Opsi
Vol 15 No 1 June 2022
p-ISSN 1693-2102
e-ISSN 2686-2352

Applying AHP-TOPSIS Approach for Selecting Marketplace based on Preferences of Generation Z in Yogyakarta, Indonesia

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doi: https://doi.org/10.31315/opsi.v15i1.6824

Received: 17th March 2022; Revised: 30th May 2022; Accepted: 1st June 2022;
Available online: 18th June 2022; Published regularly: June 2022

ABSTRACT

The increasing ease of internet access leads to good opportunities for marketplace growth. The marketplace's popularity is gaining among many people, especially Generation Z, and makes the marketplace becomes their primary solution for online shopping. According to the massive amount of generation Z and their lives that get used to sophisticated technology, this generation can become the critical marketplace consumer in the upcoming years. This research examines the selection of generation Z's preferences towards the marketplace using the AHP-TOPSIS approach. The selection was based on three criteria: service quality, information, and price. AHP approach was applied to calculate each criterion's weight, while TOPSIS was used to obtain the alternative ranking of marketplaces. The result shows that service quality becomes the most influential criterion for selecting marketplace platforms. The weight of each criterion is service quality of 0.425, information quality of 0.280, and price of 0.295. Shopee is chosen as the most suitable marketplace platform for Generation Z. The proposed model of this research can allow the business players to effectively select the suitable marketplace for selling their products targeted to Generation Z.

Keywords: *AHP-TOPSIS, generation Z, marketplace*

1. INTRODUCTION

In the past years, the advancement of technology in the past years has improved rapidly and helped human life become more accessible and faster. Internet needs for today seem to become a necessity and very influential for most people (Ulfa, Selo, & Hidayat, 2021). Its advancement helps in almost every aspect of daily life, such as entertainment, education, healthcare, and business. The internet application in business has changed marketing, advertisement, and promotional activities (Mohapatra, 2013). The optimization of using the internet as one of the marketing media can be helpful to increase the engagement of products. Moreover, during the pandemic of covid-19, customers were pushed to do shopping activities and transactions through online platforms. The limitations of activities due to government policy during pandemic covid-19 made the customers tend to do online shopping rather than go to offline stores.

According to the report of AppsFlyer, Indonesia has become the third country with the biggest user of Android marketplace in the world. Marketplace users increased more than 70% from January 2020 to July 2021 (Appsflyer, 2021). The marketplace user was dominated by millennials and generation Z (Lokadata.id, 2020).

Generation Z was the generation born between 1997-2012, who the oldest are currently in the workforce (Michael, 2019). This generation dominates the Indonesian population by 27,94%, and in upcoming years all parts of this generation will be entering the productive age. Generation Z grew up in a technological

p-ISSN 1693-2102
e-ISSN 2686-2352

environment where technology was already accessible. According to the enormous population known as the digital native generation, generation Z is expected to become the critical factor of marketplace consumers in a short time.

There are many marketplaces in Indonesia. Each marketplace has its unique feature, which makes the seller or business player have to consider selecting which marketplace they will use. Decision-making must be conducted for business players to select the alternatives of a marketplace to achieve their goals.

TOPSIS is a tool in Multi Criteria Decision Making (MCDM) problem with the priciple that the best alternative has the closest distance from the positive ideal solution and the farthest distance from the negative ideal solution (Zavadskas, et. al., 2016). Jatiningrum et. al. (2021) applied TOPSIS to solve MCDM problem in choosing video on demand service application for students. Moreover, TOPSIS was also used to determine the best employee or other similar case by building the decision support system (Ardiansyah, 2017; Muljadi, Khumaidi, & Chusna, 2020). However, the assessment of criteria in the TOPSIS method was carried out independently between criteria. Therefore, the principle of pairwise comparison assessment in Analytical Hierarchy Process (AHP) can complement the use of the TOPSIS method to solve multi-criteria problems. AHP is a tool for the decision-makers to make an excellent and accurate decision based on their agreed criteria (Tamrakar, Tawari, & Tandon, 2014). AHP has been used in previous research as the multi-criteria decision-making tool in many fields, namely, consumer preferences (Jatiningrum et al., 2019), facility location (Chadawada, Sarfaraz, Jenab, & Pourmohammadi, 2015), and human resources (Kusumawardani & Agintiara, 2015).

This research focused on the application of combining AHP and TOPSIS for selecting a marketplace by generation Z. The Analytical Hierarchy Process (AHP) was used first to determine the subject weight for each criterion, and TOPSIS was applied to determine the alternative ranking process. The results of this research are expected to be a recommendation for sellers or business players who are targetting generation Z to be their market in selecting the marketplace to expand their opportunities.

