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Comparison of TOPSIS and SMARTER Methods in Selecting Delivery Services

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Abstract

The rapid growth of the e-commerce world has propelled the demand for freight forwarding services, a pivotal component in maintaining the smooth flow of this business. Major companies like JNE, TIKI, Kantor Pos Indonesia, SiCepat, and J&T Express are involved. However, despite this convenience, various challenges often accompany the shipping process. Some of these include delayed deliveries, lost or damaged items, or even misdeliveries to the wrong customers. This presents a dilemma for leading e-commerce companies in selecting the most suitable delivery service partner. Hence, a decision support model is necessary in choosing a freight forwarding service. This study will outline comparison methods based on both Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Simple Multi Attribute Rating Technique Exploiting Ranks (SMARTER). The proposed methods have strong relevance to the rapid growth of the e-commerce world. This research emphasizes the importance of selecting freight forwarding services in maintaining the smooth operation of e-commerce businesses. The results of this study have obtained ranking results from the final value of each method. The first place in the TOPSIS method with a value of 0.7033 at sensitivity 3 and the lowest in the SMARTER method with a value of 0.1303 at the first sensitivity, and at the second sensitivity, all methods have the same value of 0.2. The conclusion is that TOPSIS is the best method compared to the SMARTER method as a decision support for the selection of freight forwarding services.

Keyword: Delivery Services, Freight Forwarding Services, Sensitivity, SMARTER, TOPSIS

1. INTRODUCTION

In the ongoing era of globalization and digital revolution, online trading activities have become a rampant phenomenon and become an inevitable trend in society [1]. Various online shopping platforms offer a wide array of products with varying ease and speed [2] [3]. The rapid growth in the e-commerce industry has fueled the demand for freight forwarding services, becoming a key element in keeping the business running smoothly. Major companies such as JNE, TIKI, Kantor Pos Indonesia, Si Cepat, and J&T Express play a central role in meeting the growing needs of freight forwarding [4] [5]. The abundance of delivery services poses a challenge for e-commerce businesses and the public in selecting the best delivery services to safely send packages to desired destinations, especially for businesses.

Business players connected in the e-commerce ecosystem have the freedom to sell their products through online platforms and manage their businesses from various locations in Indonesia [6]. This necessitates a significant role from delivery services to assist them in delivering orders to customers, both domestically and internationally. There are many delivery service options available for users based on criteria and desired types of services. One such option is a delivery service that offers relatively fast delivery times, affordable shipping costs, and ensures the safety of goods during the delivery process [7]. Common issues in parcel delivery include long delivery times and the risk of losing items. Although these services assist the public in sending goods to various locations, many find it challenging to choose a suitable service. Therefore, an alternative method is

needed to help individuals determine the most effective delivery service to support online shopping transactions.

In this context, parcel delivery services have become an integral part of current business operations, serving as the main communication channel between sellers and buyers [8]. Consequently, the selection of a parcel delivery partner is a crucial decision [9]. This process involves exploring the profiles of various delivery service partners and conducting a thorough assessment of the services offered. However, this process consumes valuable time, forcing companies to understand every aspect of the services offered by potential partners [10]. Therefore, in choosing the best delivery service, a mechanism is needed to ensure the successful delivery of goods to the final destination. One way to achieve this is by using a Decision Support Method

Research related to decision support methods, such as Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), indicates advantages in preference ranking by considering the distance between alternatives and the ideal solution [11] [12]. TOPSIS produces better sensitivity test values and more varied preference values [13] [14]. Previous studies by Erna & Hastari, using Simple Additive Weighting (SAW) and TOPSIS on Information System students, found that TOPSIS is more absolute and straightforward compared to SAW [15]. Furthermore, research by Siti Maesyaroh, using Analytic Hierarchy Process (AHP) and TOPSIS, shows that the accuracy of TOPSIS is greater than AHP in selecting laboratory assistants at Faculty of Computing (FKOM) UNIKU (73% compared to AHP 45%) [16]. Additionally, based on research by Fawwaz et al., (2021) the TOPSIS method can provide recommendations for selecting cities implementing large-scale social restrictions based on criteria [17].

The next algorithm, Simple Multi Attribute Rating Technique Exploiting Ranks (SMARTER) in Decision Support Technique [18] uses ratings to compare alternatives [19]. Previous research shows that SMARTER can produce more optimal and effective values in determining Predatech members [20] and has a high percentage of decision support systems to determine the suitability of eucalyptus plantations [21]. In selecting the location for an affordable store, SMARTER has a smaller sensitivity test value but provides good ranking results [22].

