

Saripudin^a
Pingki Rosalia^b
Ageng Firmansyah Putra^c
Sultan Sholahuddin Aldila^d
Robi'ah Al Adawiyah Salsabila^e
Muhamad Azriel Azhari^f
Anila Yunizhar^g

DETERMINING THE TOP E-WALLET IN INDONESIA: APPLYING THE AHP METHOD TO OPTIMAL FINANCIAL CHOICES

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Abstract

The aim of this study is to aid individuals in selecting the most suitable e-wallet among five alternatives (Go-Pay, OVO, Shopee-Pay, DANA, and LinkAja) based on criteria such as Price and promotion, Ease of use, Features, Merchant availability, and Security. The research involved distributing questionnaires to 111 respondents via Google Forms and employed

^a Faculty of Economics and Business, Perbanas Institute Jakarta, Indonesia, e-mail: iip@perbanas.id, ORCID: 0000-0003-1979-9257.

^b Faculty of Economics and Business, Perbanas Institute Jakarta, Indonesia, e-mail: pingkirosalia.adm@gmail.com, ORCID: 0009-0004-8285-2748.

^c Faculty of Economics and Business, Perbanas Institute Jakarta, Indonesia, e-mail: agengfirman1807@gmail.com, ORCID: 0009-0007-3981-8028.

^d Faculty of Economics and Business, Perbanas Institute Jakarta, Indonesia, e-mail: sultanaldila4@gmail.com, ORCID: 0009-0005-4970-4863.

^e Faculty of Economics and Business, Perbanas Institute Jakarta, Indonesia, e-mail: r.a.salsabila21@gmail.com, ORCID: 0009-0004-8285-2748.

^f Faculty of Economics and Business, Perbanas Institute Jakarta, Indonesia, e-mail: azhari.azriel@gmail.com, ORCID: 0009-0002-3702-2417.

^g Faculty of Economics and Business, Perbanas Institute Jakarta, Indonesia, e-mail: anila-yunizhar123@gmail.com, ORCID: 0009-0008-0629-2020.

a quantitative approach utilizing the Analytic Hierarchy Process (AHP) model. The findings revealed that Go-Pay was ranked as the top e-wallet alternative, followed by OVO, Shopee-Pay, LinkAja, and DANA. This research is intended to serve as a valuable guide for users in making informed choices regarding the e-wallet that aligns best with their preferences and needs.

Keywords: e-wallet, security, ease of use, features, merchant availability, prices and promotions.

1 Introduction

Indonesia is currently experiencing significant growth in mobile wallet adoption, ranking as the third fastest-growing country in this regard globally. Projections indicate that mobile wallet penetration is set to triple, with transactions expected to increase tenfold over the next five years. According to the 2020 monthly report, mobile wallet transactions in Indonesia were estimated to reach 1.7 billion in 2020 and are anticipated to soar to 16 billion by 2025. In terms of transaction value, 2020 saw \$28 billion, and this figure is projected to rise substantially to \$107 billion or IDR 1.55 quadrillion in 2025. Currently, there are 63.6 million mobile wallet users in Indonesia, constituting 25.6% of the total population. This number is predicted to surge to 202 million users, representing 76.5% of the market share, by 2025. The report also highlights the fierce competition among five major players in the Indonesian mobile wallet market. When ranked on the basis of their transaction growth in 2020, these five mobile wallets are: (1) OVO with \$10.7 million, (2) Shopee-Pay with \$4.3 million, (3) LinkAja with \$3.9 million, (4) Go-Pay with \$3.7 million, and (5) DANA with \$3.4 million. In terms of market share, OVO leads the way with a 38.2% share, followed by Shopee-Pay (15.6%), LinkAja (13.9%), Go-Pay (13.2%), DANA (12.2%), and others (6.9%). In summary, Indonesia is experiencing remarkable growth in mobile wallet adoption, with projections indicating significant increases in both the number of users and transaction volumes, making it a competitive and dynamic market.

Digital payments have experienced significant growth in Indonesia in recent years. The emergence of new technologies and wider penetration of mobile devices have transformed the way people conduct financial transactions. One increasingly popular form of digital payment is the use of e-wallets or digital wallets. An e-wallet is a digital form of currency that offers the convenience of cashless transactions, eliminating the need to carry physical money. It can be utilized not only for shopping but also for various other activities (Megadewandanu, Suyoto and Pranowo, 2017). By utilizing an e-wallet, customers can make electronic payments without using physical cash, simply by scanning a QR

code to input their mobile number as an identification action. According to Figure 1 and data from Bank Indonesia (BI), the circulating electronic money reached 772.57 million units in November 2022. This amount represents a 34.28% increase from the year-end 2021 position.

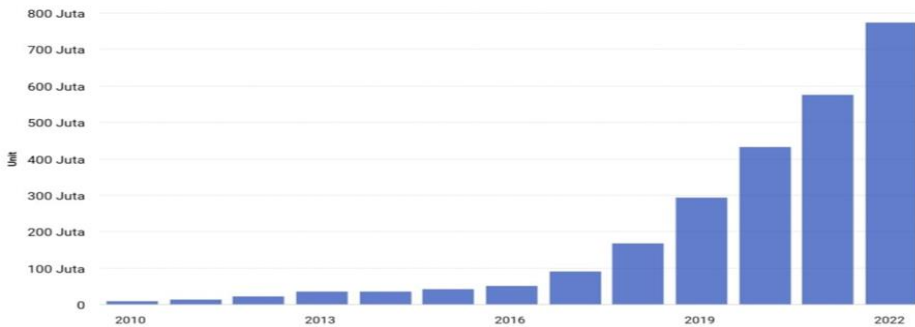


Figure 1: The circulating electronic money

Source: Bank Indonesia (BI).

As shown in Figure 2 of the ‘Mobile Wallets Report 2021’ by Book Inc., OVO was the dominant player in Indonesia’s e-wallet market in 2020, holding a substantial 38.2% market share. During that period, OVO’s transactions amounted to a significant US\$ 10.75 billion. Securing the second position was Shopee-Pay, with a market share of 15.6%, followed by LinkAja at 13.9%. Go-Pay held a market share of 13.2%, and Dana accounted for 12.2% of the market share (Anestia, 2021).

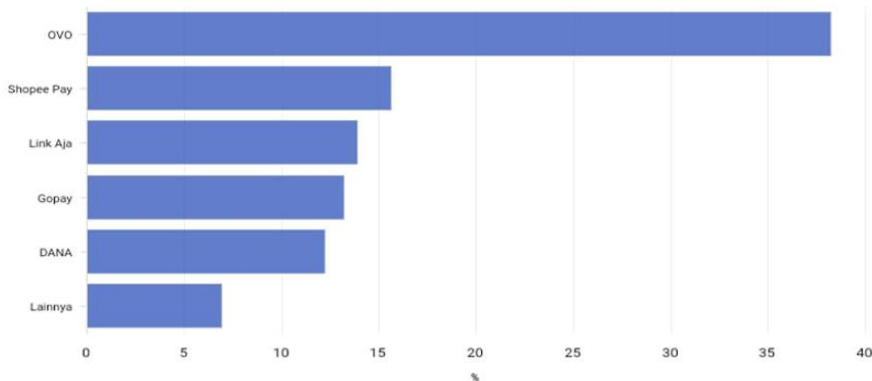


Figure 2: Market share of e-wallets in Indonesia

Source: Mobile Wallets Report (2021).

In August 2019, the Central Bank of Indonesia, as the payment system regulator in Indonesia, introduced a payment channel that utilizes a shared delivery channel for server-based payment instruments known as Quick Response Indonesia Standard (QRIS) (Bank Indonesia, 2019). This payment channel aims to simplify and standardize all non-cash transactions using QR codes. The use of QRIS can be implemented through various payment applications installed on smartphones and connected to the internet. An e-wallet is a digital application that allows individuals to electronically store money and conduct a wide range of financial transactions, including paying bills, transferring funds, and making purchases of products and services. E-wallets offer various benefits such as convenience, speed, and security in conducting transactions, as well as enhancing accessibility to financial services, especially for individuals who do not possess bank accounts.

