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A web-based decision support system for e-wallet selection using AHP-TOPSIS with integrated economic and technical values

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ABSTRACT

The rapid growth of financial technology in Indonesia has introduced a diverse range of digital wallet (e-wallet) options including OVO, GoPay, DANA, and ShopeePay. While this abundance of choice benefits consumers, it also creates decision-making challenges, particularly since most prior studies have neglected the balanced integration of economic and technical criteria in e-wallet evaluation. This study addresses that gap by developing a web-based decision support system for e-wallet selection using the AHP-TOPSIS method with integrated economic and technical criteria. Nine criteria were applied, comprising three economic criteria (cost structure, financial incentives, additional fees) and six technical criteria (data security, ease of use, merchant coverage, transaction speed, customer service, additional features). Primary data were collected from 85 active e-wallet users through a Likert scale 1 – 5 questionnaire. Results indicate that OVO ranked first with a TOPSIS preference score of 0.5835, followed by DANA (0.5802), GoPay (0.4654), and ShopeePay (0.3994). The developed system demonstrated the ability to produce objective, adaptive, and user-friendly recommendations to empower users with an interactive, data-driven decision support tool.

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1. INTRODUCTION

The digital transformation that has taken place in recent years has fundamentally changed the financial transaction patterns of Indonesian society. Digital wallets (e-wallets) have become an integral part of daily life, widely used for online shopping, bill payments, transportation, donations, and various other financial activities. The COVID-19 pandemic further accelerated e-wallet adoption as users shifted from cash to contactless digital transactions. Today, many Indonesians actively use more than one e-wallet platform simultaneously, taking advantage of the different benefits offered by each service.

Data from Bank Indonesia shows that electronic money transaction values have consistently grown year by year [1]. A survey by Populix (2025) reported via GoodStats found that e-wallet is the most favored payment method among Indonesian consumers at 62%, surpassing QRIS (54%) and cash (51%). Furthermore, data from Jakpat (2025) revealed that DANA leads e-wallet usage at 72%, followed by GoPay (60%), ShopeePay (46%), and OVO (27%) [2, 3]. However, despite widespread e-wallet adoption, many users who have already experienced multiple platforms still struggle to determine which one best meets their needs. The abundance of platforms—each offering different feature advantages, fee policies, incentive programs, and security standards—creates a challenge not just for new users, but also for existing users who seek to optimize their choice based on objective economic and technical considerations.

This situation has indeed received attention from several researchers. Putri et al. [4] developed an analytical system for e-wallet prioritization using a combination of AHP and TOPSIS, and their results showed that this approach is effective for systematically ranking alternatives based on multiple criteria. Setiawan [5], in his study of four e-wallet services in Indonesia, found that data security was the dominant factor in user preferences using the Profile Matching method. Mustofa et al. [6] used AHP alone for e-wallet criteria weighting, although the final ranking was not further developed. Hidayatullah et al. [7] tested a combination of Entropy, AHP, and TOPSIS to compare the performance of several digital wallets and proved that this method can produce consistent rankings based on various performance indicators. Meanwhile, Shakira and Sulaiman [8] demonstrated how the AHP-TOPSIS combination can be applied to e-wallet selection among students with adaptive and reliable results.

Nevertheless, a review of the above studies reveals an unfilled gap. Most studies still tend to focus on technical aspects alone, while economic factors such as transaction cost structures, cashback programs, and fee policy transparency have not been explored proportionally. In fact, empirical findings show that economic considerations are one of the main factors influencing users' assessments of e-wallet platforms [9]. In addition, most previous studies have not implemented the analysis results into a web-based system that can be directly used to visualize multi-criteria prioritization outputs in an accessible format.

Based on this background, this research was conducted. Therefore, this research aims to design and develop a web-based decision support system for e-wallet selection using AHP-TOPSIS with integrated economic and technical criteria. This system is specifically designed to assist users who have already experienced using e-wallets, providing data-driven, objective guidance to help them select the platform that best suits their comprehensive financial and operational preferences.

2. RESEARCH METHODS

This research methodology is systematically structured using a quantitative approach. The research stages consist of eight steps: (1) problem identification, (2) literature study, (3) data collection, (4) data division, (5) data analysis using AHP and TOPSIS, (6) system design, (7) web-based system development, (8) system testing, and (9) evaluation and suggestions.

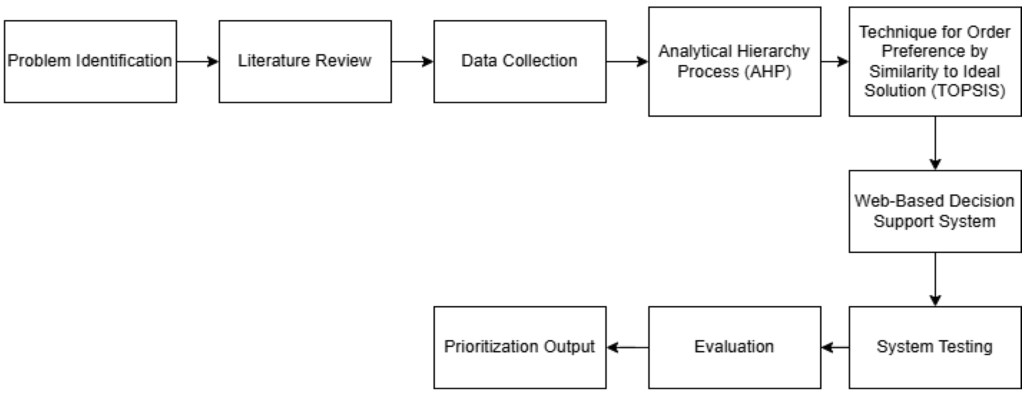

Figure 1. Research stages.