2. MATERIALS AND METHOD

This research aims to select a marketplace according to the preference of generation Z by using the AHP-TOPSIS approach. The alternatives of the marketplace are the three most visited marketplace in the first quarter of 2021 in Indonesia, namely Tokopedia, Shopee, and Bukalapak (TrenAsia, 2021). The questionnaires were distributed to 47 university students in Yogyakarta who belonged to generation Z and became a user of the marketplace as a customer. The survey was conducted in Yogyakarta, the region known as the student city.

AHP-TOPSIS was applied as the tool for analyzing the decision for Generation Z as decision-makers in selecting the marketplace based on their preferences. Three criteria to determine the decision were considered: service quality, information quality, and price.

2.1 Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) is a tool used to solve multi-criteria decision-making problems (Siew, Bakar, Hoe, Wai, & Lee, 2018). By using AHP, the MCDM problem can be solved in an organized frame of mind to be expressed to make effective decisions for the problem.

AHP approach aims to arrange the priority from various available alternatives (Narti, Sriyadi, Rahmayani, & Syarif, 2019). AHP can be applied to simplify the complex problems with multi-criteria to assist the decision-making process for selecting a marketplace. These are steps for applying the AHP method (Saaty, 2008).

1. Identify the problem and its objective.
2. Arrange the hierarchical structure that starts with the top goal and is followed by the criteria and alternatives.
3. Construct a pairwise comparison matrix that describes the relative importance of each element towards the objective or the element in the level immediately above by using the ratio scale shown in Table 1.

Table 1. Ratio-Scale for Pairwise Comparison

Scale	Meaning
1	Equal importance
3	Weak importance to the preferred
5	Essential importance to the preferred

p-ISSN 1693-2102
e-ISSN 2686-2352

7	Demonstrate importance to the preferred
9	Absolute importance to the preferred
2,4,6,8	Intermediate importance

The example of a pairwise-comparison matrix is presented below.

$$C = \begin{bmatrix} \begin{pmatrix} C11 & C12 & \cdots & C1j \\ C21 & C22 & & C2j \\ \vdots & & \ddots & \vdots \\ Ci1 & Ci2 & \cdots & Cij \end{pmatrix} \end{bmatrix} \quad (1)$$

C_{ij} is the degree of preference of element i to element j.

4. Normalize data by dividing each elements' value in the pairwise-comparison matrix with the total value for each column. The formulation is shown as equation (2)

$$x_{ij} = \frac{C_{ij}}{\sum_{i=1}^{n} C_{ij}} \quad (2)$$

xij is defined as the normalized weight from the degree preference of criterion i to attribute j.

5. Determine the weight for each criterion using the formulation below.

$$W = \frac{\sum_{i=1}^{n} Xij}{n} \quad (3)$$

It is known that n is the total number of criteria, and W is the normalized weight of the criteria.

6. Calculate eigenvector and eigenvalue (λmax) in each row. Let the A indicates n-dimensional column vector, which portrays the sum of weighted values for the significance degrees of criteria as below.

$$A = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix} \times \begin{bmatrix} W_1 \\ W_2 \\ W_3 \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix} \quad (4)$$

After getting A vector, the eigenvector can be represented with vector Cv, which contained elements that defined by using formulation (5)

$$CV_i = \frac{a_i}{W_i} \quad i = 1,2,\ldots,n \quad (5)$$

Wi denotes the criteria weight of criterion i. The next step is determining the eigenvalue (λmax), which can be carried out using formulation (6)

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} CV_i \quad (6)$$

The result of the eigenvalue (λ_{max}) will be used to calculate the consistency index.

7. Calculate Consistency Index (CI) and check the consistency ratio (CR). The formula of CI is shown in equation (7)

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (7)$$

Consistency calculation is needed for proving the consistency level of the respondents' answers and the hierarchy structure. The consistency index can be known by subtracting the maximum eigenvalue (λ_{max}) with the number of elements in the matrix (n) and dividing it with the value of n minus one. While, the formulation to calculate CR is shown in equation (8)

$$CR = \frac{CI}{RI} \quad (8)$$

The last step for validating the consistency is by calculating the consistency ratio. The consistency ratio is calculated by dividing the value of the consistency index by a random index. The random index is obtained based on the number of criteria. The value of CR has to be less than 0,1 to indicate that the pairwise comparisons are consistent, and the result can be used to be next processed with TOPSIS. If the CR has a value higher than 0.1, it means the judgments should be re-evaluated.

