been determined into fuzzy numbers. Next, the weight of each criterion is converted into a fuzzy number which is shown in Table 2.

Next, the weight of each criterion is converted into a fuzzy number as shown in Table 3.

4 Results and Discussion

The reference for the development of the decision support system (SPK) is based on researches commonly conducted on the e-wallet selection process. And in this study, each e-wallet was assessed based on criteria. This study used the Simple Additive Weighting

Value	Rating Scale
1	Very poor
2	Poor
3	Average
4	Good
5	Excellent

Table 2: Rating Scale.

Criteria	Description	Weight
C_1	Admin charge	$30\% = 0.3$
C_2	Display	$10\% = 0.1$
C_3	Accessibility	$10\% = 0.1$
C_4	Topup Ease	$25\% = 0.25$
C_5	Amount of Ballance Limit	$10\% = 0.1$
C_6	Number of Payment functions	$15\% = 0.15$

Table 3: Weight Criteria .

(SAW) method and the Technique for Preference by Similarity to Ideal Solution (TOPSIS) method, having criteria and weights to do calculations so as to obtain the best alternative.

Case sample:

The e-wallets to be studied were determined by taking those most in demand by the public and using several criteria such as admin charge, display, accessibility, topup ease, amount of balance limits, number of payment functions of the e-wallet.

In processing the research data, the researchers determined the completion steps in accordance with the Simple Additive Weighting (SAW) method, covering four stages, that is, determining the criteria to be used as a reference, determining the match rating of each alternative on each criterion, making a decision matrix, and ranking.

The criteria to be used as reference in decision making, that is, C_i, was determined as described in Chapter 2. There are six variables to be used as reference criteria to assess the customer satisfaction with the e-wallets by using the SAW method, namely admin charge, display, accessibility, topup ease, the amount of ballance limit, and the number of payment functions.

Below is the table listing the initials of the respondents along with the values of the assessment results received from the Google form. The value data for each respondent is then converted to a predetermined fuzzy number in Chapter 3, see Table 2.

4.1 Simple additive weighting (SAW) method

4.1.1 Determining match rating

The next step is to determine the match rating of each alternative for each criterion based on Table 4 contained in Chapter 4, as shown in Table 6.

E-Wallet	No	Average Value					
		C_1	C_2	C_3	C_4	C_5	C_6
Shopeepay	70	3.7142	3.8857	4.0714	3.8714	3.8142	4.0571
Dana	70	3.7142	4.0285	4.0857	4.0571	3.6714	4.0857
Ovo	70	3.4285	3.7142	3.7142	3.7571	3.5285	3.6571
Gopay	70	3.4142	3.7285	3.7714	4	3.5714	3.8857
Sakuku	70	3.3	3.3714	3.3428	3.3857	3.4285	3.3285

Table 4: Average Value.

Criteria	Description	Weight
C_1	Admin charge	$30\% = 0.3$
C_2	Display	$10\% = 0.1$
C_3	Accessibility	$10\% = 0.1$
C_4	Topup Ease	$25\% = 0.25$
C_5	Amount of Ballance Limit	$10\% = 0.1$
C_6	Number of Payment functions	$15\% = 0.15$

Table 5: Weight Criteria.

Alt	Average Value					
	C_1	C_2	C_3	C_4	C_5	C_6
A_1	3.7142	8.8857	4.0714	3.8714	3.8142	4.0571
A_2	3.7142	4.0285	4.0285	4.0571	3.6714	4.0857
A_3	3.4285	3.7142	3.7142	3.7571	3.5285	3.6571
A_4	3.4142	3.7285	3.7714	4	3.5714	3.8857
A_5	3.3	3.3714	3.3428	3.3857	3.4285	3.3285

Table 6: Match Rating.

4.1.2 Determining decision matrix

The following step for the formation of the decision matrix (x) made by referring to the table of the match rating of each alternative on each criterion is as follows:

$$X = \begin{pmatrix} 3.7142 & 8.8857 & 4.0714 & 3.8714 & 3.8142 & 4.0571 \\ 3.7142 & 4.0285 & 4.0285 & 4.0571 & 3.6714 & 4.0857 \\ 3.4285 & 3.7142 & 3.7142 & 3.7571 & 3.5285 & 3.6571 \\ 3.4142 & 3.7285 & 3.7714 & 4 & 3.5714 & 3.8857 \\ 3.3 & 3.3714 & 3.3428 & 3.3857 & 3.4285 & 3.3285 \end{pmatrix}.$$