However, due to the growing multitude of e-wallet platforms in the Indonesian market, users frequently encounter difficulty when selecting the e-wallet that aligns most effectively with their requirements. Aside from the user confusion caused by the different ways of working and features of each e-wallet, there are some additional problems or challenges that can arise due to the large number of e-wallets to choose from:

1. **Interoperability Limitations:** Some e-wallets may have limitations in terms of interoperability, which means that not all e-wallets can be used universally at all shops or merchants. This can cause inconvenience for users, especially if they have to switch between e-wallets for different payment needs.
2. **Additional Fees for Users:** The large number of e-wallets may lead users to open and maintain multiple e-wallet accounts simultaneously. Each account may incur additional fees, such as certain administrative fees or transaction fees, which can increase the financial burden on the user.
3. **Security Risk:** The more e-wallets are used, the more financial information is spread across various platforms. If one of the e-wallet accounts suffers a security breach, the risk of financial loss for the user may increase.
4. **Availability of Customer Service:** The abundance of e-wallets may result in a rise of customer service requests, and not all e-wallet providers may be able to provide adequate customer support. Users may find it difficult to get help or solutions if they encounter a problem with their e-wallet.
5. **Changes in Policies and Terms:** With lots of competition in the e-wallet market, providers may make changes to policies or terms on a regular basis to attract users or increase profits. This can cause uncertainty for users and disrupt the overall user experience.

6. Separation of Funds: Users with multiple e-wallets may have to divide their funds across several accounts, which can make financial planning and money management difficult.
7. Difficulty Comparing Performance: The sheer number of e-wallets can make it difficult for users to compare the performance or benefits of each platform. Users need to do more in-depth research to understand the features and benefits offered by each e-wallet.

To overcome this challenge, the role of education and financial literacy is very important. Users should be better educated about the differences and features of each e-wallet before making a decision to use one of them. Governments and e-wallet providers can also play a role in increasing transparency and providing clear information to users about applicable policies, fees and conditions. Thus, users can make smarter decisions and choose the e-wallet that best suits their needs and preferences. In this context, the Analytical Hierarchy Process (AHP) method serves as a valuable decision-making tool. AHP helps users compare relevant criteria and assign appropriate weights to each criterion, resulting in more objective priorities in choosing the most ideal e-wallet. Using AHP, users can consider important factors such as security, user-friendliness, features and functionality, cost and fees, coverage and acceptance when choosing an e-wallet that suits their preferences and needs. This research aims to optimize the digital payment experience by using AHP as a guide in choosing the best e-wallet. The goal is to assist users in choosing an e-wallet that suits their needs and preferences. Users often face many choices available, therefore a systematic method is needed. An approach for evaluating the most suitable e-wallet is through the application of AHP.

2 Literature review

2.1 Mobile wallets

Mobile wallets represent the latest advancement in mobile payment technology, serving as a modern alternative to traditional wallets while offering a host of advanced features. These versatile applications go beyond facilitating mobile transactions, encompassing a wide array of functions typically associated with physical wallets, such as storing membership cards, loyalty cards, and travel cards. Additionally, they serve as a secure repository for sensitive personal information, including passports, credit card details, PIN codes, online shopping accounts, order details, and insurance policies, which can be safeguarded through encryption and password protection to ensure the security and privacy of users' data (Shin, 2009). An e-wallet is a smartphone application that empowers users to conduct various financial transactions using their mobile devices (Qasim, Siddiqui and Rehman, 2012).

Here are some alternative e-wallets that are popular in Indonesia and can serve as research material:

1. **OVO (Omnibus Value Object)**. OVO is a popular digital payment platform in Indonesia that was launched in 2017. Users can perform various transactions such as bill payments, money transfers, purchasing prepaid credits, and making payments at physical stores. OVO also offers point rewards and cash-back features, and collaborates with various merchants. The OVO application can be downloaded on Android and iOS devices; users can link it to their bank accounts or top up the balance through bank transfers or OVO agents (Mufti, 2020).
2. **Go-Pay (Good Payment)**. Go-Pay is a popular digital payment platform in Indonesia and is part of the on-demand technology company Gojek. Launched in 2016, Go-Pay enables users to perform various transactions, including payments at physical stores, purchasing prepaid credits, bill payments, money transfers, and payments at Gojek's partner merchants. Users can access Go-Pay through the Gojek application on Android and iOS devices by linking their accounts to their bank accounts or topping up the balance through bank transfers or Go-Pay agents. Go-Pay also offers promotions and cashback to users (www 1).
3. **DANA**. DANA is a popular digital payment platform in Indonesia. Launched in 2018, DANA enables users to perform various transactions such as bill payments, money transfers, purchasing prepaid credits, and making payments at physical stores. The DANA application can be downloaded on Android and iOS devices, and users can link it to their bank accounts or top up the balance through bank transfers or DANA agents (www 2).
4. **Shopee-Pay**. Shopee-Pay enables users to make easy and secure payments while shopping on the Shopee platform. With Shopee Pay, users can purchase products, pay bills, buy vouchers, and transfer money to other users within the Shopee ecosystem. Shopee Pay offers various promotions and discounts to users who utilize the service. It also allows users to store a balance within the application, facilitating seamless transactions on Shopee. Users can access Shopee Pay through the Shopee application, available for both Android and iOS devices. The service can be activated and linked to the user's bank account, or users can load their Shopee Pay balance through bank transfers or other available payment methods on the Shopee platform. Shopee Pay has become a popular payment option in Indonesia, especially among active Shopee users (www 3).
5. **LinkAja**. LinkAja is a well-known digital payment platform in Indonesia. It was introduced in 2019 through a collaboration between several prominent financial institutions in the country, including Telkomsel, Bank Mandiri,

Bank Rakyat Indonesia (BRI), Bank Negara Indonesia (BNI), and Bank Tabungan Negara (BTN). LinkAja empowers users to engage in a wide range of financial activities, such as making in-store payments, buying prepaid credits, settling bills, transferring money to other LinkAja users, purchasing tickets, and accessing additional financial services. The platform also offers promotions and cashback incentives to its users. Accessible through a mobile application compatible with both Android and iOS devices, LinkAja allows users to link their accounts to their bank accounts or top up their balances through bank transfers or at LinkAja payment agents situated throughout Indonesia. Being one of the leading digital payment platforms in Indonesia, LinkAja has gained popularity as a convenient choice for managing everyday financial transactions (www 4).

2.2 Analytical Hierarchy Process (AHP) method

The Analytic Hierarchy Process (AHP) method was created by Thomas L. Saaty in the 1970s and has since evolved into one of the primary methods for preference-based decision-making. AHP aids decision-makers in addressing the intricacies and subjectivity involved in evaluating multiple criteria and alternatives to arrive at the optimal decision. It is widely recognized as a Multi-Criteria Decision Making (MCDM) tool, specifically designed to tackle MCDM problems. AHP's popularity is on the rise due to its ease of comprehension and straightforward application. It has found applications in various fields, including:

- **Management:** AHP can be used in strategic decision making, business planning, performance appraisal, selection of investment projects, product development (Karmaker, Halder and Ahmed, 2019), supply chain management (Tramarico et al., 2015), prioritization, risk management (Roux III and Eng., 2014), and human resource management (Dong and Yang, 2006).
- **Engineering:** AHP can be used in infrastructure planning, site selection (Serra Costa, Borges and Machado, 2016), technology product development (Ahmad and Lee, n.d.; Jain and Rao, 2013), project management (Piratelli and Belderrain, 2010), system design, quality control, process improvement, and operation and maintenance management.
- **Economics:** AHP can be used in investment analysis, economic assessment of projects, investment portfolio selection (Saracoglu, 2015), target market selection, business and new business evaluation, policy analysis, pricing, and financial management (Kaftandzieva, n.d.).
- **Environment:** AHP can be used in environmental impact assessment, management of natural resources, selection of environmentally friendly technologies, evaluation of environmental policies, planning of waste management, and prioritization of environmental protection measures (Chung, 2016).

- Information Systems: AHP can be used in software selection (Even, Goldreich and Yacobi, 1984; Mohamed et al., 2022), prioritization of information system development, evaluation of IT systems, prioritization of information security, IT risk management, and management of IT services (Ahmad and Lee, n.d.; Jain and Rao, 2013).
- Health: AHP can be used in the selection of treatment or therapy, assessment of the quality of health services, prioritization of medical research, allocation of health resources, health policy planning, and health risk assessment (Kafandzieva, n.d.; Sava et al., 2020).
- Transportation: AHP can be used in prioritizing transportation infrastructure development, choosing transportation modes, planning transportation networks, traffic management, determining road repair priorities, and evaluating transportation policies (Abdou and Tkiouat, 2021; Sari, Mohamed and Alil, 2021; Verma and Koul, 2012; Saripudin, 2021).
- Defense sector: AHP can be used in determining the selection of warships (dos Santos, de Araújo Costa and Gomes, 2021; Hamurcu and Eren, 2020).