2.1. Problem Identification

The research began by identifying problems arising from the rapid development of e-wallet services in Indonesia. The availability of many platforms such as OVO, GoPay, DANA, and ShopeePay with varying features, fee policies, and security standards creates confusion for some users in making choices. This condition is exacerbated by the lack of data-based guidance that balances economic and technical aspects. To address this problem, this study proposes the development of a web-based decision support system for e-wallet selection using AHP-TOPSIS with integrated economic and technical criteria.

2.2. Literature Study

The literature study stage was conducted by reviewing various relevant scientific references, including AHP-TOPSIS analytical method theory, digital wallet concepts, AHP and TOPSIS methods, and previous studies on e-wallet selection and the application of multi-criteria methods to digital financial services. This literature study became the theoretical basis for determining evaluation criteria, the conceptual framework of the research, and the selection of methods used.

2.3. Data Collection

The dataset used in this study consisted of primary data collected through an online questionnaire (Google Form) distributed to active digital wallet users. The questionnaire used a Likert scale of 1–5 to assess four e-wallets—OVO, GoPay, DANA, and ShopeePay—based on nine predetermined criteria. Before distribution, the questionnaire instrument was validated by expert representatives from Bank Indonesia Riau to ensure the relevance and clarity of each question item [1]. Secondary data were obtained from official reports from Bank Indonesia, the Financial Services Authority, official publications of e-wallet providers, and indexed scientific articles discussing e-wallet selection factors and digital payment systems [4].

2.4. Analytical Hierarchy Process (AHP)

AHP is a multi-criteria decision-making method developed by Thomas L. Saaty. This method works by breaking down complex problems into a hierarchical structure and then comparing each element pairwise using a 1–9 ratio scale. The AHP procedure in this study includes: (1) constructing a pairwise comparison matrix between criteria, (2) matrix normalization, (3) calculating the eigenvector as priority weights, and (4) consistency testing using the Consistency Ratio (CR). Criteria weights are declared valid if the CR value ≤ 0.1.

Table 1. Saaty pairwise comparison scale.

Importance Level	Definition
1	Equal importance compared to another
3	Moderate importance compared to another
5	Strong importance compared to another
7	Very strong importance compared to another
9	Extreme importance compared to another
2, 4, 6, 8	Compromise values between adjacent levels

In this study, nine criteria were considered equal, so each received a weight:

$$w = \frac{1}{9} = 0.111 \tag{1}$$

1. The pairwise comparison matrix was constructed by comparing each pair of criteria using the Saaty scale 1–9. Because all criteria were treated equally, all matrix elements were 1. This matrix is 9×9 as shown in Equation 2.

$$A = \begin{bmatrix} C_{11} & C_{12} & C_{13} & C_{14} & C_{15} & C_{16} & C_{17} & C_{18} & C_{19} \\ C_{21} & C_{22} & C_{23} & C_{24} & C_{25} & C_{26} & C_{27} & C_{28} & C_{29} \\ C_{31} & C_{32} & C_{33} & C_{34} & C_{35} & C_{36} & C_{37} & C_{38} & C_{39} \\ C_{41} & C_{42} & C_{43} & C_{44} & C_{45} & C_{46} & C_{47} & C_{48} & C_{49} \\ C_{51} & C_{52} & C_{53} & C_{54} & C_{55} & C_{56} & C_{57} & C_{58} & C_{59} \\ C_{61} & C_{62} & C_{63} & C_{64} & C_{65} & C_{66} & C_{67} & C_{68} & C_{69} \\ C_{71} & C_{72} & C_{73} & C_{74} & C_{75} & C_{76} & C_{77} & C_{78} & C_{79} \\ C_{81} & C_{82} & C_{83} & C_{84} & C_{85} & C_{86} & C_{87} & C_{88} & C_{89} \\ C_{91} & C_{92} & C_{93} & C_{94} & C_{95} & C_{96} & C_{97} & C_{98} & C_{99} \end{bmatrix} \tag{2}$$

2. Normalization was performed by dividing each matrix element by the corresponding column sum. Since each column sum = 9 and each element = 1, each normalized element = 1/9 = 0.111. The normalized matrix is shown in Table 2.

Table 2. Criteria priority weights.

Criteria	E1	E2	E3	T1	T2	T3	T4	T5	T6
E1	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111
E2	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111
E3	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111
T1	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111
T2	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111
T3	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111
T4	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111
T5	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111
T6	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111	0,1111

3. Priority weights for each criterion were obtained by calculating the row average of the normalized matrix. Because all normalized values are identical (0.1111), the weight for each criterion is 0.1111, as summarized in Table 3.

$$w_i = \frac{1}{9} \approx 0{,}111(\text{untuk i} = 1{,}2, \dots, 9) \tag{3}$$

Table 3. AHP priority weights per criterion.

Criteria	Code	Weight (w)
Cost structure	E1	0.1111
Financial incentives	E2	0.1111
Additional costs	E3	0.1111
Data security	T1	0.1111
User convenience	T2	0.1111
Merchant coverage	T3	0.1111
Transaction speed	T4	0.1111
Customer service	T5	0.1111
Additional features	T6	0.1111
Total weight		1

4. Consistency test:
   1. Calculating the λ_{max} (maximum eigenvalue);

$$\lambda_{max} = \sum_{i=i}^{n} \frac{1}{n} \frac{(A_w)}{w_i} = 9.0000 \tag{4}$$

   2. Calculating the Consistency Index (CI);

$$CI = \frac{\lambda_{max} - n}{n-1} = \frac{9.000-9}{9-1} = \frac{0}{8} = 0.0000 \tag{5}$$

   3. Determine the Random Index (RI) for n = 9 based on the Saaty table;

$$RI = 1.45 \tag{6}$$

   4. Calculating the Consistency Ratio (CR);

$$CR = \frac{CI}{RI} = \frac{0{,}0000}{1{,}45} = 0{,}0000 \tag{7}$$

Since CR = 0 ≤ 0.1, the pairwise comparison matrix is declared consistent and the priority weights are valid. The consistency test results are presented in Table 4.