In choosing the TOPSIS and SMARTER methods, this research considers the advantages of each method in the context of this study. Previous research on decision support methods has shown the superiority of TOPSIS in several aspects, such as better sensitivity test values and more varied preference values. Meanwhile, SMARTER has also proven to produce more optimal and effective values in specific contexts. Therefore, the selection of these methods is made to meet the specific needs and characteristics of selecting delivery services.

This research contributes to filling the gap by introducing and comparing the TOPSIS and SMARTER decision support methods in the context of selecting delivery services, with the hope of providing more accurate and effective guidance for e-commerce businesses and the general public. The adapted approach for selecting methods specifically for the context of choosing delivery services, by integrating the TOPSIS and SMARTER methods, is the main innovation presented by this research, aiming to provide a holistic and reliable solution to support effective decision-making.

Based on the above description, the author conducted research on determining delivery services by comparing the SMARTER and TOPSIS methods. The aim of this research is to assist not only e-commerce entities but also the general public in choosing delivery services, especially those who frequently use delivery services as sellers or buyers. This research aims to provide insights into the selection of delivery services as an alternative process in buying and selling transactions, with the expectation that individuals will consider various criteria.

2. MATERIAL AND METHOD

This research method is explained in the following flowchart based on figure 1, while in literature studies it is carried out by studying journals, publications, and supporting materials in this study.

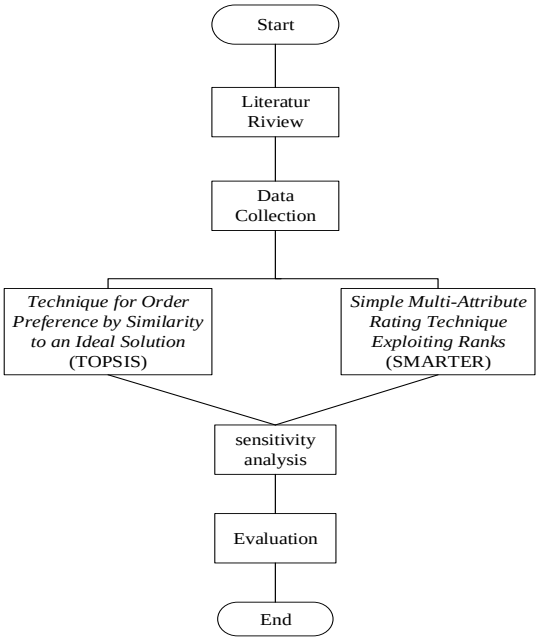
The following are the stages in this research:

2.1. Literatur Review

This research begins with an in-depth literature study to understand the concept and development of TOPSIS and SMARTER methods in the context of choosing freight forwarding services. Analysis of previous research is the basis for detailing the advantages, weaknesses, and recent developments of both methods

2.2. Data Collection

Data collection involves tracing findings and methodologies from previous studies relevant to the selection of freight forwarding services, becoming a basis for understanding the criteria that are the focus in the selection of freight forwarding services.



Picture 1. Research Flow

2.3. Technique

The application of the TOPSIS and SMARTER methods is the next step, by identifying relevant criteria and assigning weight to each criterion. This process is meticulously carried out to ensure the integrity and validity of the results. The next stage is sensitivity analysis, during which the responses of both methods to changes in weights and changes in data are evaluated. This is important to understand the extent of reliability and consistency of the TOPSIS and SMARTER methods in the context of the selection of freight forwarding services.

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

TOPSIS is one of the MADM (Multi-attribute Decision Making) solving methods introduced by Yoon and Hwang in 1981 [23]. TOPSIS is a decision support method based on the concept that the best alternative not only has the shortest distance from the positive ideal solution, but also has the longest distance from the negative ideal solution [24] [25]. TOPSIS is also a simple ranking method in concept and application [26].

