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Application of Weight Product and TOPSIS Methods in Selecting the Best Online Transportation Service

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ABSTRACT

This study emphasises the application of mathematical and computational modelling to support multi-criteria decision-making in the selection of online transportation services. Using **Microsoft Excel**, the research employs the Weighted Product (WP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods to assess alternatives based on six quantitative criteria: price, promotion, service variety, payment method, convenience, and punctuality. The integrated application of WP and TOPSIS provides a systematic process of normalisation, weighting, and ranking to determine the optimal alternative. The findings indicate that GOJEK achieves the highest preference value (0.6107), followed by GRAB (0.5533), IN-DRIVE (0.5000), and MAXIM (0.3893). The methodological contribution of this research lies in demonstrating how the integration of WP and TOPSIS within computational tools establishes an effective mathematical framework for optimising decision-making in service evaluation.

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1. INTRODUCTION

Technological and computational developments have significantly transformed decision-making processes across various sectors, including online-based transportation services. Rather than focusing on historical aspects, this study emphasises the scientific rationale behind applying mathematical decision-support methods to evaluate multiple service criteria objectively. The use of quantitative models enables systematic and measurable analysis in determining the optimal online transportation service.

The novelty of this research lies in the integration of the Weighted Product (WP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods to enhance the accuracy of multi-criteria decision-making. By combining these two computational approaches, the study provides a new comparative framework that improves ranking consistency and decision reliability compared to using a single method.

Quantitatively, the study aims to calculate and compare preference values for four online transportation service providers—GOJEK, GRAB, IN-DRIVE, and MAXIM—based on six numerical evaluation criteria: price (C1), promotion (C2), service variety (C3), payment method (C4), convenience (C5), and punctuality (C6).

In Indonesia, especially in big cities like Medan, the high level of congestion makes online transportation a favorite choice for people. Several popular platforms such as Gojek, Grab, Maxim, and InDrive continue to compete to provide the best service to users. However, the large selection of these transportation applications often causes confusion for consumers in determining the service that best suits their needs.

Various factors can influence customer decisions in choosing online transportation services, including convenience, security, price, punctuality, and promotions or discounts offered (Arum Wahyuni Purbohastuti, 2018).

To formulate the decision-making process mathematically, this study integrates two quantitative techniques within a Decision Support System (DSS) framework: the Weighted Product (WP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods. The WP method determines the relative preference of each alternative through the multiplicative aggregation of weighted and normalised criteria, assuming independence among attributes. Meanwhile, the TOPSIS method, introduced by Hwang and Yoon (1981), ranks alternatives based on their geometric distance from the positive and negative ideal solutions. By combining WP and TOPSIS, the study develops a structured mathematical formulation that enhances the precision of alternative ranking and provides a consistent computational foundation for multi-criteria optimisation in online transportation service selection

Based on this presentation, this study was conducted to combine the two methods — WP and TOPSIS — to find out the extent of the accuracy and effectiveness of the combination of the two in determining the best online transportation services among students of public universities in Medan City, namely USU, UNIMED, and UINSU.

2. RESEARCH METHOD

This study employs a quantitative approach, which focuses on collecting and analysing numerical data. The quantitative method is used to test a pre-established hypothesis through a structured measurement process. Data collection was conducted using research instruments in the form of questionnaires distributed to respondents, and the responses were statistically analysed using a Likert scale.

A total of 100 respondents were selected as the research sample. The determination of the sample size was carried out using Quota Sampling and Accidental Sampling techniques.

- Quota Sampling was applied by setting a specific number of respondents as a target to be fulfilled from the research population.
- Accidental Sampling refers to respondents who were incidentally encountered by the researcher and were willing to provide relevant information.

Criterion C1 (price) is treated as a cost because its value is inversely proportional to consumer preference — the lower the price, the higher the satisfaction level. Conversely, other criteria such as promotion, service variety, payment method, convenience, and punctuality are considered benefits, as their values increase in line with service quality.

In the computational process, the distinction between *cost* and *benefit* criteria is addressed through a mathematical normalization transformation, in which the *cost* criterion values are inverted to align proportionally with *benefit* criteria before applying the weighting and ranking procedures using the Weighted Product (WP) and TOPSIS methods.

To ensure computational reproducibility, all calculations and analyses were performed using Microsoft Excel, supported by mathematical functions and structured formulas.