These are just a few examples of areas where AHP has been widely applied. However, AHP can be applied in a variety of multi-criteria decision contexts where selecting the optimal or ranking of alternatives is required.

The Analytical Hierarchy Process (AHP) method is a decision support method that structures complex multi-factor or multi-criteria problems into a hierarchical framework. According to Saaty (Saaty and Vargas, 2012), a hierarchy is defined as a representation of a complex problem organized into a multilevel structure. This structure typically starts with the top level representing the overall goal, followed by criteria factors, sub-criteria, and so on, culminating in the lowest level containing the alternatives or choices. The core principle of AHP is to simplify intricate decision problems by breaking them down into a hierarchy comprising three key levels:

1. Goal: This top level represents the overarching objective or purpose of the decision-making process.
2. Criteria: The second level includes the factors or attributes relevant to the decision, and these factors play a role in achieving the stated goal.
3. Alternatives: The bottom level contains the available options or choices that can be considered when making the decision.

In essence, the AHP method provides a systematic and structured approach for evaluating and prioritizing alternatives based on a set of criteria and a defined goal, making it a valuable tool for complex decision-making scenarios.

Following Saaty (2008), AHP can be divided into the following steps:

1. Determine the Goal: Identify the main objective of the decision-making and state it clearly. The main goal is to identify and determine the top e-wallet service providers in the market.
2. Determine the Criteria: Identify the relevant criteria for evaluating the existing alternatives. Our criteria are: security, user-friendliness, features and functionalities, costs and fees, while the alternatives are: Shopee-Pay, Go-Pay, OVO, DANA, LinkAja.
3. Create a Hierarchy: Formulate the hierarchy by placing the goal at the top level, criteria at the second level, and sub-criteria at subsequent levels.

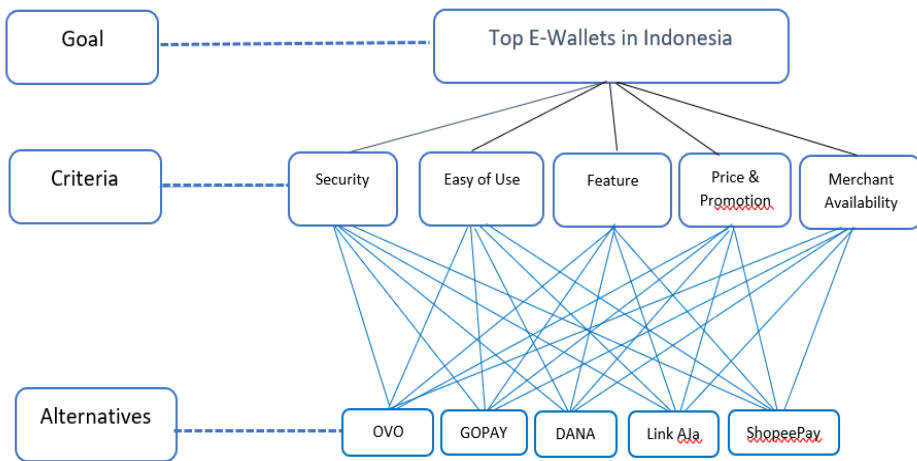


Figure 3: AHP structure diagram for evaluating the top e-wallets in Indonesia

4. Pairwise Comparison: Conduct pairwise comparisons between elements at each level of the hierarchy. Use a rating scale to determine the extent to which one element is more important than another.

Table 1: Comparison scale for pairwise comparison matrix

| Importance | Explanation |
|------------|---|
| 1 | Two criteria contribute equally to the objective |
| 3 | Importance of criteria i is slightly higher than that of j towards the objective |
| 5 | Importance of criteria i is strongly higher than that of j towards the objective |
| 7 | Importance of criteria i is very strongly higher than that of j towards the objective |
| 9 | Importance of criteria i is absolutely higher than that of j towards the objective |
| 2, 4, 6, 8 | Used to represent intermediate values |

Source: Saaty (2008).

5. Calculate Consistency Ratio: Evaluate the consistency of pairwise comparisons using the consistency index (CI). When the Consistency Ratio (CR) is below 0.1, it indicates that the pairwise comparisons are deemed to be consistent.
6. Calculate Aggregate Weights: Calculate the aggregate weights for each element at each level of the hierarchy by multiplying the relative weights from pairwise comparisons.
7. Calculate the global priorities for each alternative by multiplying the combined weights obtained from each level.
8. Conduct sensitivity analysis to investigate how alterations in weights impact global priorities, referring to Figures 11-15 for guidance.
9. Make a Decision: Use the global priorities to make the appropriate decision on the basis of the predetermined goal (see Figures 9-10).

The AHP method enables decision makers to make more informed and objective decisions by considering preferences and weights assigned to each criterion. In the context of selecting the best e-wallet in Indonesia, AHP can be used to compare criteria such as security, ease of use, features and functionality, costs and fees, and coverage and acceptance, in order to determine priorities and choose the e-wallet that best suits the needs and preferences of users. Security is a critical factor when evaluating e-wallet options. Users need assurance that their financial information and transactions are protected from unauthorized access and fraud. Several studies have highlighted the importance of robust security measures in e-wallets, including encryption protocols, biometric authentication, and tokenization techniques (Zhang et al., 2018). It is crucial for e-wallet providers to invest in state-of-the-art security infrastructure to gain users' trust and confidence. Ease of use is another key criterion in evaluating e-wallets. Users expect intuitive interfaces, simple registration processes, and seamless transaction experiences. Studies have emphasized the significance of user-friendly designs, clear navigation, and minimal steps required for transactions (Alalwan et al., 2017). E-wallet providers that prioritize ease of use are more probable to draw in and maintain users in the highly competitive market. The range and usefulness of features offered by e-wallets play a significant role in their adoption and user satisfaction. Common features include fund transfers, bill payments, mobile top-up, and integration with other services such as ride-hailing or food delivery applications. Research has shown that the availability of diverse and valuable features enhances the overall user experience and contributes to the preference for specific e-wallets (Kim, Mirusmonov and Lee, 2010). A promotion price, also known as a sale price, refers to a discounted price at which a business sells its products or services for a limited period. The purpose of offering such temporary discounts is to attract potential customers and boost sales.

By lowering prices temporarily, businesses aim to enhance customers' perception of the value offered by the product or service, thus driving higher sales. Promotional pricing serves as a sales tactic that can contribute to short-term sales growth while also fostering customer loyalty and generating repeat business in the long run. To support this strategy, businesses employ marketing campaigns and promotions that align with the discounted pricing (Rowe and Clark, 2012).

3 Methodology

The following is a more complete explanation of the research methodology "Determining the Top E-Wallet in Indonesia: Applying the AHP Method for Optimal Financial Choices" using quantitative descriptive research methods and the Analytical Hierarchy Process (AHP) model:

1. **Research Objectives:** This research aims to identify the leading e-wallets in Indonesia based on optimal financial criteria using the Analytical Hierarchy Process (AHP) methodology.
2. **Research Approach:** This study employs a quantitative descriptive approach, focusing on an accurate and systematic description of observed phenomena or events. The quantitative aspect involves gathering and analyzing numerical data to measure relationships among the research variables.
3. **Research Model:** The research utilizes the Analytical Hierarchy Process (AHP) methodology, which facilitates the comparison and ranking of alternatives based on multiple criteria and sub-criteria. AHP assists in determining the relative weights of these criteria and sub-criteria, ultimately yielding optimal priorities.
4. **Data Source:** Primary data is collected through a questionnaire distributed via Google Form to 111 respondents. The questionnaire gathers information on respondents' preferences and perceptions regarding their current or intended use of e-wallets. Additionally, secondary data sources, such as market reports and verified industry data, may be utilized to supplement the research.
5. **Population and Sample:** The study's population consists of individuals in Indonesia who use or plan to use e-wallets. A random sample of 111 respondents was selected to ensure unbiased decision-making. Among the survey participants there were 40 men and 70 women. The age distribution revealed the highest number of respondents (60) in the 21-30 age group, followed by 32 respondents in the under-21 age group. Additionally, 15 respondents were in the 31-40 age group, while 4 respondents were above 41 years old. In terms of income, the majority (81 respondents) had incomes below IDR 5,000,000, while 15 respondents had incomes ranging from IDR

5,000,000 to IDR 10,000,000, and another 15 had incomes exceeding IDR 10,000,000.