Table 4. AHP consistency test result.

Parameter	Value	Description
n (number of criteria)	9	Number of criteria
λ_{max} (maximum eigenvalue)	9	Calculated from average λ per criterion
CI (Consistency Index)	0	CI = (λ_{max} – n) / (n – 1)
RI (Random Index, n=9)	1,45	Tabel Saaty
CR (Consistency Ratio)	0	CR = CI / RI
Conclusion	CR ≤ 0,1 → Consistent	Weights are valid

Table 5. Economic and technical criteria (with sub-criteria scales 1 – 5).

Code	Criteria	Description	Sub-criteria (scale 1–5)
E1	Cost structure	Assesses transaction and administrative fee policies	5 = Transfer and top-up Free (Rp0) 4 = Transfer fee < Rp500 per transaction 3 = Transfer fee Rp500-Rp1,499 per transaction 2 = Transfer fee Rp1,500-Rp2,500 per transaction 1 = Transfer fee > Rp2,500 per transaction
E2	Financial incentives	Measures direct economic benefits for users	5 = Cashback >5% per transaction, regular promos available 4 = Cashback 3%-5% per transaction 3 = Cashback 1%-3% per transaction 2 = Reward points only, no cashback 1 = No cashback or rewards (0 %)
E3	Additional fees	Assesses hidden fees and affordability	5 = No additional fees at all (Rp0) 4 = Almost none, only conditional fees 3 = Only 1 type of additional fee (cash withdrawal) 2 = 2 – 3 types of additional fees 1 = ≥ 4 additional fee (inactivity, PIN change, withdrawal, admin, etc.)
T1	Data security	Measures protection of user data and transactions	5 = 2FA + end-to-end encryption + PCI DSS + no data breach history 4 = PCI DSS + end-to-end encryption 3 = Meets PCI DSS standars 2 = Only basic encryption, not industry-standar 1 = No clear security features, and/or history of data breach
T2	Ease of Use	Asseasses UI quality and user experience	5 = Very intuitive UI, all features easily accessible, no errors 4 = Features easy to understand, clean and comfortable display 3 = Quick registration, but some features need learning 2 = Complicated navigation, features hard to find 1 = App often crashes, very confusing navigation
T3	Merchant coverage	Measures the breadth of merchant network	5 = Lebih dari 1.000.000 merchant (online + offline) 4 = 500.000 – 1.000.000 merchants 3 = 100.000 – 500.000 merchants 2 = 50.000 – 100.000 merchants 1 = < 50.000 merchants
T4	Transaction speed	Measures transaction process efficiency	5 = Transaction completed in <3 seconds (almost instant) 4 = 3 – 5 seconds 3 = 5 – 10 seconds 2 = 10 – 30 seconds 1 = > 30 seconds
T5	Customer service	Asseasses quality and responsiveness of customer service	5 = Live chat 24/7, instant response (<1 minute) 4 = Response in < 5 minutes, multiple communication channels 3 = Response in 5 – 30 minutes 2 = Only via email/phone, response >30 minutes 1 = CS very hard to reach, no response
T6	Additional features	Asseasses completeness of features beyond payment	5 = Investment + insurance + bills + complete financial ecosystem 4 = Investment (mutual funds/gold) + bill payments 3 = Bill payments (electricity, water, internet, etc.) 2 = Only top-up and peer-to-peer transfer 1 = Basic payment only, 0 additional features

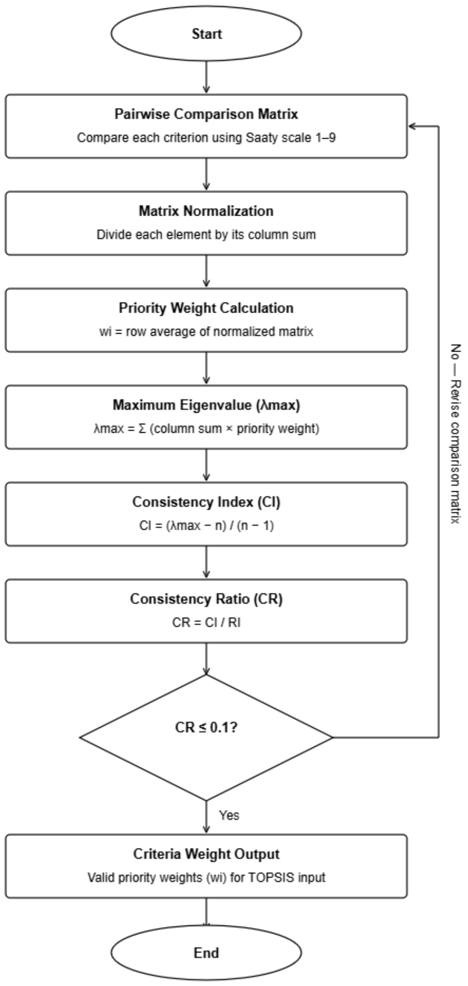

Figure 2. AHP calculation flowchart.

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

TOPSIS ranks alternatives based on their distance to two reference points: the positive ideal solution (A^+) and the negative ideal solution (A^-). The best alternative is the one with the shortest distance to A^+ and the farthest distance from A^-.