Then, calculate the normalized value of each alternative with formula (1) as follows:

a. Criteria for Admin Charge (C_1):

$$r_{11} = \frac{3.7142}{3.7142} = 1, r_{21} = \frac{3.7142}{3.7142} = 1, r_{31} = \frac{3.4285}{3.7142} = 0.9230,$$

$$r_{41} = \frac{3.4142}{3.7142} = 0.9192, r_{51} = \frac{3.3}{3.7142} = 0.8884$$

so that the normalized value of the alternative production cost is obtained, then look for the normalized value of other alternatives.

b. Criteria for Display (C_2):

$$r_{12} = \frac{3.8857}{4.0285} = 0.9645, r_{22} = \frac{4.0285}{4.0285} = 1, r_{32} = \frac{3.7142}{4.0285} = 0.9291,$$

$$r_{42} = \frac{3.7285}{4.0285} = 0.9255, r_{52} = \frac{3.3714}{4.0285} = 0.8368$$

so that the normalized value of the alternative display is obtained, then find out the normalized value of another alternative.

c. Criteria for Accessibility (C_3):

$$r_{13} = \frac{4.0714}{4.0857} = 0.9965, r_{23} = \frac{4.0857}{4.0857} = 1, r_{33} = \frac{3.7142}{4.0857} = 0.9090,$$

$$r_{43} = \frac{3.7714}{4.0857} = 0.9263, r_{53} = \frac{3.3428}{4.0857} = 0.8181$$

so that the normalized value of the alternative accessibility is obtained, then find out the normalized value of another alternative.

d. Criteria for Topup Ease (C_4):

$$r_{14} = \frac{3.8714}{4.0571} = 0.9542, r_{24} = \frac{4.0571}{4.0571} = 1, r_{34} = \frac{3.7571}{4.0571} = 0.9260,$$

$$r_{44} = \frac{4}{4.0571} = 0.9859, r_{54} = \frac{3.3857}{4.0571} = 0.8345$$

so that the normalized value of the alternative Topup Ease is obtained, then find out the normalized value of another alternative.

e. Criteria for the Amount of Balance Limit (C_5):

$$r_{15} = \frac{3.8142}{3.8142} = 1, r_{25} = \frac{3.6714}{3.8142} = 0.9625, r_{35} = \frac{3.5285}{3.8142} = 0.9250,$$

$$r_{45} = \frac{3.5714}{3.8142} = 0.9363, r_{55} = \frac{3.4285}{3.8142} = 0.8988$$

so that the normalized value of the alternative amount of balance limit is obtained, then find out the normalized value of the other alternative.

f. Criteria for the Number of Payment Functions (C_6):

$$r_{16} = \frac{4.0571}{4.0857} = 0.9930, r_{26} = \frac{4.0857}{4.0857} = 1, r_{36} = \frac{3.6571}{4.0857} = 0.8950,$$

$$r_{46} = \frac{3.8857}{4.0857} = 0.9510, r_{56} = \frac{3.3285}{4.0857} = 0.8146$$

so that the normalized value of the alternative number of payment functions is obtained.

Then, the normalization results are made into the normalized matrix, while the normalized matrix R in this study is as follows:

$$R = \begin{pmatrix} 1 & 0.9645 & 0.9965 & 0.9542 & 1 & 0.9930 \\ 1 & 1 & 1 & 1 & 0.9625 & 1 \\ 0.9230 & 0.9219 & 0.9090 & 0.9260 & 0.9250 & 0.8950 \\ 0.9192 & 0.9255 & 0.9263 & 0.9859 & 0.9363 & 0.9510 \\ 0.8883 & 0.8368 & 0.8181 & 0.8345 & 0.8988 & 0.8146 \end{pmatrix}.$$

4.1.3 Ranking

The last step is to calculate the final preference value (V_i) obtained from the sum of the multiplication of the normalized matrix row elements (R) with the preference weight (W) while the weights used are as follows:

$$W = \{0.30; 0.1; 0.1; 0.25; 0.1; 0.15\}.$$

For the ranking process, use formula (2). Based on the results of the ranking above, it can be concluded that the results are ranked by the value of V, from the highest and smallest values, so that an alternative customer satisfaction survey for the e-wallets is obtained based on the highest value as shown in the following table:

No.	Alternative	The Final Result	Ranking
1	Shopeepay	0.9836	2
2	Dana	0.9962	1
3	Ovo	0.9183	4
4	Gopay	0.437	3
5	Sakuku	0.8527	5

Table 7: Ranking Results.

4.1.4 Description of research data analysis results

Among V_1, V_2, V_3, V_4, and V_5, the highest value is V_2 so that the alternative chosen and entitled to become an e-wallet with the highest customer satisfaction is $V_2 = 0.9962$. Funds with a resulted value of 0.9962 are based on calculations using the Simple Additive Weighting (SAW) method. It is concluded that Dana is the e-wallet with the highest customer satisfaction based on predetermined criteria. Then the most satisfied criterion or service is C_4 (Ease of Topup) with a higher average value compared to other criteria or services.