6. **Research Variables:** The main variables in this study are the choice of e-wallet (alternative) and financial criteria (Ease of use, Features, Merchant availability, Price and promotion, Security). Gender, age, and income variables are used as demographic data to provide an overview of the characteristics of the respondents.
7. **Data Collection:** Primary data were collected through an online questionnaire filled out by the respondents. The questionnaire contained questions about preferences, experience, and the level of importance of the criteria provided, as well as the selection of e-wallets (alternatives) that respondents want to use.
 - a. **Data Processing with Excel:** Data from the online questionnaire are then processed in Excel to calculate the representation of each criterion and alternative using the Geomean formula (Geometric Mean). The Geomean formula is used to calculate the median value of several values, which are used as representative values or relative weights for each criterion and alternative. If pairwise comparisons are conducted through a questionnaire involving multiple respondents, preliminary data processing is essential before the results are organized into a matrix. Since the questionnaire data are qualitative and ordinal in nature, the values are derived using the geometric average (geometric mean) to ensure an accurate representation of the respondents' assessments (Cahyadi and Muzaqin, 2019; Malacaria et al., 2023).
 - b. **Use of the Super Decisions Application:** After the data representing the criteria and alternatives are generated in Excel, the data is entered into the Super Decisions application. This application is a useful tool in the AHP analysis. Super Decisions help compare each criterion and alternative and produce priority rankings based on the relative weight of the processed data.
 - c. **Comparing Criteria:** In the Super Decisions application, each of the criteria (Ease of use, Features, Merchant availability, Price and promotion, Security) is compared to determine the relative weight or importance of each one in evaluating e-wallets.
 - d. **Comparing Alternatives:** Next, each of the e-wallet alternatives (Go-Pay, OVO, LinkAja, DANA, and Shopee-Pay) is compared on the basis of pre-determined criteria in the Super Decisions application.
 - e. **Results and Conclusions:** From the AHP analysis carried out in the Super Decisions application, we obtain results in the form of priority rankings of e-wallets which are the optimal financial choices based on preferences and the relative weight of the criteria provided.

8. Research Limitations: This study has several limitations, such as the limited sample size and its focus on financial criteria only. In addition, this study only covers e-wallets that are popular or commonly used in Indonesia; newer or less well-known e-wallets may not be included in the analysis.
9. The findings from the AHP analysis will be analyzed to determine the leading e-wallets in Indonesia according to the optimal financial preferences and priorities of the respondents.

4 Results and discussion

The following are the design goals, criteria and alternatives for choosing the best e-wallet in Indonesia. There are three levels: the first one is the objective, which is to find the best e-wallet. The second level consists of the criteria, which include Security, Ease of use, Feature availability, Price and promotion, and Merchant availability. The third level consists of the alternatives, namely OVO, Go-Pay, DANA, LinkAja, and Shopee-Pay.

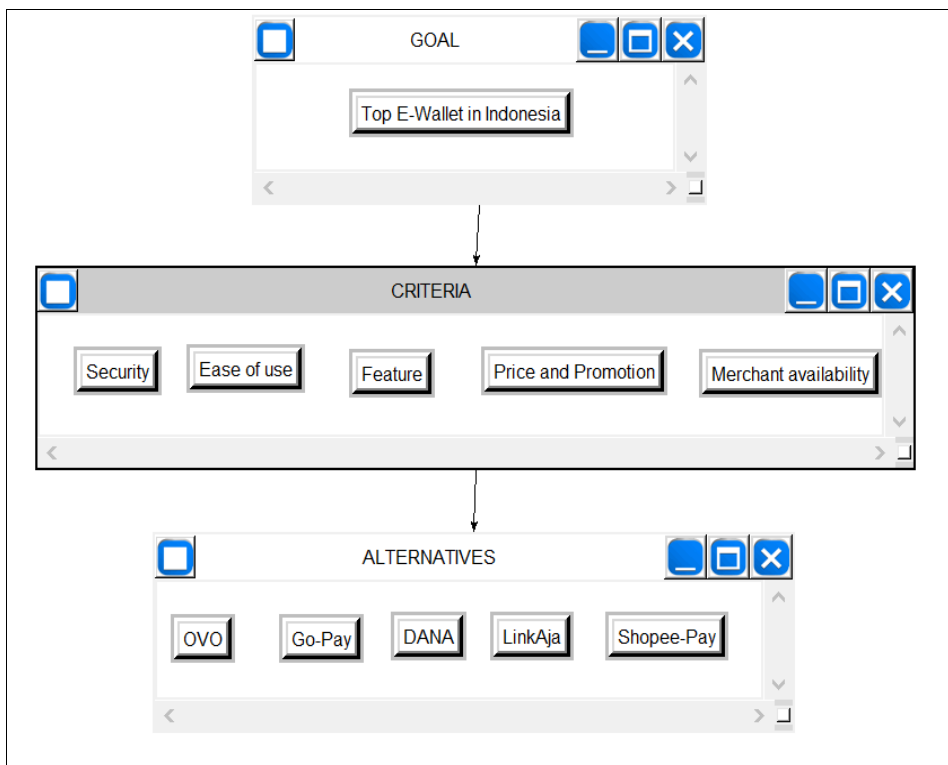


Figure 4: Screen view of AHP of top e-wallets in Indonesia

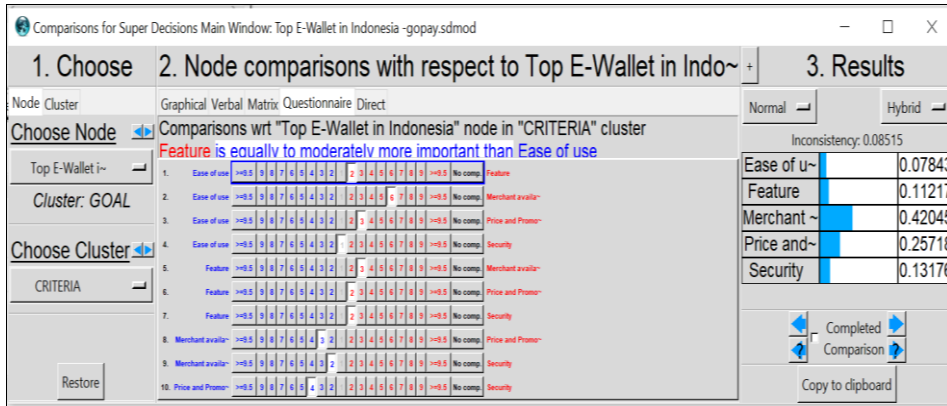


Figure 5: Pairwise comparison matrix which compares the main criteria with respect to the overall goal

Figure 5 compares all the criteria (Security, Ease of use, Merchant availability, Price and promotion, Feature), where the eigenvalue for Ease of use is 10%, for Feature is 7%, for Merchant availability is 11%, for Price and promotion is 26%, while for Security is 13%. The consistency ratio is below 10% or 0.1, which is 0.08515 (8%). Based on the criteria comparison, the highest value is achieved by Merchant availability, namely 42%.

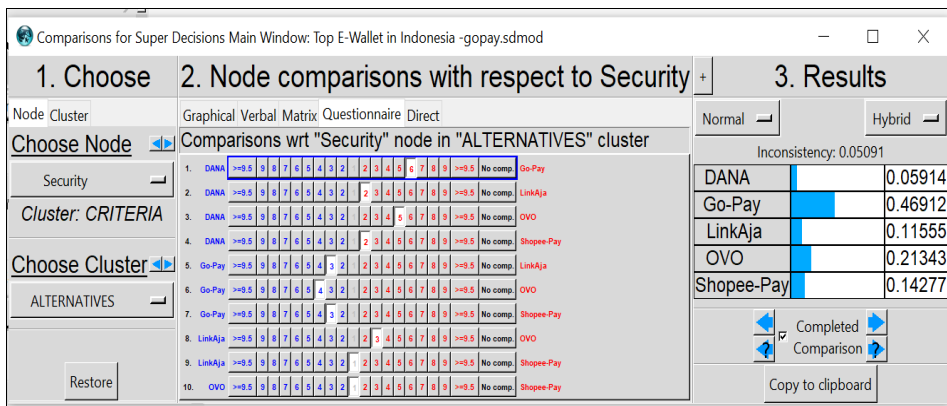


Figure 6: Pairwise comparison matrix of specific information related to Security

Figure 6 compares five digital wallet alternatives (DANA, Go-Pay, LinkAja, OVO, Shopee-Pay) on the basis of the security aspect, where the eigenvalue for DANA is 6%, for Go-Pay is 47%, for LinkAja is 11%, for OVO is 21%, and for Shopee-Pay is 14%. The consistency ratio is below 10% or 0.1, which is 0.05091 (5%). Based on the comparison of alternatives for the security criterion, the highest value is achieved by Go-Pay, namely 47%.