The TOPSIS steps are:

1. Normalize the decision matrix using Euclidean norm:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{8}$$

2. ultiply normalized values by criteria weights:

$$v_{ij} = w_j \times r_{ij} \tag{9}$$

3. Determine positive ideal solution (A^+) and negative ideal solution (A^-):

$$A^+ = \{\max v_{ij}\}, A^- = \{\min v_{ij}\} \tag{10}$$

4. Calculate Euclidean distances:

$$D_i^+ = \sqrt{\sum(v_{ij} - v_j^+)^2}, D_i^- = \sqrt{\sum(v_{ij} - v_j^-)^2} \tag{11}$$

5. Calculate preference value:

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-}, 0 \leq C_i \leq 1 \tag{12}$$

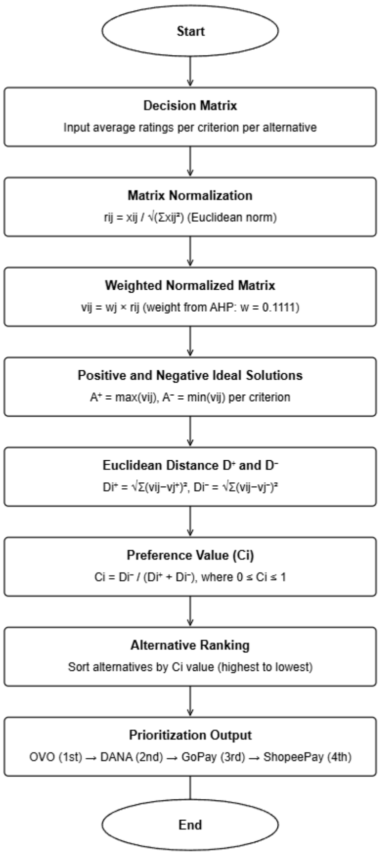

Figure 3. TOPSIS calculation flowchart.

2.6. Web-Based Decision Support System

This web-based Decision Support System (DSS) was developed to process multi-criteria assessment data from active e-wallet users and compute prioritization rankings. The system accepts questionnaire inputs from respondents with direct experience using the evaluated platforms, performs criteria weighting using the Analytical Hierarchy Process (AHP), and ranks e-wallet alternatives using the TOPSIS method.

In terms of technical architecture, the system is built using JavaScript as the primary programming language, utilizing React.js and Vite as build tools. Respondent data is securely managed and stored in a PostgreSQL database via the Supabase platform. The hardware environment utilized during development consisted of an AMD Ryzen 9 7945HX processor, 16 GB DDR5 RAM, a 1 TB SSD, and the Windows 11 operating system.

2.7. System Testing

System testing was carried out in two stages to evaluate both the functional correctness and user acceptance of the developed system. The first stage, Black Box Testing, was conducted to verify the accuracy of calculations and the correctness of the input-output flow across all system modules. The second stage, User Acceptance Testing (UAT), was conducted using a Likert scale questionnaire (1–5) administered to 10 representative end users who tested the complete application workflow—from the homepage through to the e-wallet recommendation output—covering 47 test items across 10 modules. The UAT aimed to assess ease of use, clarity of information presented, and overall user satisfaction with the system.

2.8. Evaluation

The evaluation stage was conducted to assess the overall performance and quality of the developed system from two complementary aspects: functional evaluation and user acceptance evaluation.

Functional evaluation was carried out by examining the results of Black Box Testing. In this approach, the system was treated as a closed box whose internal logic is not directly visible to the tester; evaluation was based solely on whether the actual outputs matched the expected outputs for a given set of inputs. Each system module—from criteria input, AHP weight calculation, TOPSIS preference computation, to the final ranking display—was tested against predefined expected outputs. A module was considered to pass if its output was identical to the manually calculated reference value; any discrepancy was recorded as a functional error requiring correction.

User acceptance evaluation was conducted through User Acceptance Testing (UAT) using a structured questionnaire administered to 10 representative end users. Each respondent tested the complete application workflow and evaluated 47 test statements covering 10 system modules, using a Likert scale of 1 to 5, where 1 = Very Poor and 5 = Very Good. The UAT scores for each respondent were averaged across all 47 items, and the overall group average was computed to represent the collective level of user acceptance.

To interpret the UAT results, the average score was mapped to an acceptance category using the scale conversion criteria presented in Table 6 below. This interpretation framework follows the standard Likert scale interval formula, dividing the range of 1 – 5 into five equal intervals of 0.80.

Table 6. UAT Score Interpretation Scale.

Average score range	Interpretation	Acceptance category
4.20 – 5.00	Very good	Highly accepted
3.40 – 4.19	Good	Accepted
2.60 – 3.39	Fair	Conditionally accepted
1.80 – 2.59	Poor	Not accepted
1.00 – 1.79	Very poor	Rejected

The combined results of both evaluations—functional correctness from Black Box Testing and user satisfaction from UAT—were used jointly to determine the system's readiness and suitability for practical deployment as an e-wallet prioritization decision support tool. A system is considered ready for use if it passes all Black Box test cases without functional errors and achieves a UAT average score of at least 3.40 (Good / Accepted).

2.9. Prioritization Output

The decision support output stage refers to the process by which the developed system computes and displays the ranked results of the e-wallet alternatives based on active user assessments. Based on the TOPSIS preference values (C_i) computed in the preceding stage, the system ranks all four e-wallet alternatives — OVO, GoPay, DANA, and ShopeePay — from highest to lowest score. The alternative with the highest C_i value is positioned at the top of the ranking, reflecting the closest distance to the positive ideal solution and the farthest distance from the negative ideal solution across all nine evaluation criteria. These ranked results are displayed through the web-based interface in a clear and accessible format, enabling stakeholders to make informed, data-driven selection decisions derived from real user experience. The recommendations produced by the system serve as empirical reference data reflecting the performance of each e-wallet as assessed by its active users across economic and technical dimensions.