The stages of the Topsis method are [27]:

1. Define in advance the criteria that will be used as a benchmark for solving problems
2. Normalizes each alternate value (normalized matrix) and weighted normalized matrix
3. Calculating the value of a Positive or Negative Ideal Solution
4. Calculates the Distance weighted value of each alternative against positive and negative ideal solutions
5. Calculating the Preference Value of each alternative
6. Ranking

The algorithm steps of the Topsis method are as follows [28]:

1. Normalizes each alternate value (normalized matrix) and weighted normalized matrix

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

2. Calculate weighted performance matrix values

$$Y_{ij} = w_i r_{ij} \quad (2)$$

Provided:

$$yj^{+} = \begin{Bmatrix} \text{Max } y_{ij}; & \text{If j is the profit attribute} \\ \text{Min } y_{ij}; & \text{If j is a cost attribute} \end{Bmatrix} \quad (3)$$

$$yj^{-} = \begin{Bmatrix} \text{Min } y_{ij}; & \text{If j is the profit attribute} \\ \text{Max } y_{ij}; & \text{If j is a cost attribute} \end{Bmatrix} \quad (4)$$

3. Calculates the Distance weighted value of each alternative against a positive ideal solution
   For which the ideal solution is positive:

$$Di^{+} = \sqrt{\sum_{j=1}^{n}\left(yi^{+} - y_{ij}\right)^{2}} \quad (5)$$

   For which the ideal solution is negative:

$$Di^{-} = \sqrt{\sum_{j=1}^{n}\left(y_{ij} - yi^{-}\right)^{2}} \quad (6)$$

4. Calculates the preference value of each alternative

$$V_i = \frac{Di^{+}}{Di^{-}+Di^{+}} \quad (7)$$

2.3.2. Simple Multi-Attribute Rating Technique Exploiting Ranks (SMARTER)

SMARTER is a simplified version of SMART created by Edwards as a development of Edward's earlier methods, SMARTER is a smart decision-making technique that is flexible in decision making, which is often faced with a wide variety of alternatives consisting of a collection of attributes. SMARTER uses a simpler approach by asking participants to sort items by importance, thereby reducing complexity and improving interpretation of Subcriteria. The steps to complete the SMARTER motode are as follows:[29]

1. Identify the problem
2. Defining criteria and subcriteria
3. Rating each criterion and subcriteria
4. Calculates the weights of criteria and subcriteria using ROC weights.

Weighting with the ROC technique is generally formulated if K is the sum of criteria, then the weight of the k criterion is:

$$Wn = \left(\frac{1}{k}\right)\sum_{i=n}^{n}\left(\frac{i}{n}\right) \quad (8)$$

If k is many criteria then the above formula can be described as follows:

$$\text{if} W_1 \geq W_2 \geq W_3 \ldots\ldots W_k \text{then,} \quad (9)$$

$$W1 = \frac{\left(1+\frac{1}{2}+\frac{1}{3}+\cdots\frac{1}{k}\right)}{k} \quad (10)$$

$$W2 = \frac{\left(0+\frac{1}{2}+\frac{1}{3}+\cdots\frac{1}{k}\right)}{k} \quad (11)$$

$$W3 = \frac{\left(0+0+\frac{1}{3}+\cdots\frac{1}{k}\right)}{k} \quad (12)$$

$$Wn = \frac{\left(0+\cdots+0+\frac{1}{k}\right)}{k} \quad (13)$$

5. Determining the Utility Value
   To determine the utility value using the equation

$$v(a)\sum_{k=1}^{k} wk.wk, \quad k = 1,2,\ldots,n \quad (14)$$

   For the calculation of the final value using the equation

$$n_i = \sum nwj\mu ij \quad (15)$$

2.4. Sensitivity Analysis

The objective of the sensitivity analysis is the accuracy of the measured values in order to take certain actions in making the most rational choices [30] . The determination of this sensitivity analysis is based on several ranges of the smallest values and in a regression progress. The search for values from sensitivity analysis is carried out in three ways, namely [31]:

First, subtract the value of the first alternative by the second. By equation the formula is used:

$$\text{Total sensitivity} = (X1 - X2) \tag{16}$$

Second, divide the value of the first alternative by the sum of the total values. By equation the formula is used:

$$\text{Total sensitivity} = \frac{xi}{\sum x} \tag{17}$$

Note:

Xi : alternative value to=i

X : alternate value

Third, add the first alternative value by the second, then divide by 2. With the equation of the formula used:

$$\text{Total sensitivity} = (X1 + X2)\ \frac{1}{2} \tag{18}$$

2.5. Evaluation

The study ended with a synthesis of the results of sensitivity analysis and thorough conclusions. This conclusion provides a clear view of the advantages, weaknesses, and context of application of the TOPSIS and SMARTER methods in the selection of freight forwarding services. Thus, this study makes an important contribution in further understanding of the application of decision support methods in the context of the selection of freight forwarding services