4.2 Technique of preference by similarity to ideal solution (TOPSIS) method

Processing the research data requires four stages, that is, determining the criteria to be used as a reference, determining the match rating, making a decision matrix, and ranking. In addition, there are also several steps for completion in accordance with the Topsis method procedure consisting of five steps given bellow.

1. Make the normalized decision matrix;

	Average Value					
	C_1	C_2	C_3	C_4	C_5	C_6
	4.0571	3.8142	3.8714	4.0714	3.8857	3.7142
	4.0857	3.6714	4.0571	4.0857	4.0285	3.7142
	3.6571	3.5285	3.7571	3.7142	3.7142	3.4285
	3.8857	3.5714	4	3.7714	3.7285	3.4142
	3.3285	3.4285	3.3857	3.3428	3.3714	3.3
Total	17.5771	18.7283	18.9855	19.0713	18.0140	19.0141
Average	3.5142	3.7456	3.7971	3.8142	3.6028	3.8028

Table 8: Ranking Results by Criteria or Services.

2. Make the weighted normalized decision matrix;
3. Determine the positive ideal solution matrix and the negative ideal solution matrix;
4. Determine the distance between the values of each alternative with the positive ideal solution matrix and the negative ideal solution matrix;
5. Determine the preference value for each alternative;

4.2.1 Determining match rating

In determining the match rating for the TOPSIS method, the same table is used as in finding out the match rating by the SAW method, that is, Table 6 which is obtained from Table 4 in Chapter 4.

4.2.2 Determining decision matrix

The next step is to form a decision matrix (x) made from the match rating table of each alternative on each criterion as follows:

$$X = \begin{pmatrix} 3.7142 & 3.8857 & 4.0714 & 3.8714 & 3.8142 & 4.0571 \\ 3.7142 & 4.0285 & 4.0857 & 4.0571 & 3.6714 & 4.0857 \\ 3.4285 & 3.7142 & 3.7142 & 3.7571 & 3.5285 & 3.6571 \\ 3.4142 & 3.7285 & 3.7714 & 4 & 3.5714 & 3.8857 \\ 3.3 & 3.3714 & 3.3428 & 3.3857 & 3.4285 & 3.3285 \end{pmatrix}.$$

Next, calculate the normalized value of each alternative:

$$|x_1| = \sqrt{(3.7142)^2 + (3.7142)^2 + (3.4285)^2 + (3.4142)^2 + (3.3)^2} = 7.8671,$$

$$r_{11} = 0.4721, r_{21} = 0.4721, r_{31} = 0.4358, r_{41} = 0.4340, r_{51} = 0.4195,$$

$$|x_2| = \sqrt{(3.8857)^2 + (4.0285)^2 + (3.7142)^2 + (3.7285)^2 + (3.3714)^2} = 8.3899,$$

$$r_{12} = 0.4631, r_{22} = 0.4802, r_{32} = 0.4427, r_{42} = 0.4444, r_{52} = 0.40818,$$

$$|x_3| = \sqrt{(4.0714)^2 + (4.0857)^2 + (3.7142)^2 + (3.7714)^2 + (3.3428)^2} = 8.5125,$$

$$r_{13} = 0.4783, r_{23} = 0.4800, r_{33} = 0.4363, r_{43} = 0.4430, r_{53} = 0.3927,$$

$$|x_4| = \sqrt{(3.8714)^2 + (4.0571)^2 + (3.7571)^2 + (4.000)^2 + (3.3857)^2} = 8.5456,$$

$$r_{14} = 0.4530, r_{24} = 0.4748, r_{34} = 0.4377, r_{44} = 0.4430, r_{54} = 0.4253,$$
$$|x_5| = \sqrt{(3.8142)^2 + (3.6714)^2 + (3.5285)^2 + (3.5714)^2 + (3.4285)^2} = 8.0615,$$
$$r_{15} = 0.4731, r_{25} = 0.4554, r_{35} = 0.4377, r_{45} = 0.4430, r_{55} = 0.4253,$$
$$|x_6| = \sqrt{(4.0571)^2 + (4.0857)^2 + (3.6571)^2 + (3.8857)^2 + (3.3285)^2} = 8.5267,$$
$$r_{16} = 0.4758, r_{26} = 0.4792, r_{36} = 0.4289, r_{46} = 0.4557, r_{56} = 0.3904.$$