3. RESULTS AND DISCUSSIONS

3.1. Respondent Profile and Questionnaire Data

Data collection was conducted through an online questionnaire distributed to active e-wallet users in Indonesia using Google Form. A total of 85 respondents successfully provided responses. All data were declared valid and suitable for analysis because each respondent completed assessments only for the e-wallets they had used.

Table 7. Sample of raw questionnaire responses.

Timestamp	Social media	Full name	Gender	Age	…	E-Wallet	E1_ Dana	E2_ Dana	E3_ Dana	Fund Satisfaction
11/26/2025 9:13:03		Eva Fajriza	Female	46 – 55	…	Dana, ShopeePay	4.4	3.6	4.8	4.00
11/26/2025 9:16:22	febriandy17 @gmail.com	Febriandy	Male	36 – 45	…	ShopeePay				
…	…	…	…	…	…	…	…	…	…	…
11/26/2025 9:20:13		Muhammad Faisal	Male	36 – 45	…	Dana	3.2	2.40	2.20	3.67
11/26/2025 9:25:05	zulfahmi_ setiawan	Zulfahmi	Male	26 – 35	…	Dana, ShopeePay	4.2	2.8	2.8	4.00
11/26/2025 9:27:34		Syafrizal	Male	36 – 45	…	Dana, ShopeePay	5.0	4.0	4.0	5.00

Table 8. Respondent Demographic Profile.

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	44	50.6%
	Female	43	49.4%
Age	18 – 25 year	6	6.9%
	26 – 35 year	27	31.0%
	36 – 45 year	35	40.2%
	46 – 55 year	15	19.5%
	56 – 65 year	2	2.3%
Total		85	100%

Table 9. Number of valid respondents per e-wallet.

E-wallet	N valid (respondents)	Percentage of 85	Description
DANA	51	58,6%	Active DANA users
ShopeePay	56	64,4%	Active ShopeePay users
OVO	37	42,5%	Active OVO users
GoPay	40	46,0%	Active GoPay users

3.2. Decision Matrix

Based on the nine criteria, each criterion was assigned a weight $w = 1/9 \approx 0.1111$. The weighted normalized matrix was obtained by multiplying each normalized value by 0.1111.

Table 10. Decision matrix (average respondent ratings).

Criteria	DANA	ShopeePay	OVO	GoPay
E1	3.5078	3.4161	3.2833	3.4150
E2	3.2627	3.4000	3.4171	3.4513
E3	3.2647	3.2309	3.3794	3.3561
T1	3.7917	3.6920	3.5147	3.8110
T2	3.5802	3.5964	3.5429	3.6100
T3	3.5153	3.2857	3.5555	3.4188
T4	3.6160	3.4786	3.4909	3.4439
T5	3.3667	3.4196	3.5818	3.2537
T6	3.5792	3.4764	3.7148	3.4684

3.3. Normalization and Weighted Matrix

Normalization was performed using the Euclidean norm. Example for criterion E1, DANA:

1. For DANA on E1;

$$r_D, E1 = \frac{3.507843137}{6.8130} \approx 0.5149 \quad (13)$$

2. Square root of the sum of squares;

$$\sqrt{46.4385 =} 6.8130, r_D, E1 = \frac{3.507843137}{6.8130} \approx 0.5149 \quad (14)$$

3. The normalized value of DANA for E1 is;

$$\frac{3.507843137}{6.8130} \approx 0.5149 \quad (15)$$

4. Sum of squares:

$$3.5078^2 + 3.4161^2 + 3.2833^2 + 3.4150^2 = 21.3139 + 11.6744 + 10.7873 + 11.6629 = 46.4385 \quad (16)$$

The normalization results for all alternatives and criteria are summarized in Table 11.

Table 11. Normalized matrix.

Criteria	DANA	ShopeePay	OVO	GoPay
E1	0.5148	0.5014	0.4819	0.5012
E2	0.4812	0.5024	0.5049	0.5100
E3	0.4933	0.4882	0.5107	0.5072
T1	0.5118	0.4983	0.4744	0.5144
T2	0.4996	0.5019	0.4944	0.5038
T3	0.5101	0.4768	0.5159	0.4961
T4	0.5154	0.4958	0.4975	0.4908
T5	0.4940	0.5017	0.5255	0.4774
T6	0.5025	0.4881	0.5215	0.4869

Since all criteria are given equal weight (w = 1/9 ≈ 0.1111), the weighted matrix value is obtained by multiplying each normalized value by 0.1111. This multiplication results in a weighted matrix that serves as the basis for determining the ideal solution. Table 12 displays the complete weighted matrix value.

Table 12. Weighted normalized matrix.

Criteria	DANA	ShopeePay	OVO	GoPay
E1	0.057208	0.055712	0.053547	0.055694
E2	0.053571	0.055826	0.056108	0.056668
E3	0.054822	0.054255	0.056749	0.056357
T1	0.056868	0.055372	0.052714	0.057157
T2	0.055521	0.055771	0.054942	0.055983
T3	0.056683	0.052981	0.057332	0.055126
T4	0.057267	0.055090	0.055286	0.054541
T5	0.054890	0.055754	0.058398	0.053047
T6	0.055838	0.054234	0.057953	0.054110

3.4. Positive and Negative Ideal Solutions

The positive ideal solution (A+) is taken from the highest value of the weighted matrix for each criterion, while the negative ideal solution (A−) is taken from the lowest value. Since all criteria in this study are benefit-based (the larger the better), the determination of A+ and A− applies uniformly. The results of determining A^+ and A^- are presented in Table 13.