3. RESULTS AND DISCUSSION

This research utilizes data from a previous study conducted by Nur et al., (2018) [32] in the selection of mobile network operators using the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method. The selection of data from this study is based on its relevance to the context of our research, which aims to compare the TOPSIS and SMARTER methods for selecting delivery service providers. The article provides pertinent insights into the application of decision analysis methods within the realm of delivery services, albeit its primary focus on selecting mobile network operators. The selection of this article is deemed significant as it furnishes a strong theoretical foundation and expands a profound understanding of employing decision-support analysis methods within the domain of service selection. Such insights can be applied in our study to compare and evaluate the effectiveness of different methods in making decisions regarding delivery services.

In the process of determining the best Freight Forwarding Service Partner is carried out using the TOPSIS and SMARTER methods, and the criteria needed, the weight of the importance of each criterion and the alternative match rating against the criteria. To find out the best freight forwarding service partners, there are 5 alternatives chosen, including JNE, Kantor Pos Indonesia, J&T Express, TIKI, and SiCepat Express.

3.1. Criteria and Weights

The first step to start the calculation with the TOPSIS and SMARTER methods is to determine the assessment criteria. The assessment criteria that have been determined are in Table 1.

Table 1. Criterion

Criterion	Information	Weight (W)	Kind
C1	Fleet Type	0,15	Benefit
C2	Range	0,20	Benefit
C3	Company Experience	0,15	Cost
C4	Price	0,25	Cost
C5	Delivery Time	0,25	Cost

The following is the original data table of freight forwarding services available on each website:

Table 2. Freight forwarding services

Alternative	C1	C2	C3	C4	C5
JNE	Land, Sea, Air	Domestic and International	28 years	19000	1-2 days
Kantor Pos Indonesia	Land, Sea, Air	Domestic and International	23 years	20000	2-4 days
J&T Express	Land, Sea, Air	Domestic and International	3 years	19000	2-3 days
TIKI	Land, Sea, Air	Domestic and International	48 years	18.500	1-2 days
SiCepat Express	Ground Air	Domestic	14 years	19000	1-2 days

In determining the cellular operator using the TOPSIS and SMARTER Methods, the initial value of each criterion is first determined. More details of value data can be seen in the Table in the following TOPSIS calculation.

3.2. TOPSIS Method Calculation

In the TOPSIS method, a criterion value transformation is carried out with a certain range of values or categories. The following is an explanation of the range and category of criteria values to be transformed ini table 3 – table 7.

Table 3. Fleet Type Criteria Scoring (C1)

Fleet	Value
Land	10
Land Sea	20
Ground Air	30
Sea Air	40
Land, Air, Sea	50

Table 4. Range Criteria Scoring (C2)

Range	Value
Domestic	10
Domestic and Overseas	20

Table 5. Corporate Experience Criteria Scoring (C3)

Experience	Value
<5 years	10
5-10 years	20
10-15 years	30
15-20 years	40
>20 years	50

Table 6. Price Criteria Scoring (C4)

Price	Value
Expensive	10
Keep	20
Cheap	30

Table 7. Delivery Time Criteria Scoring (C5)

Delivery Time	Value
Slow	10
Keep	20
Fast	30

After determining the range of values, in the next study, data transformation was carried out on all criteria based on the range of values that had been set in each criterion. Data on prospective scholarship recipients who have been transformed can be seen in table 8

Table 8. Match rating of each alternative on each criterion

Alternative	C1	C2	C3	C4	C5
JNE	50	20	50	20	30
Kantor Pos Indonesia	50	20	50	10	10

Alternative	C1	C2	C3	C4	C5
J&T Express	50	20	10	20	20
TIKI	50	20	50	20	30
SiCepat Express	30	10	30	20	30

Next calculate the value of the preference weight for each alternative, obtained from equation (7).