2.2 TOPSIS

TOPSIS is a multi-criteria decision-making method that Yoon and Hwang first established in 1981 (Vimal, Chaturvedi, & Dubey, 2012). The basic concept of this method is that the selected alternative has the closest distance to the positive ideal situation and has the farthest distance to the negative ideal solution (Prakash & Barua, 2015). The step by step of TOPSIS is explained as follows.

a. Construct normalized decision matrix from the collected data.

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{j=1}^{J} X^2_{ij}}}, \; (i = 1,2, \ldots, J; j = 1, 2, \ldots, n) \quad (9)$$

r_{ij} denotes the element of the normalized decision matrix, meanwhile X_{ij} denotes the

p-ISSN 1693-2102
e-ISSN 2686-2352

degree of prederence of alternative i to attribute j.

b. Determine the weighted normalized decision matrix by multiplying the weights (w_j) of evaluation criteria with the normalized decision matrix (r_{ij})

$$y_{ij} = w_i \times r_{ij},\ j = 1,2,3 \dots, m\ ;\ i = 1,2,3,\dots,n \quad (10)$$

y_{ij} denotes the element of the weighted normalized decision matrix. While w_j indicates the weight of j-criterion r_{ij} is the element of normalized decision matrix

c. Determine the positive ideal solution matrix (A^+) and negative ideal solution matrix (A^-) using the formulation as follows in equations (11) and (12).

$$A^+ = \{y_1^+, y_2^+, \dots, y_j^+, \dots, y_n^+\} \text{ minimum values} \quad (11)$$
$$= \{\max(y_{ij}) \mid j \in J\ ; \min(y_{ij}) \mid j \in J^-\}$$

$$A^- = \{y_1^-, y_2^-, \dots, y_j^-, \dots, y_n^-\} \text{ minimum values} \quad (12)$$
$$= \{\min(y_{ij}) \mid j \in J\ ; \max(y_{ij}) \mid j \in J^-\}$$

d. Calculate the distance of each alternative from a positive ideal solution and negative ideal solution using the formulation as follows.

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (y^+{}_j - y_{ij})^2}\ ,\ j = 1,2,\dots,J \quad (13)$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_j^-)^2}\ ,\ j = 1,2,\dots,J \quad (14)$$

$y^+{}_j$ is the elements of positive ideal solution matrix meanwhile y_j^- is the elements of ideal negative solution matrix.

e. Calculate the preference value using the formulation as follows.

$$V_i = \frac{D^-{}_i}{D^-{}_i + D^+{}_i} \quad (15)$$

The result of the calculation above is the TOPSIS score. The alternatives can be ranked by descending the order of V_i.

3. RESULTS AND DISCUSSION

The methodology was applied for the market selection. AHP method was applied to determine the weight for each criterion. Meanwhile, the TOPSIS method was applied to determine the ranking of the alternatives.

3.1 AHP

The initial procedure that needs to be conducted in using AHP is to structure a hierarchical problem. The conceptual framework of this research was mapped to the hierarchy structure presented in figure 1. The AHP hierarchy consists of three levels. Level 1 shows the goal or objective of the research, level 2 shows the criteria considered to reach the goal, and level 3 shows alternatives of the decision to reach the goal. This research aims to determine the marketplace for generation Z by considering some criteria. The criteria are determined by observation and interviews toward generation Z to dig up information according to their preferences.

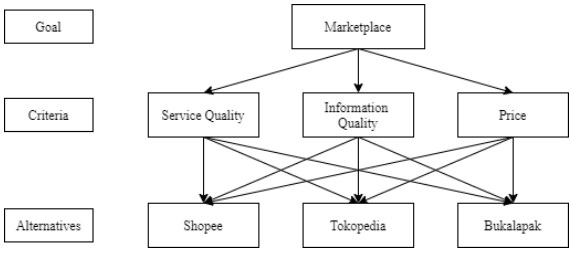

Figure 1. Hierarchy Structure of Selecting Marketplace

According to the survey, three criteria were considered by generation Z to select the appropriate marketplace.

a. Service Quality
Service Quality is defined as the customer assessment for the service they received (Ramseook-Munhurrun, Naidoo, & Nundlall, 2010). Service quality is one of the customer considerations to purchase something. The service quality of the marketplace refers to the quality of service experienced by the customer, such as transaction and information security, product delivery, personalization, and communication with the site owner (Adellia & Prasetio, 2016).

b. Information Quality
Information results from processed data that has meaning and is beneficial (Susanto, 2004). Information quality can be defined as an ability of a company to satisfy the customers' expectations towards stated nor implied needs of information (Gustavsson & Wänström, 2009). Information quality of marketplace refers to the site's content, the

p-ISSN 1693-2102
e-ISSN 2686-2352

suitability of the information for the user's purposes, such as the accuracy, format, and relevancy (Adellia & Prasetio, 2016).

c. Price
Price is defined as all forms of monetary costs customers sacrifice to obtain, possess, or utilize service and goods from a product (Hasan, 2008). The previous research stated that seeking the best price becomes a major motivation for the online shopper (Korgaonkar & Wolin, 1999).