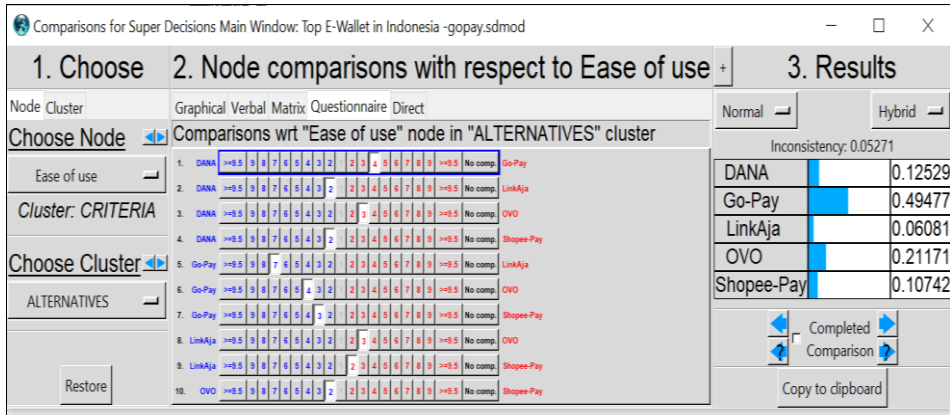


Figure 7: Pairwise comparison matrix of specific information related to Ease of use

Figure 7 compares five digital wallet alternatives (DANA, Go-Pay, LinkAja, OVO, Shopee-Pay) on the basis of the Ease of use aspect, where the eigenvalue for DANA is 12%, for Go-Pay is 49%, for LinkAja is 6%, for OVO is 21%, and for Shopee-Pay is 11%. The consistency ratio is below 10% or 0.1, which is 0.05271 (5%). Based on the comparison of alternatives for the Ease of use criterion, the highest value is achieved by Go-Pay, namely 49%.

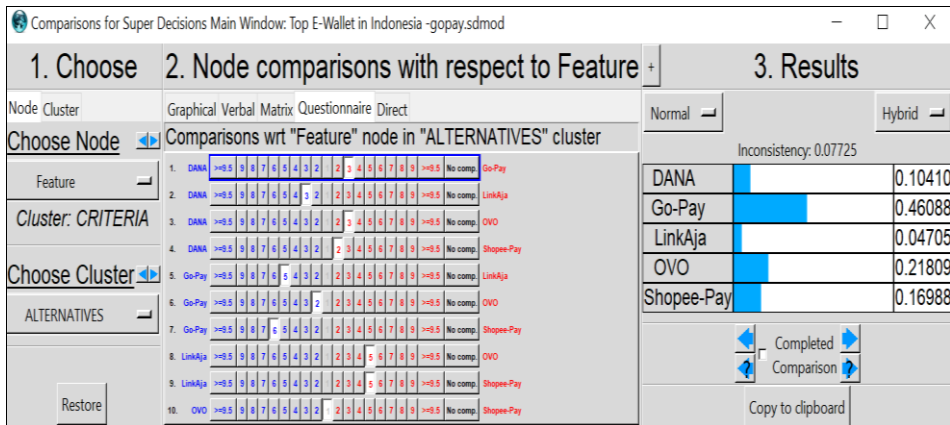


Figure 8: Pairwise comparison matrix of specific information related to Feature

Figure 8 compares five digital wallet alternatives (DANA, Go-Pay, LinkAja, OVO, Shopee-Pay) on the basis of the feature aspect, where the eigenvalue for DANA is 10%, for Go-Pay is 46%, for LinkAja is 5%, for OVO is 22%, and for Shopee-Pay is 17%. The consistency ratio is below 10% or 0.1, which is 0.07725 (8%). Based on the comparison of alternatives for the feature criterion, the highest value is achieved by Go-Pay, namely 46%.

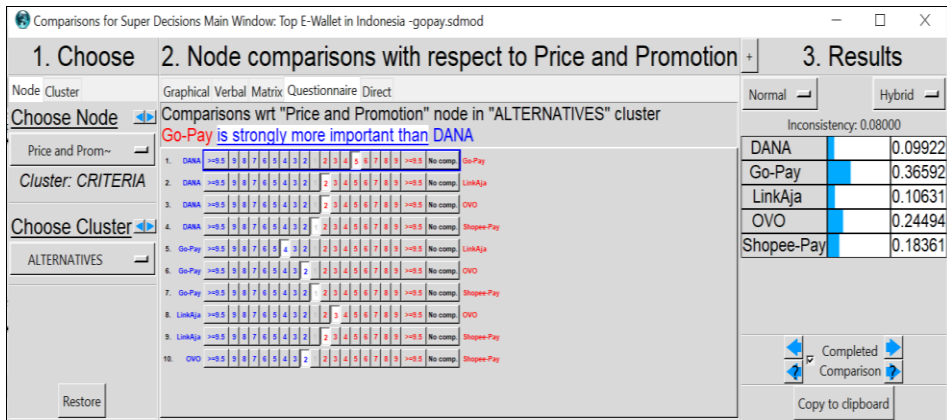


Figure 9: Pairwise comparison matrix of specific information related to Price and promotion

Figure 9 compares five digital wallet alternatives (DANA, Go-Pay, LinkAja, OVO, Shopee-Pay) on the basis of the Price and promotion aspect, where the eigenvalue for DANA is 9%, for Go-Pay is 36%, for LinkAja is 11%, for OVO is 24%, and for Shopee-Pay is 18%. The consistency ratio is below 10% or 0.1, which is 0.08000 (8%). Based on the comparison of alternatives for the price criterion, the highest value is achieved by Go-Pay, namely 36%.

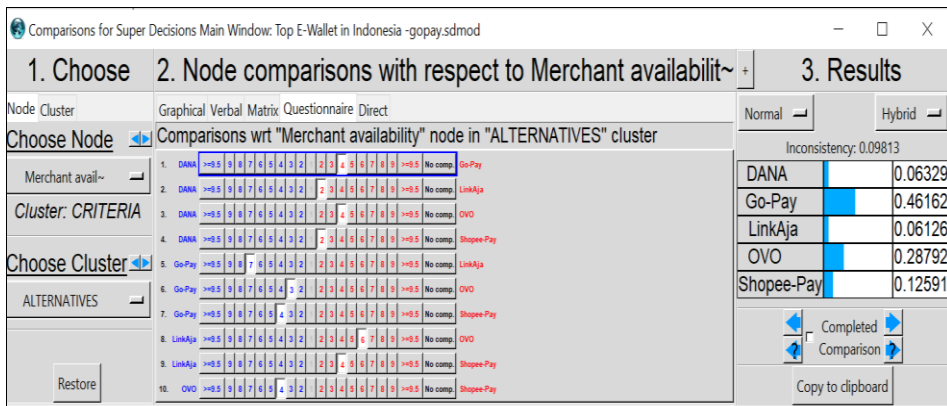


Figure 10: Pairwise comparison matrix of specific information related to Merchant availability

Figure 10 compares five digital wallet alternatives (DANA, Go-Pay, LinkAja, OVO, Shopee-Pay) on the basis of the Merchant availability aspect, where the eigenvalue for DANA is 6%, for Go-Pay is 46%, for LinkAja is 6%, for OVO is 29%, and for Shopee-Pay is 12%. The consistency ratio is below 10% or 0.1, which is 0.09813 (10%). Based on the comparison of alternatives for the Merchant availability criterion, the highest value is achieved by Go-Pay, namely 46%.