$$V1 = = 1\frac{D1-}{D1- + D1+}\frac{0{,}1384}{0{,}1384 + 0}$$

$$V2 = = 0{,}8359\frac{D2-}{D2- + D2+}\frac{0{,}0876}{0{,}0876 + 0{,}0172}$$

$$V3 = = 0{,}5480\frac{D3-}{D3- + D3+}\frac{0{,}0953}{0{,}0953 + 0{,}0786}$$

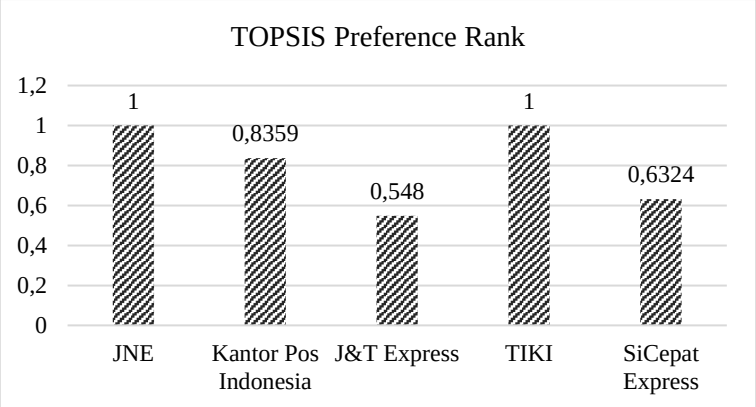
$$V4 = = 1\frac{D4-}{D4- + D4+}\frac{0{,}1384}{0{,}1384 + 0}$$

$$V5 = = 0{,}6324\frac{D5-}{D5- + D5+}\frac{0{,}1120}{0{,}1120 + 0{,}0651}$$

Table 9. TOPSIS Preference Weight Value

Alternative	Final Grades	Rank
JNE	1,0000	1
Kantor Pos Indonesia	0,8359	3
J&T Express	0,5480	5
TIKI	1,0000	1
SiCepat Express	0,6324	4

The Preference value is obtained from dividing the distance of the negative ideal solution by summing the distance of the positive and negative ideal solutions. The preference value is a reference in determining ranking with the TOPSIS method as shown in figure 2.



Picture 2. Alternative Ranking and Preference Value of the TOPSIS Method

Based on Figure 2, JNE and TIKI ranked first with the highest preference value of 1. While Alternative C3 in the last rank with a preference value of 0.5480 is the J&T Express

3.3. SMARTER Method Calculation

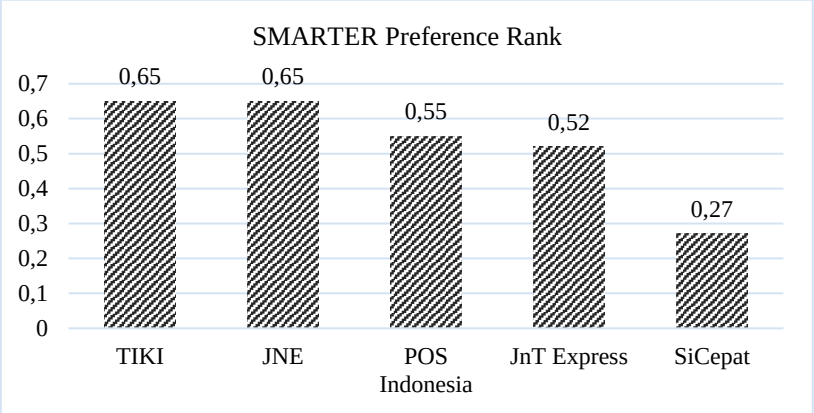
The scale in the previous data that will be used in the normalization stage and application of the SMARTER method, sub-criteria and priority weights can be seen in table 10.

Table 10. Sub Criteria Weight Ranking

Criterion	Sub Criteria	Sub-Criteria weight	Rank
Fleet Type	Land, Air, Sea	0,46	1
	Sea Air	0,26	2
	Ground Air	0,16	3
	Land Sea	0,09	4

Criterion	Sub Criteria	Sub-Criteria weight	Rank
Range	Land	0,04	5
	Domestic and Overseas	1,25	1
	Domestic	0,25	2
Company Experience	>20 years	0,46	1
	15-20 years	0,26	2
	10-15 years	0,16	3
	5-10 years	0,09	4
	< 5 years	0,04	5
Price	Cheap	0,61	1
	Keep	0,28	2
	Expensive	0,11	3
Delivery Time	Fast	0,61	1
	Keep	0,28	2
	Slow	0,11	3

The next stage is alternative transformation based on the Centroid Rank Order (ROC) value on the sub-criteria. Then proceed with the calculation of the utility value on the criteria. The following results of the summation of utility values in each alternative can be seen in Figure 3.