Then the weighted normalized matrix or normalized matrix R is obtained, that is,

$$R = \begin{pmatrix} 0.4721 & 0.4631 & 0.4783 & 0.4530 & 0.4731 & 0.4758 \\ 0.4721 & 0.4802 & 0.4800 & 0.4748 & 0.4554 & 0.4792 \\ 0.4358 & 0.4427 & 0.4363 & 0.4397 & 0.4377 & 0.4289 \\ 0.4340 & 0.4444 & 0.4430 & 0.4681 & 0.4430 & 0.4557 \\ 0.4195 & 0.4018 & 0.3927 & 0.3962 & 0.4253 & 0.3904 \end{pmatrix},$$

$$W = \{0.30; 0.10; 0.10; 0.25; 0.10; 0.15\},$$
$$v_{11} = 0.1416, v_{21} = 0.1416, v_{31} = 0.1307, v_{41} = 0.1302, v_{51} = 0.1258,$$
$$v_{12} = 0.0463, v_{22} = 0.0480, v_{32} = 0.0443, v_{42} = 0.0444, v_{52} = 0.0402,$$
$$v_{13} = 0.0478, v_{23} = 0.0480, v_{33} = 0.0436, v_{43} = 0.0443, v_{53} = 0.0393,$$
$$v_{14} = 0.1133, v_{24} = 0.1187, v_{34} = 0.1099, v_{44} = 0.1170, v_{54} = 0.0990,$$
$$v_{15} = 0.0473, v_{25} = 0.0455, v_{35} = 0.0438, v_{45} = 0.0443, v_{55} = 0.0425,$$
$$v_{16} = 0.0714, v_{26} = 0.0719, v_{36} = 0.0643, v_{46} = 0.0684, v_{56} = 0.0586.$$

The matrix Y is

$$Y = \begin{pmatrix} 0.1416 & 0.0463 & 0.0478 & 0.1133 & 0.0473 & 0.0714 \\ 0.1416 & 0.0480 & 0.0480 & 0.1187 & 0.0455 & 0.0719 \\ 0.1307 & 0.0443 & 0.0436 & 0.1099 & 0.0438 & 0.0643 \\ 0.1302 & 0.0444 & 0.0443 & 0.1170 & 0.0443 & 0.0684 \\ 0.1258 & 0.0402 & 0.0393 & 0.0990 & 0.0425 & 0.0586 \end{pmatrix}.$$

The positive ideal solution (A^+) is calculated based on formula (5). So it is obtained as

$$A^+ = \{0.1416; 0.0480; 0.0480; 0.1187; 0.0473; 0.0719\}.$$

The negative ideal solution (A^-) is calculated based on formula (6). So it is obtained as

$$A^- = \{0, .258; 0.0402; 0.0393; 0.0990; 0.0425; 0.0586\}.$$

The distance between the weighted values of each alternative and the positive ideal solution can be found using formula (7). So it is obtained as

$$D^+ = \{0.0057; 0.0018; 0.0173; 0.0135; 0.0312\}.$$

The distance between the weighted values of each alternative and the negative ideal solution can be found using formula (8). So it is obtained as

$$D^- = \{0.0274; 0.0310; 0.0146; 0.0220; 0.0000\}.$$

4.2.3 Ranking

The last step is to calculate the final preference value (V_i) obtained from the previously calculated distance using formula (9).

So the closest ideal alternative solution is obtained as

$$V_1 = \frac{0.0274}{0.0274 + 0.0057} = 0,8272; V_2 = \frac{0.0310}{0.0310 + 0.0018} = 0.9459,$$

$$V_3 = \frac{0.0146}{0.0146 + 0.0173} = 0.4579; V_4 = \frac{0.0220}{0.0220 + 0.0425} = 0.6203,$$

$$V_5 = \frac{0.0000}{0.0000 + 0.0312} = 0.0000.$$

Based on the ranking of the V values of the highest through lowest values, it is obtained that

$$V_1 = 0.8272; V_2 = 0.9459; V_3 = 0.4579; V_4 = 0.6203; V_5 = 0.0000.$$

So, the best alternative in terms of having the highest value in e-wallet user satisfaction is $V_2 = Dana$, equal to 0.9459. So it can be concluded that DANA is the e-wallet with the highest customer satisfaction based on predetermined criteria.

5 Conclusion and Suggestions

5.1 Conclusion

Based on the results of the e-wallet user satisfaction survey research above, it was concluded that the first ranking of e-wallet user satisfaction surveys by the SAW and TOPSIS methods is DANA, the second is Shopeepay, the third is Gopay, the fourth is OVO, and the last is Sakuku.

5.2 Suggestions

Based on the research conducted, there were some problems encountered and it needs improving. In this case, the researchers make the following suggestions:

1. Many people do not use e-wallet, meaning not enough respondents, therefore, it is necessary that the Google form be distributed more widely to ensure having more respondents.
2. The number of the e-wallets used in the research is limited, then it is necessary that more e-wallets be added. In fact, many users use other e-wallets unlisted in this study.

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