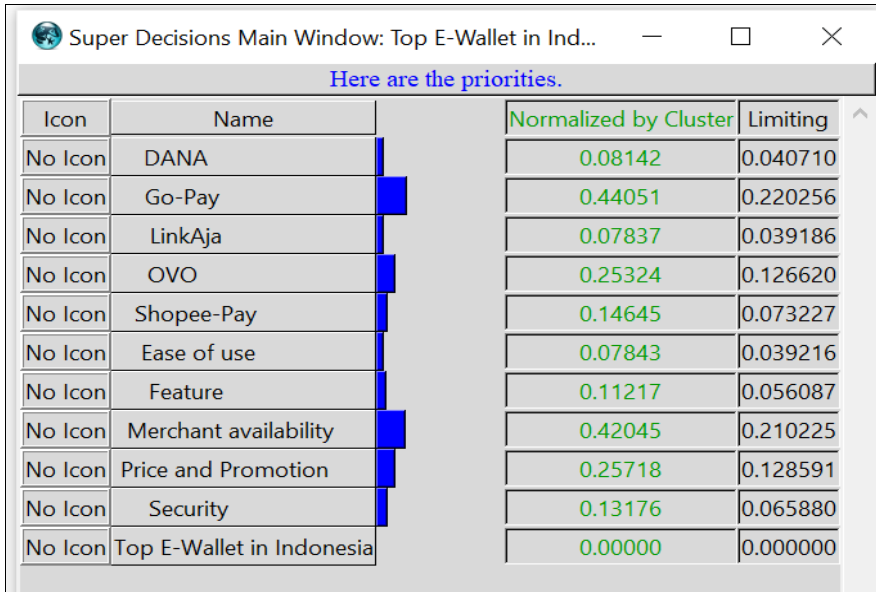


Figure 11: Priorities of Criteria and Alternatives

In Figure 11, Priorities of Criteria and Alternatives have been scored on the basis of various factors. Merchant availability has the highest score for the criteria at 42% and the best e-wallet alternative is Go-Pay with the score of 44%.

Table 2: Alternative rankings

| Graphic | Alternatives | Total | Normal | Ideal | Ranking |
|---------|--------------|--------|--------|--------|---------|
| | DANA | 0.0407 | 0.0814 | 0.1848 | 4 |
| | Go-Pay | 0.2203 | 0.4405 | 1.0000 | 1 |
| | LinkAja | 0.0392 | 0.0784 | 0.1779 | 5 |
| | OVO | 0.1266 | 0.2532 | 0.5749 | 2 |
| | Shopee-Pay | 0.0732 | 0.1465 | 0.3325 | 3 |

From the alternative rankings data above, we see the results of an analysis or comparison of several e-wallet platforms in Indonesia, with each score given in the range from 0 to 1.

Ranking interpretation:

1. Go-Pay: Obtained the highest score of 0.4405, which places it first. Therefore Go-Pay is considered the most suitable with respect to the criteria or parameters used in the assessment.
2. OVO: Obtained a score of 0.2532, which placed it second. OVO gets a good rating, but still loses to Go-Pay in this analysis.

3. Shopee-Pay: Earned a score of 0.1465, which places it third. Shopee-Pay ranks below Go-Pay and OVO, but is still higher than the other two e-wallets.
4. DANA: Obtained a score of 0.0814, which placed it fourth. DANA has a lower position than the previous three e-wallets, but still a higher one than the last e-wallet.
5. LinkAja: Obtained a score of 0.0784, which placed it fifth. LinkAja is the e-wallet with the lowest score among all the alternatives.

It should be noted that this interpretation is based on the data provided. A higher score indicates better performance or judgment according to the given criteria. However, it is important to know the criteria and methodology used in this analysis in order to understand more comprehensively why each e-wallet has earned a certain rating. Each of these ratings can be considered as a result of relative analysis, and e-wallet ratings may change over time or with changing scoring criteria. So, these priority results provide insight into what criteria users consider the most important in choosing a digital payment service. Merchant availability is the main factor followed by promotional prices, security, features, and ease of use.

Sensitivity analysis

In the final step of the AHP analysis, a sensitivity analysis was conducted to assess how adjustments to various model parameters would impact the selection of the best alternative in terms of personal finances. This sensitivity analysis is crucial because the prioritization of alternatives relies heavily on the subjective judgments used to assign weights to the main criteria. Therefore, it is necessary to test the stability of the rankings when the criteria weights are modified. Figures 3-7 present a series of sensitivity analyses carried out to investigate how changing the priority of criteria would affect the ranking of alternatives. In total, ten different scenarios were examined, with two scenarios considered for each criterion. Initially, the importance of the financial security criterion was increased by approximately 90%, and then decreased by around 10%. The results of the sensitivity analysis, as shown in Figure 3, reveal that altering the weight of this criterion did not have a significant influence on the importance of the alternatives. Consequently, the overall ranking of the final outcome remained consistent with the ranking shown in Table 2.

Performing sensitivity analysis is a vital aspect of the AHP analysis because it helps evaluate how modifications to various factors impact the selection of the best alternative as regards personal finances. This analysis is particularly important because the prioritization of alternatives is heavily dependent on the subjective assignment of weights to the primary criteria. As these weights are typically determined subjectively, it is crucial to assess the stability of the rank-

ings when these criteria weights are altered (Chang et al., 2007). Figures 12-16 provide a series of sensitivity analyses that were conducted to assess how changing the priority of criteria would affect the ranking of alternatives. A total of ten different scenarios were considered, with two scenarios examined for each criterion. Initially, the importance of the financial Security criterion was increased by approximately 90%, and then decreased by around 10%.

Sensitivity analysis for Security

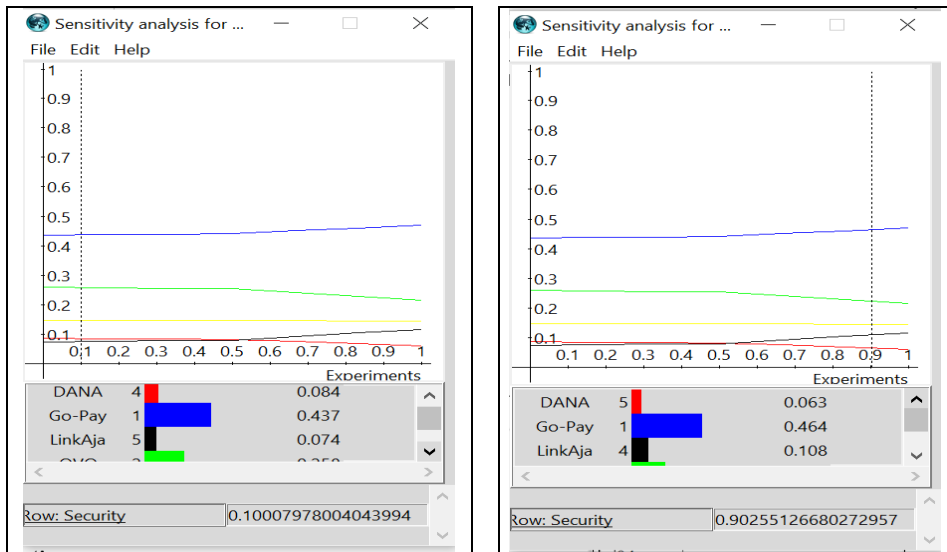


Figure 12: The Security criterion increased by 90% (right) and decreased by 10% (left)

An increase of the criteria of Security by 90% has an impact on the ranking: Go-Pay ranks 1st (46%), OVO ranks 2nd (22%), Shopee-Pay ranks 3rd (14%), LinkAja ranks 4th (11%) and DANA ranks 5th (6%). A decrease of the criteria of Security by 10% has no impact on the change of rankings: Go-Pay maintains the first rank (43%), OVO ranks 2nd (26%), Shopee-Pay ranks 3rd (15%), DANA ranks 4th (8%), and LinkAja ranks 5th (7%).