Table 13. Positive (A^+) and negative (A^-) ideal solutions.

Criteria	A^+	A^-
E1	0.057208304 (DANA)	0.053546845 (OVO)
E2	0.056667576 (GoPay)	0.053571035 (DANA)
E3	0.056748944 (OVO)	0.054255205 (ShopeePay)
T1	0.057157163 (GoPay)	0.052713698 (OVO)
T2	0.055982865 (GoPay)	0.054941632 (OVO)
T3	0.057331647 (OVO)	0.052980735 (ShopeePay)
T4	0.057266764 (DANA)	0.054541247 (GoPay)
T5	0.05839769 (OVO)	0.053047401 (GoPay)
T6	0.057953496 (OVO)	0.054109678 (GoPay)

The obtained ideal solution values include $A^+(E1)$ = 0.057208304 (DANA), $A^+(T1)$ = 0.057157163 (GoPay), and $A^+(T5)$ = 0.05839769 (OVO). Meanwhile, the negative ideal solution values are $A^-(E1)$ = 0.053546845 (OVO), $A^-(T1)$ = 0.052713698 (OVO), and $A^-(T5)$ = 0.053047401 (GoPay). These values serve as reference points for calculating the Euclidean distance in the subsequent step.

3.5. Determination of Positive Ideal Solutions (A^+) and Negative Ideal Solutions (A^-)

The distance of each alternative to the positive (D^+) and negative (D^-) ideal solutions is calculated using the Euclidean distance formula:

$$Formula: D_i^+ = \sqrt{(}\sum\left(v_{ij} + v_j^+\right)^2 \quad (17)$$

$$Formula: D_i^- = \sqrt{(}\sum\left(v_{ij} + v_j^-\right)^2 \quad (18)$$

3.5.1. DANA

Table 14. Distance to ideal solutions (D^+/ D^-) DANA.

D^+ Dana			D^- Dana		
Criteria	Calculation	Result	Criteria	Calculation	Result
E1	((0.057208304 − 0.057208304)²)	0	E1	((0.057208304 − 0.053546845)²)	0.000013406
E2	((0.053571035 − 0.056667576)²)	0.000009588	E2	((0.053571035 − 0.053571035)²)	0
E3	((0.054821969 − 0.056748944)²)	0.000003713	E3	((0.054821969 − 0.054255205)²)	0.000000321
T1	((0.056867567 − 0.057157163)²)	0.000000084	T1	((0.056867567 − 0.052713698)²)	0.000017254
T2	((0.055520864 − 0.055982865)²)	0.000000213	T2	((0.055520864 − 0.054941632)²)	0.000000336
T3	((0.056682805 − 0.057331647)²)	0.000000421	T3	((0.056682805 − 0.052980735)²)	0.000013705
T4	((0.057266764 − 0.057266764)²)	0	T4	((0.057266764 − 0.054541247)²)	0.000007428
T5	((0.054889877 − 0.05839769)²)	0.000012304	T5	((0.054889877 − 0.053047401)²)	0.000003394
T6	((0.05583793 − 0.057953496)²)	0.000004475	T6	((0.05583793 − 0.054109678)²)	0.000002986
Σ (difference)²		0.000030800	Σ (difference)²		0.000058832
√Σ		0.005549818	√Σ		0.007670266

3.5.2. ShopeePay

Table 15. Distance to ideal solutions (D^+/ D^-) ShopeePay.

D⁺ ShopeePay			D⁻ ShopeePay		
Criteria	Calculation	Result	Criteria	Calculation	Result
E1	((0.055711628 − 0.057208304)²)	0.000002240	E1	((0.055711628 − 0.053546845)²)	0.000004686
E2	((0.05582608 − 0.056667576)²)	0.000000708	E2	((0.05582608 − 0.053571035)²)	0.000005085
E3	((0.054255205 − 0.056748944)²)	0.000006218	E3	((0.054255205 − 0.054255205)²)	0
T1	((0.055372227 − 0.057157163)²)	0.000003185	T1	((0.055372227 − 0.05271369)²)	0.000007067
T2	((0.055771396 − 0.055982865)²)	0.000000045	T2	((0.055771396 − 0.054941632)²)	6.885082956
T3	((0.052980735 − 0.057331647)²)	0.000018930	T3	((0.052980735 − 0.052980735)²)	0
T4	((0.055090301 − 0.057266764)²)	0.000004736	T4	((0.055090301 − 0.054541247)²)	0.000000301
T5	((0.055753596 − 0.05839769)²)	0.000006991	T5	((0.055753596 − 0.053047401)²)	0.000007323
T6	((0.054234119 − 0.057953496)²)	0.000013833	T6	((0.054234119 − 0.054109678)²)	0.000000015
Σ (difference)²		0.000056890	Σ (difference)²		0.000025168
√Σ		0.007542548	√Σ		0.005016795

3.5.3. OVO

Table 16. Distance to ideal solutions (D^+/ D^-) OVO.