Data were collected from respondents who asses the criteria and alternatives through a pairwise comparison questionnaire. Table 2 presents the pairwise comparison matrix, which compares the relative importance criteria towards each other based on respondent results.

Table 2. Pairwise Comparison Matrix Criteria

	Service Quality	Information Quality	Price
Service Quality	1	2,0330	1,0975
Information Quality	0,4919	1	1,2520
Price	0,9111	0,7987	1

The pairwise comparison matrix needs to be normalized for the next step. The normalization can be applied by dividing the matrix value by the total value of each criterion in the column. Table 3 shows the result of the normalization of the pairwise comparison matrix.

Table 3. Normalization of Pairwise Comparison Matrix

Criteria	Service Quality	Information Quality	Price
Service Quality	0.416	0.531	0,328
Information Quality	0.205	0.261	0,374
Price	0.379	0,208	0,299

The next step for determining the rank of criteria is by calculating the weight of each criterion by using formulation (3). The result of each criterion weight is shown below.

Table 4. Normalized Weight Criteria

Criteria	Normalized Weight
Service Quality	0.425
Information Quality	0.280
Price	0.259

Checking the consistency of the hierarchy is necessary, and the first step for checking the consistency level is creating the sum weighted values vector as follows.

$$A = \begin{bmatrix} 1 & 2.033 & 1.098 \\ 0.429 & 1 & 1.252 \\ 0.911 & 0.799 & 1 \end{bmatrix} \times \begin{bmatrix} 0.425 \\ 0.280 \\ 0.295 \end{bmatrix} = \begin{bmatrix} 1.318 \\ 0.859 \\ 0.906 \end{bmatrix}$$

The eigenvector can be determined using equation (5) for every element.

$$CV = \begin{bmatrix} 3.102 \\ 3.068 \\ 3.607 \end{bmatrix}$$

Eigenvalue is determined by the calculation using equation (6).

$$\lambda_{max} = \frac{3.102 + 3.068 + 3.607}{3} = 3.079$$

After getting the eigenvalue, the consistency index can be obtained using the formulation (7).

$$CI = \frac{3.079 - 3}{3 - 1} = 0.0396$$

The final consistency ratio is calculated using equation (8).

$$CR = \frac{0.0396}{0.58} = 0{,}068$$

Table 5. Index Random Consistency

n	1	2	3	4	5	6	7	8	9	10
RI	0.0	0.0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

The value of random index consistency is according to the number of criteria used in this research. The table of random index consistency is represented in table 5. The result of CR of this research is 0.068, and it is above 0.10. It implies that the pairwise comparison matrix and criteria weight did not contain inconsistencies.

The most important criterion based on the result is service quality (0.425), followed by price (0,295), and the least essential criterion is information quality (0.280). This result shows that Generation Z tends to prioritize service quality when using the marketplace for online shopping. Generation Z chooses the marketplace, which can provide them the security of their transaction and information, punctual delivery product, correct personalization from the marketplace, and good communication with the site owner or customer

p-ISSN 1693-2102
e-ISSN 2686-2352

service. The result of this criteria decision could become an evaluation for the marketplace company to improve their qualification for service quality, information quality, and price.

3.2 TOPSIS

TOPSIS in this present research was used for determining the ranking of three marketplaces as the alternatives. After criteria weight was obtained, the ranking of the alternatives was carried out using the TOPSIS method. Questionnaires about the alternative assesment based on each criterion were distributing to respondents. Then, recapitulation was carried out by calculating the average score based on the results of data collection. This is summarized in Table 6.

Table 6. Alternative Assesment based on Criteria

	Service Quality	Information Quality	Price
Shopee	4.042	4.128	4.145
Tokopedia	3.936	3.830	3.808
Bukalapak	3.532	3.532	3.617

The first step using TOPSIS method is creating the normalized matrix based on the respondents' answers. The elements of the matrix are constructed by using formulation (9). Table 7 shows the result of the normalized decision matrix.

Table 7. Normalized Decision Matrix

	Service Quality	Information Quality	Price
Service Quality	0.607	0.621	0.620
Information Quality	0.591	0.576	0.569
Price	0.531	0.531	0.540

Using the criteria weight from AHP method and multiplying it with the normalized decision matrix, the weighted normalized matrix is created as shown in Table 8.