Sensitivity analysis for Price and promotion

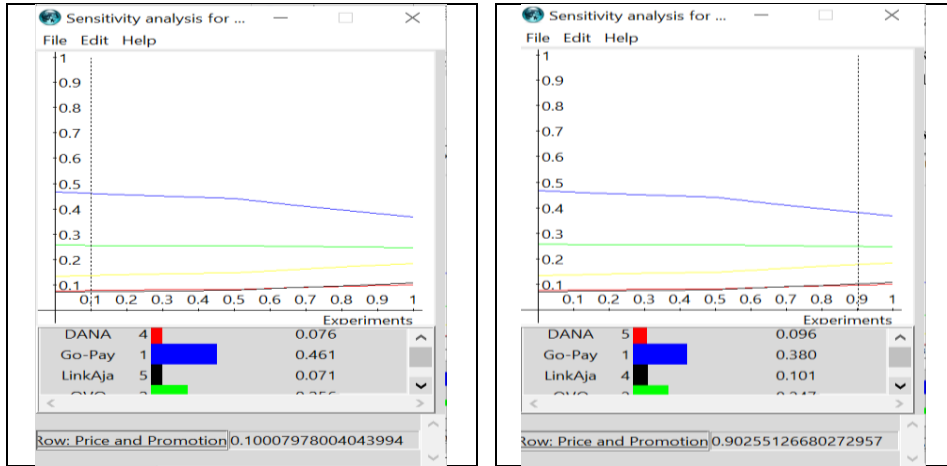


Figure 13: Sensitivity analysis for the Price and promotion criterion: increased by 90% (right) and decreased by 10% (left)

The increase of the criteria of Price and promotion by 90% has no impact on the change of priorities or rankings: Go-Pay ranks 1st (38%), OVO ranks 2nd (25%), Shopee-Pay ranks 3rd (18%), LinkAja ranks 4th (10%), and DANA ranks 5th (9%). The decrease of the criteria of Price and promotion by 10% has no impact on the change of priorities or rankings: Go-Pay maintains the 1st rank (46%), OVO ranks 2nd (26%), Shopee-Pay ranks 3rd (14%), DANA ranks 4th (7.6%), and LinkAja ranks 5th (7.2%).

Sensitivity analysis for Merchant availability

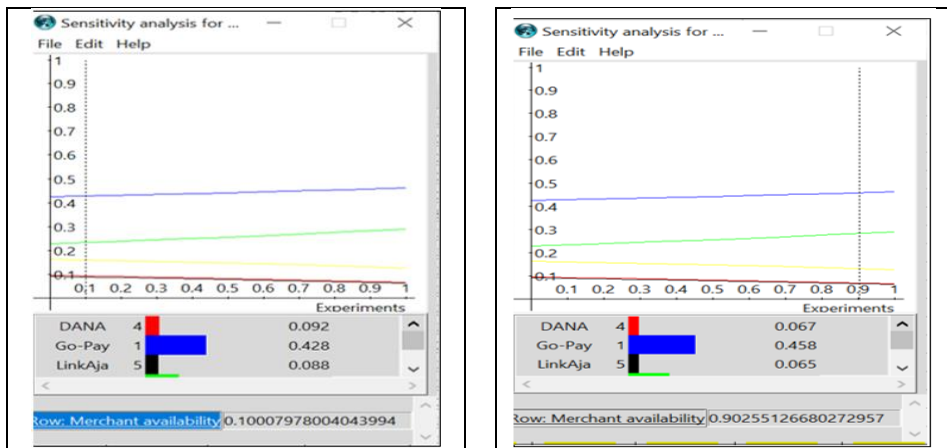


Figure 14: Sensitivity analysis for the Merchant availability criterion: increased by 90% (right) and decreased by 10% (left)

The increase of the criteria of Merchant availability by 90% has no impact on the change of priorities or rankings: Go-Pay ranks 1st (46%), OVO ranks 2nd (28%), Shopee-Pay ranks 3rd (13%), DANA ranks 5th (7%) and LinkAja ranks 4th (6%). The decrease of the criteria of Merchant availability by 10% has no impact on the change of priorities or rankings: Go-Pay maintains the 1st rank (43%), OVO ranks 2nd (23%), Shopee-Pay ranks 3rd (16%), DANA ranks 4th (9%), and LinkAja ranks 5th (9%).

Sensitivity analysis for Ease of use

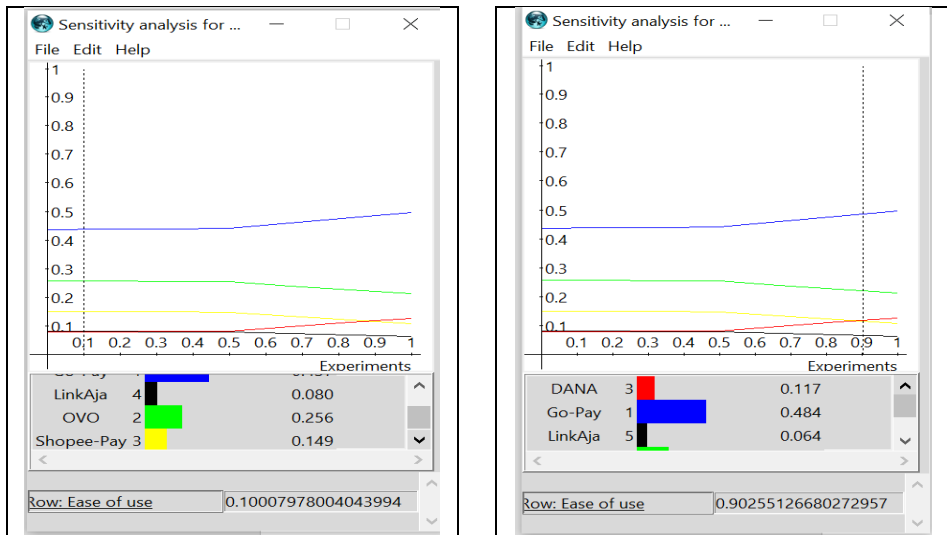


Figure 15: Sensitivity analysis for the Ease of use criterion: increased by 90% (right) and decreased by 10% (left)

The increase of the criteria of Ease of use by 90% has no impact on the change of priorities or rankings: Go-Pay ranks 1st (44%), OVO ranks 2nd (26%), Shopee-Pay ranks 3rd (15%), LinkAja ranks 4th (8%), and DANA ranks 5th (8%). The decrease of the criteria of Ease of use by 10% has no impact on the change of priorities or rankings: Go-Pay maintains the 1st rank (48%), OVO ranks 2nd (22%), Go-Pay ranks 3rd (20%), DANA ranks 4th (12%), and LinkAja ranks 5th (6%).

Sensitivity analysis for Feature

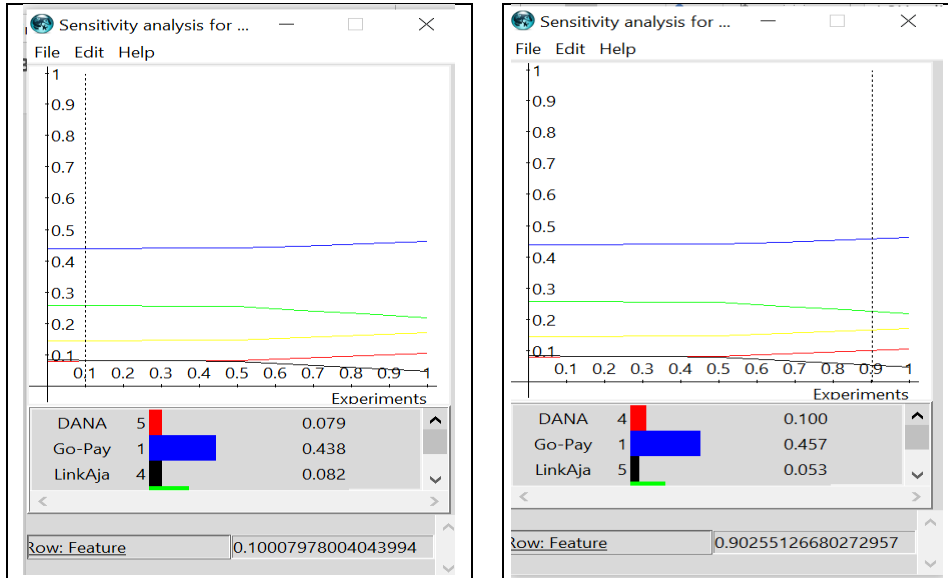


Figure 16: Sensitivity analysis for the Feature criterion: increased by 90% (right) and decreased by 10% (left)

The increase of the criteria of Feature by 90% has no impact on the change of priorities or rankings: Go-Pay ranks 1st (46%), OVO ranks 2nd (22%), Shopee-Pay ranks 3rd (16%), DANA ranks 4th (10%), and LinkAja ranks 5th (5%). The decrease of the criteria of Feature by 10% has no impact on the change of priorities or rankings: Go-Pay maintains the 1st rank (44%), OVO ranks 2nd (26%), Shopee-Pay ranks 3rd (14%), LinkAja ranks 4th (8%), and DANA ranks 5th (7%).