D⁺ OVO			D⁻ OVO		
Criteria	Calculation	Result	Criteria	Calculation	Result
E1	((0.053546845 − 0.057208304)²)	0.000013406	E1	((0.053546845 − 0.053546845)²)	0
E2	((0.056107556 − 0.056667576)²)	0.000000314	E2	((0.056107556 − 0.053571035)²)	0.000006433
E3	((0.056748944 − 0.056748944)²)	0	E3	((0.056748944 − 0.054255205)²)	0.000006218
T1	((0.052713698 − 0.057157163)²)	0.000019744	T1	((0.052713698 − 0.052713698)²)	0
T2	((0.054941632 − 0.055982865)²)	0.000001084	T2	((0.054941632 − 0.054941632)²)	0
T3	((0.057331647 − 0.057331647)²)	0	T3	((0.057331647 − 0.052980735)²)	0.000018930
T4	((0.055285693 − 0.057266764)²)	0.000003924	T4	((0.055285693 − 0.054541247)²)	0.000000554
T5	((0.05839769 − 0.05839769)²)	0	T5	((0.05839769 − 0.053047401)²)	0.000028625
T6	((0.057953496 − 0.057953496)²)	0	T6	((0.057953496 − 0.054109678)²)	0.000014774
Σ (difference)²		0.000038473	Σ (difference)²		0.000075537
√Σ		0.006202668	√Σ		0.008691251

3.5.4. GoPay

Table 17. Distance to ideal solutions (D^+/ D^-) GoPay.

	D^+ GoPay			D^- GoPay	
Criteria	Calculation	Result	Criteria	Calculation	Result
E1	((0.055694155− 0.057208304)²)	0.000002292	E1	((0.055694155− 0.053546845)²)	0.000004610
E2	((0.056667576− 0.056667576)²)	0	E2	((0.056667576− 0.053571035)²)	0.000009588
E3	((0.056357439− 0.056748944)²)	0.000000153	E3	((0.056357439− 0.054255205)²)	0.000004419
T1	((0.057157163− 0.057157163)²)	0	T1	((0.057157163− 0.052713698)²)	0.000019744
T2	((0.055982865− 0.055982865)²)	0	T2	((0.055982865− 0.054941632)²)	0.000001084
T3	((0.055125879− 0.057331647)²)	0.000004865	T3	((0.055125879− 0.052980735)²)	0.000004601
T4	((0.054541247− 0.057266764)²)	0.000007428	T4	((0.054541247− 0.054541247)²)	0
T5	((0.053047401− 0.05839769)²)	0.000028625	T5	((0.053047401− 0.053047401)²)	0
T6	((0.054109678− 0.057953496)²)	0.000014774	T6	((0.054109678− 0.054109678)²)	0
Σ (difference)²		0.000058140	Σ (difference)²		0.000044049
√Σ		0.007624979	√Σ		0.006636948

3.6. Distance Calculation and Preference Ranking

The distance of each alternative to A+ (D+) and A− (D−) is calculated using the Euclidean distance formula for all nine criteria. The complete calculation results are presented in Table 18 below.

The preference value (Ci) is calculated using the formula:

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \tag{19}$$

Table 18. Final TOPSIS ranking results.

Alternative	D^+	D^-	Ci	Rank
GoPay	0.007624979	0.006636948	0.465361238	3
OVO	0.006202668	0.008691251	0.583543593	1
DANA	0.005549818	0.007670266	0.580197978	2
ShopeePay	0.007542548	0.005016795	0,399447248	4

3.7. Interpretation of Results

Based on the table above, OVO achieved the highest preference score of 0.583543593, ranking first. DANA came in second with a preference score of 0.580197978, while GoPay came in third with a preference score of 0.465361238. ShopeePay came in last with a preference score of 0.399447248.

OVO's superiority in first place reflects its relatively balanced performance across various assessment criteria, particularly in additional fees (E3), merchant coverage (T3), customer service (T5), and additional features (T6), where it achieved the positive ideal solution. This balanced strength across both economic and technical dimensions resulted in the highest preference score compared to other alternatives. This finding aligns with research by Setiawan [5], which found that OVO has a strong perception of security and service integration among users.

DANA, in second place, demonstrated excellent performance, particularly in cost structure (E1) and transaction speed (T4), where it achieved the positive ideal solution. This indicates that DANA remains highly competitive in offering low transaction costs and fast service to users. These results are also consistent with the findings of Hidayatullah et al. [7], who identified multi-criteria evaluation as an effective approach for assessing digital wallet platforms in the Indonesian market.

GoPay ranked third, excelling in financial incentives (E2), data security (T1), and ease of use (T2), demonstrating strong promotional offerings and reliable technical performance. However, despite these strengths, GoPay's overall preference score fell below OVO and DANA due to its relatively greater distance from the positive ideal solution on other criteria. Nevertheless, these results support the findings of Shakira and Sulaiman [8], who demonstrated that AHP-TOPSIS can effectively rank e-wallet alternatives and produce consistent prioritization results among users.

ShopeePay ranked last in the rankings. Although it did not achieve the positive ideal solution on any single criterion, its overall performance remained reasonably balanced across the economic and technical dimensions assessed. This indicates that promotional strategies and financial incentives alone are not sufficient to produce the highest preference score if not matched by leading performance on other key criteria.

3.8. System Testing

Black Box testing verified that all system modules—from criteria input, AHP weight calculation, TOPSIS preference computation, to the result display and visualization—functioned according to design and produced accurate outputs consistent with the expected AHP-TOPSIS calculation logic. No functional errors were found during testing.

User Acceptance Testing (UAT) was conducted by 10 representative end users. Each respondent tested the complete application flow and evaluated 47 test statements across 10 modules using a Likert scale of 1–5. All respondents gave positive responses, with scores distributed exclusively across scale 4 (Good) and scale 5 (Very Good)—no respondent assigned a score of 1, 2, or 3 to any test item. The overall average UAT score was 4.20 out of 5.00, corresponding to a satisfaction rate of 84.0%, indicating a high level of user acceptance. The distribution of UAT scores per respondent is presented in Table 19 below.

Table 19. UAT score recapitulation per respondent.