Table 8. Weighted Normalized Matrix

	Service Quality	Information Quality	Price
Service Quality	0.258	0.174	0.183
Information Quality	0.251	0.161	0.168
Price	0.225	0.149	0.160

The next step is to determine the value of the positive ideal solution (A+) and negative ideal solution (A-) using formulations 11 and 12. The results are shown in Table 9.

Table 9. Positive and Negative Ideal Solutions

A+	0,25798	0,17377	0,1831
A-	0,22539	0,14869	0,15962

Table 10 shows the value of di+ (distance between the alternative and positive ideal solution) and di- (distance between the alternative and negative ideal solution). The values were obtained by using formulations 13 and 14.

Table 10. Distance from Positive and Negative Ideal Solution

Alternatives	Di+	Di-
Shopee	0	0,04735
Tokopedia	0,02071	0,02990
Bukalapak	0,04735	0

After obtaining the di+ and di-values, the preference value can be calculated using formulation 14. The preference value of each alternative will be fundamental for determining the alternative ranking. The result of preference values can be seen in Table 11.

Table 11. Preference Value and Alternative Rank

Alternative	Preference Value	Alternative Rank
Shopee	1	1
Tokopedia	0.591	2
Bukalapak	0	3

According to the preference value calculation result, an alternative ranking was obtained. Shopee received the highest preference value (1) and has become the priority for generation Z as the marketplace they choose for online shopping. Tokopedia placed in the second rank with its preference value (0.591), while Bukalapak followed in the last place (0) based on the result of this research.

The aim of this research is to find the most suitable and the best online marketplace for Generation Z. This research gives new perspectives from the previous researches (Frieyadie, Sukmawati, & Nurajijah, 2020; Ishak, Ginting, & Wanli, 2021). This can be happened because this research focuses on Generation-Z as the respondents. Meanwhile

p-ISSN 1693-2102
e-ISSN 2686-2352

other previous studies examined the problem of multi-criteria decision making conducted by general users, with a wider age range. According to research by Ishak, Ginting &Wanli (2021), Tokopedia was become the first priority due to the best service quality. Likewise, according to Frieyadie, Sukmawati, & Nurajijah (2020), the chosen alternative decision is Tokopedia based on criteria app display, feature, interactivity, transaction security, and customer service.

In this research, all the evaluation and judgement for the criteria and final alternatives were carried out by Generation Z. The result of data collection in Table 6 showed that Shopee has better scores on each criterion that other marketplaces. Then, the final result also showed that Generation Z choose Shopee as the priority of marketplace. This study proposes to gain more customers from Generation Z who have huge potential to increase business through the online marketplace.

3.3 Managerial Implication

This research was conducted using the combination of AHP and TOPSIS methods to determine the marketplace preferences of generation Z as customers in Indonesia. The criteria analysis section using AHP shows that service quality is the essential criterion for generation Z to choose the marketplace for online shopping. Therefore, the marketplace should keep improving its service quality. The marketplaces are advised to ensure the customers can get a good experience online shopping through their service. Transaction and information security, personalization, product delivery, and communication with the owner or customer service are the things that are needed to attract more consumers from generation Z. The final result shows that Shopee has placed in the first rank of marketplace chosen by generation Z. This result can be a recommendation for the manufacturer company or seller to choose a marketplace for marketing their products, especially segmented and targeted to the generation Z. Furthermore, this result can be an input for the marketplace company to consider the following business decision, whether to focus on the current segment and target or expand the market to another age alliances.

4. CONCLUSION

The marketplace is essential for business players to reach more customers by selling products online. Generation Z, who grew up in the technology environment, has enormous potency for becoming the key marketplace consumer. This paper investigated generation Z's marketplace preferences among Indonesia's three most visited marketplaces using AHP and TOPSIS methods. Three criteria were considered to determine the most suitable marketplace: service quality, information quality, and price. AHP method was used for calculating the criteria weight which portrays the influence degree of each criterion. The result shows that the most influential criterion for selecting a marketplace is service quality (0,425). Customers prioritize more on the service quality of the marketplace for online shopping. The transaction and information security, product delivery, personalization, and communication with the site owner are essential for customers in determining which marketplace they would go for a shop. The final alternative was calculated by using TOPSIS. The final result shows Shopee has the highest preference value (1) and becomes the priority for the marketplace, followed by Tokopedia and Bukalapak. For future research, it is recommended to add more criteria or adjust with the products that want to be marketed.

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