Table 3: Rank Influence Market

| Net: Toplevel network | Parameter value | DANA | Go-Pay | LinkAja | OVO | Shopee-Pay | Ranking DANA | Ranking Go-Pay | Ranking LinkAja | Ranking OVO | Ranking Shopee-Pay |
|-----------------------------|-----------------|----------|----------|----------|----------|------------|--------------|----------------|-----------------|-------------|--------------------|
| Original Values | 0.500000 | 0.081421 | 0.440512 | 0.078372 | 0.253241 | 0.146454 | 4 | 1 | 5 | 2 | 3 |
| DANA:upper | 0.900000 | 0.816284 | 0.088102 | 0.015674 | 0.050648 | 0.029291 | 1 | 2 | 5 | 3 | 4 |
| Go-Pay:upper | 0.900000 | 0.016284 | 0.888102 | 0.015674 | 0.050648 | 0.029291 | 4 | 1 | 5 | 2 | 3 |
| LinkAja:upper | 0.900000 | 0.016284 | 0.088102 | 0.815674 | 0.050648 | 0.029291 | 5 | 2 | 1 | 3 | 4 |
| OVO:upper | 0.900000 | 0.016284 | 0.088102 | 0.015674 | 0.850648 | 0.029291 | 4 | 2 | 5 | 1 | 3 |
| Shopee-Pay:upper | 0.900000 | 0.016284 | 0.088102 | 0.015674 | 0.050648 | 0.829291 | 4 | 2 | 5 | 3 | 1 |
| Ease of use:upper | 0.900000 | 0.116513 | 0.483921 | 0.064324 | 0.220016 | 0.115227 | 3 | 1 | 5 | 2 | 4 |
| Feature:upper | 0.900000 | 0.099561 | 0.456806 | 0.053312 | 0.225122 | 0.165199 | 4 | 1 | 5 | 2 | 3 |
| Merchant availability:upper | 0.900000 | 0.066914 | 0.457395 | 0.064685 | 0.280984 | 0.130022 | 4 | 1 | 5 | 2 | 3 |
| Price and promotion:upper | 0.900000 | 0.095656 | 0.380839 | 0.100726 | 0.246601 | 0.176177 | 5 | 1 | 4 | 2 | 3 |
| Security:upper | 0.900000 | 0.063593 | 0.463399 | 0.108115 | 0.221389 | 0.143504 | 5 | 1 | 4 | 2 | 3 |
| DANA:lower | 0.100000 | 0.016284 | 0.471655 | 0.083977 | 0.270925 | 0.157159 | 5 | 1 | 4 | 2 | 3 |
| Go-Pay:lower | 0.100000 | 0.132646 | 0.088102 | 0.126773 | 0.414979 | 0.237500 | 3 | 5 | 4 | 1 | 2 |
| LinkAja:lower | 0.100000 | 0.087023 | 0.470114 | 0.015674 | 0.270322 | 0.156867 | 4 | 1 | 5 | 2 | 3 |
| OVO:lower | 0.100000 | 0.103058 | 0.561007 | 0.099307 | 0.050648 | 0.185979 | 3 | 1 | 4 | 5 | 2 |
| Shopee-Pay:lower | 0.100000 | 0.092974 | 0.500247 | 0.089612 | 0.287876 | 0.029291 | 3 | 1 | 4 | 2 | 5 |
| Ease of use:lower | 0.100000 | 0.078434 | 0.436817 | 0.079568 | 0.256069 | 0.149112 | 5 | 1 | 4 | 2 | 3 |
| Feature:lower | 0.100000 | 0.079129 | 0.438453 | 0.081539 | 0.256794 | 0.144086 | 5 | 1 | 4 | 2 | 3 |
| Merchant availability:lower | 0.100000 | 0.091945 | 0.428263 | 0.088302 | 0.233114 | 0.158375 | 4 | 1 | 5 | 2 | 3 |
| Price and promotion:lower | 0.100000 | 0.076492 | 0.461172 | 0.070633 | 0.255540 | 0.136163 | 4 | 1 | 5 | 2 | 3 |
| Security:lower | 0.100000 | 0.084126 | 0.437039 | 0.073859 | 0.258074 | 0.146902 | 4 | 1 | 5 | 2 | 3 |

5 Conclusion

Based on the given data, Go-Pay is the top e-wallet in Indonesia. It has the highest normalized score among the e-wallets listed. Additionally, when comparing the criteria scores, it has performed well across various factors: Go-Pay's normalized score (0.44051) is significantly higher than that of the other e-wallets. Go-Pay has a strong presence in Merchant availability (0.42045), indicating that it is widely accepted at various retailers and establishments. It also scores well in Price and promotion (0.25718), which may attract users with its competitive offers. While it doesn't have the highest score in Security, it still has a decent score (0.13176), indicating a reasonable level of safety for users. Although OVO also has a respectable normalized score (0.25324), it falls behind Go-Pay, making Go-Pay the preferred choice among the e-wallets listed. The other e-wallets, such as Shopee-Pay, DANA, LinkAja have lower normalized scores and do not stand out as much as Go-Pay and OVO. One should keep in mind that this conclusion is based on the given data and criteria. Real-world scenarios may involve additional factors and considerations. Nevertheless, according to the information provided, Go-Pay appears to be the top e-wallet in Indonesia.

Here is additional information and analysis to further explore the e-wallet landscape in Indonesia:

- **Market Share:** It is important to consider the market share of each e-wallet provider. While Go-Pay appears to be the top e-wallet based on the given data, it is essential to verify its market dominance compared to its competitors. Market share can provide insights into the popularity and adoption rate of each e-wallet among Indonesian users.
- **User Reviews and Ratings:** Another crucial aspect in determining the top e-wallet is user feedback. Positive user reviews and high ratings often indicate a satisfactory user experience, which contributes to the overall popularity of an e-wallet. Checking online platforms and app stores for user reviews can help gain a better understanding of user satisfaction.
- **Innovation and Partnerships:** The continuous development of new features and partnerships with merchants can influence an e-wallet's popularity. E-wallet providers that regularly introduce innovative features, such as cash-back rewards, discounts, or easy integration with other services, might attract more users.
- **Accessibility:** The availability of the e-wallet on various platforms, such as mobile apps, web browsers, or even offline transactions, can significantly impact its adoption. An e-wallet that offers versatility in usage may have a competitive advantage.

- **Security and Fraud Prevention:** While the security score is provided in the data, it is important to delve deeper into the security measures implemented by each e-wallet provider. Users value the safety of their transactions and personal information, so a robust security system can increase trust in the platform.
- **Customer Support:** A responsive and helpful customer support team can enhance the user experience and resolve any issues promptly. Reliable customer support is essential for gaining and retaining users.

To draw a comprehensive conclusion about the top e-wallet in Indonesia, we need more information and a broader analysis beyond the data provided. It is recommended to conduct further research, considering the factors mentioned above, as well as any recent updates or changes in the e-wallet market in Indonesia. Additionally, consulting user surveys or market research reports can also provide valuable insights into the preferences and behaviors of e-wallet users in the country.

Overall, the findings of this research can serve as a valuable reference for users looking for the best e-wallet to meet their financial requirements. It also provides valuable information for e-wallet providers to improve their services and meet the expectations of their target audience.

Example of Questionnaire Appendix

DETERMINING THE TOP E-WALLET IN INDONESIA: APPLYING AHP METHOD FOR OPTIMAL FINANCIAL CHOICES

This questionnaire was prepared as part of data collection for research on the identification of the best E-Wallets using the AHP method. We encourage your participation in completing or providing genuine answers to the questions in this questionnaire.

For Rating scale in comparing two E-Wallets. The assessment criteria are as follows:

- 1: Equally Preferred
- 2: Quite Equally Preferred
- 3: Simply Preferred
- 4: Medium to strong options
- 5: Highly Liked
- 6: Very Most Liked
- 7: Very Well Liked
- 8: Most powerful Liked
- 9: Highly Liked
- 2,4,6,8: Represents the value between two adjacent assessments

For each question, please answer on one alternative E-wallet only, while the other E-wallet does not need to be answered.

Gender *

- Man
- Woman

Age *

- <21
- 21-30
- 31-40
- >41

How much do you make in a month? *

- < 5,000,000
- 5.000.000 -10.000.000
- > 10,000,000

What is your most used E-Wallet? *
(can choose more than one)

- OVO
- GO PAY
- FUNDS
- LinkAja
- SHOPEEPAY

Do you think *ease of use* is more important than *merchant availability*? **(Choose one from a scale of 1-9)**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Ease of Use | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Merchant availability | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Do you think *feature availability* is more important than *merchant availability*? **(Choose one from a scale of 1-9)**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Feature availability | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Merchant availability | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

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