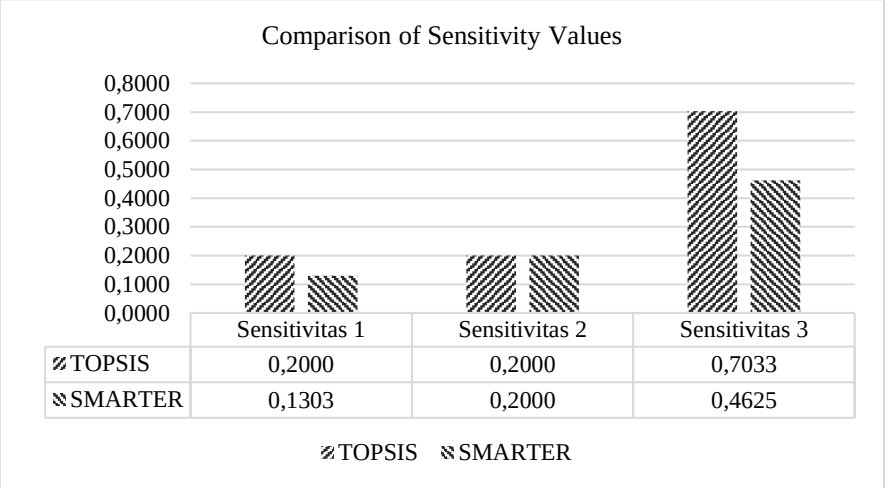
Picture 3. SMARTER Preference Rank

Based on the results of the total utility value generated using the SMARTER method, the final result illustrates the sum of utility values in each existing alternative based on the highest final value to the lowest final value. From the graph above, it can be seen that the alternative that has the highest utility value is the alternative delivery service TIKI and JNE with the same value of 0.65, while the lowest utility value in alternative SiCepat delivery services with a utility value of 0.27. based on the results of the same preference rank between TIKI and JNE, it can be seen the criteria of TIKI and JNE delivery services that TIKI has more shipping prices cheaper than JNE and also TIKI shipping services have a longer experience than JNE. So TIKI is superior to JNE.

3.4. Sensitivity Analysis

Measuring the accuracy of pranking results is done by conducting a sensitivity test, namely by subtracting the value of the first alternative and the second alternative, then dividing the value of the first alternative by the sum of all existing alternative values, and dividing the two results of the sum of the first and second alternative values. The sensitivity test results can be seen in Figure 3 below.

Based on the graph above, sensitivity tests were carried out on 2 methods used. The sensitivity test produces the highest Sensitivity Test value, which is at sensitivity 1 in TOPSIS with a value of 0.2. The highest sensitivity value is found in sensitivity 2 in the TOPSIS and SMARTER methods with the same value of 0.2. Then at sensitivity 3, the lowest sensitivity test value is found in the SMARTER method with a value of 0.4625 while the highest sensitivity is found in the TOPSIS method with a value of 0.7033. In this study, it can be concluded that TOPSIS is the best method.



Picture 4. Comparison of Sensitivity Values

4. CONCLUSION

Based on the study by Nur et al., (2018), it is shown that establishing criteria in the selection of delivery services provides crucial guidance for users. The MOORA method employed in the research aids in determining the optimum value through steps such as decision matrix formation, normalization, value computation, and ranking. As a result, the application of MOORA in the selection of delivery services offers valuable information to consumers.

In this research, ranking results have been obtained from the final value of each method based on criteria, namely Fleet Type, Range, Company Experience, Price and Delivery Time. First place in the TOPSIS method with a value of 0.7033 at sensitivity 3 and the lowest in the SMARTER method with a value of 0.1303 at first sensitivity. And at the second sensitivity, all methods have the same value of 0.2. So it can be concluded that TOPSIS is the best method of the SMARTER method as a decision support for the selection of freight forwarding services.

The practical recommendation to be drawn is the need for further examination regarding the factors influencing the comparison between TOPSIS and SMARTER in the selection of delivery services. Although TOPSIS demonstrates superior performance in this study, further research is necessary to ascertain the effectiveness and consistency of these methods. Researchers can explore specific conditions where SMARTER might be more effective or consider using TOPSIS as a more reliable decision support tool, tailored to the specific needs and context of each situation, integrating multiple methods to create a more comprehensive and reliable framework in decision support.

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