No	Name	Total Score	Score 4 (Good)	Score 5 (Very Good)	Average	Satisfaction (%)	Result
1	Fajriza Mukhlis	198	37	10	4.21	84.3	Positive / Accepted
2	Marianto Syam	197	38	9	4.19	83.8	Positive / Accepted
3	Indra Barlian	198	37	10	4.21	84.3	Positive / Accepted
4	Aprilia Yelfitra	197	38	9	4.19	83.8	Positive / Accepted
5	Pardi	198	37	10	4.21	84.3	Positive / Accepted
6	Rudy Saputra	197	38	9	4.19	83.8	Positive / Accepted
7	Novrian Akhdany Marifa	198	37	10	4.21	84.3	Positive / Accepted
8	Ardhia Dayanthi	197	38	9	4.19	83.8	Positive / Accepted
9	Febriandy	198	37	10	4.21	84.3	Positive / Accepted
10	I Gusti Putu Rio Parbowo	197	38	9	4.19	83.8	Positive / Accepted
Overall average		1975	375	95	4.20	84.0	Positive

Note: Score 4 = Good; Score 5 = Very Good. All 10 respondents assigned ratings exclusively within scale 4 and scale 5, confirming uniformly positive acceptance across the entire respondent group.

Table 20 below summarizes the UAT results by module, showing the average score and satisfaction percentage for each of the 10 tested modules.

Table 20. UAT summary by module.

No	Module / Page Tested	No. of Items	Average	Satisfaction (%)	Interpretation
1	A. Beranda (Home)	7	4.00	80.0	Good
2	B. Form — Respondent Identity	4	4.00	80.0	Good
3	C. Form — E-Wallet Selection	4	4.00	80.0	Good
4	D. Form — Criteria Assessment	6	4.07	81.3	Good
5	E. Form — Summary & Submit	4	4.45	89.1	Good
6	F. Result Page (Ranking & Visualization)	8	4.91	98.3	Very Good
7	G. Baseline Data Page	4	4.00	80.0	Good
8	H. Respondent Data Page	3	4.00	80.0	Good
	Overall average		4.20	84.0	Good

Note: Scores are averaged across all 10 respondents per module. Scale: ≥4.50 = Very Good; 4.00–4.49 = Good.

The highest-rated module was the Result Page (Ranking & Visualization) with an average score of 4.91 (98.3%), indicating that users found the AHP-TOPSIS computation outputs, comparative charts, radar diagrams, and transparency features to be highly clear and informative. The Form Summary & Submit module ranked second with an average of 4.45 (89.1%). All remaining modules achieved an average of 4.00, which falls within the Good category. Taken together, these results confirm that the system was well received by users and is suitable for practical deployment as an e-wallet prioritization decision support tool.

4. CONCLUSION

This research successfully developed a web-based decision support system for e-wallet selection based on multi-criteria assessments from active users. By combining the AHP method for criteria weighting and TOPSIS for alternative ranking, the system produces structured, objective, and easy-to-understand recommendations to support selection decisions.

This research successfully developed a web-based analytical system to prioritize e-wallet alternatives based on multi-criteria assessments from active users. By combining the AHP method for criteria weighting and TOPSIS for alternative ranking, the system produces structured, objective, and easy-to-understand prioritization outputs.

Based on the analysis of respondent data from 85 active e-wallet users—predominantly in the 20–55 age range, which aligns with the typical age profile of civil servants (PNS) who formed the majority of respondents in this study as the primary target users of the system—using nine criteria consisting of three economic criteria and six technical criteria, the results show that OVO ranked first with a TOPSIS preference value of 0.5835, followed by DANA (0.5802), GoPay (0.4654), and ShopeePay (0.3994). Notably, OVO achieved this top ranking despite having the fewest valid respondents among the four platforms, with only 37 out of 85 respondents (42.5%) providing OVO evaluations—compared to 51 for DANA, 56 for ShopeePay, and 40 for GoPay. This finding is particularly meaningful: despite the smaller evaluator pool, OVO's respondents consistently gave high assessments, with 46.4% of all OVO criterion scores falling at or above the level of 4 on the Likert scale. The criterion with the highest proportion of scores at level 4 and 5 was T6 (Additional Features), where 21 out of 44 data points (47.7%) reached this level, and T3 (Merchant Coverage) and T5 (Customer Service) each had 17 respondents (51.5%) giving scores of 4 or above. This pattern indicates that OVO's superiority in the TOPSIS ranking is driven by genuinely strong and consistent quality assessments across multiple criteria, rather than being an artifact of sample size. DANA ranked second with advantages in cost structure (E1) and transaction speed (T4). ShopeePay ranked last because, despite its strengths in promotion and financial incentives, its overall performance on technical criteria remains relatively lower compared to the other alternatives.

This research also proves that the balanced integration of economic and technical dimensions in a single evaluation model provides a more comprehensive picture than approaches that focus only on one aspect. The system developed using the prototyping method was also well accepted by users, as shown by the average User Acceptance Test (UAT) score of 4.2 out of 5.

In the future, this research can be further developed in several directions. First, the sample size should be significantly expanded beyond the current 85 respondents to improve the statistical representativeness and reliability of the results. Second, future studies are encouraged to broaden the target age range to cover 17–40 years, which represents the ideal demographic for Gen-Z and young millennial e-wallet users who are the most active adopters of digital financial services in Indonesia. This age range would provide richer, more diverse usage perspectives compared to the civil servant-oriented 20–55 range used in this study. Third, more varied criteria such as regulatory aspects and service sustainability could be added, and domain experts should be involved more explicitly in the AHP weighting process to produce richer and more representative evaluations. Additionally, system development towards real-time data integration from e-wallet platforms is also an interesting research opportunity to dynamically improve recommendation accuracy and relevance.

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