Based on the calculation results, a total population of 103,669 students from three universities in Medan City was obtained. The distribution of the population and the research sample is presented in the following table:

Table 1. Population and Sample Distribution of Respondents

No	University	Population	Sample
1	UINSU Medan	30.735	33
2	UNIMED	30.247	29
3	USU	42.687	41
Total	-	103.669	100

To determine the number of samples from each university, the researcher used a non-tiered scale formation, taking into account the proportion of the population for each university to be proportionally represented.

3. RESULT AND ANALYSIS

In the application of the combined method of Weight Product (WP) and TOPSIS in the decision support system for the selection of the best online transportation, the first step is to determine the criteria and weights on which the assessment is based. Each criterion is weighted based on its level of importance. The criteria used in this study are shown in Table 2 below:

Table 2. Online Transportation Selection Criteria

No	Criteria Code	Criterion	Quality
1	C1	Price	Cost
2	C2	Promos/Discounts	Benefit
3	C3	Product Variations	Benefit
4	C4	Payment Methods	Benefit
5	C5	Comfort	Benefit
6	C6	Timeliness	Benefit

The number of respondents used in this study was 100 people, while the number of alternative online transportation services compared was four companies, namely Gojek, Grab, Maxim, and InDrive.

The first step before making calculations using the Weight Product (WP) method is to determine the weight of the importance of each criterion. Next, a decision matrix is formed, which is a representation of the value of each alternative to each criterion. In this study, the decision matrix is 4 × 6, which means that there are four alternatives and six criteria. The values in the matrix were obtained from the results of the recapitulation of the questionnaire based on the Likert scale, where the rating scale ranged from 1 (very negative) to 5 (very positive).

The following are the results of the recapitulation of the assessment of 100 respondents on each alternative online transportation service:

Table 3. Results of the Assessment of 100 Respondents Using the Likert Scale

Alternatif	Price	Promos /Discounts	Product Variations	Payment Methods	Comfort	Timeliness
Gojek	5	5	5	5	5	5
Grab	5	5	5	5	5	4
Maxim	4	4	4	4	4	4
InDrive	5	4	5	5	5	4

The next step in the Weight Product (WP) method is to make weight corrections (weight normalization) for each criterion, which is obtained through calculations using the WP method formula.

$$W_j = \frac{W_j}{\sum W_j}$$

With $\sum W_j = 1$

The weight of the importance of each criterion is as follows:

Table 4. Criterion Of Weight

Criterion	Original Weight	Normalized Weight
Price	5	0,192307692
Promos/Discounts	4	0,153846154
Product Variations	4	0,153846154
Payment Methods	4	0,153846154
Comfort	5	0,192307692
Timeliness	4	0,153846154

Furthermore, the decision matrix for each criterion was normalized using the Weight Product method formula.

$$s_i = \prod_{j=1}^{n} x_{ij}^{wj}$$

So that the results of the normalization matrix are obtained by the weight Product method:

$$S = \begin{bmatrix} 1,362753508 & 1,280954922 & 1,280954922 & 1,280954922 & 1,362753508 & 1,280954922 \\ 1,362753508 & 1,280954922 & 1,280954922 & 1,280954922 & 1,362753508 & 1,237726285 \\ 1.305511698 & 1,237726285 & 1,237726285 & 1,237726285 & 1,305511698 & 1,237726285 \\ 1,362753508 & 1,237726285 & 1,280954922 & 1,280954922 & 1,362753508 & 1,237726285 \end{bmatrix}$$

The results of this normalization are the basis for calculating the preference value of each alternative.

Implementation of the TOPSIS Method

After the calculation stage using the **Weighted Product (WP)** method was completed, the process continued with the application of the **Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)** method to compute the **weighted normalized decision matrix** using the combined approach. The simultaneous use of both methods aims to achieve more accurate, stable, and mathematically verifiable ranking outcomes.

$$v_{ij} = w_i r_{ij}$$

So that the results of the normalized decision matrix are obtained weighted with the TOPSIS method as follows:

$$V = \begin{bmatrix} 6,813767538 & 5,123819688 & 5,123819688 & 5,123819688 & 6,813767538 & 5,123819688 \\ 6,813767538 & 5,123819688 & 5,123819688 & 5,123819688 & 6,813767538 & 4,950905141 \\ 6,527558489 & 4,950905141 & 4,950905141 & 4,950905141 & 6,527558489 & 4,950905141 \\ 6,813767538 & 4,950905141 & 5,123819688 & 5,123819688 & 6,813767538 & 4,950905141 \end{bmatrix}$$

Next, determine the relative distance of each alternative to the positive ideal solution (Y^+) and the negative ideal solution (Y^-).

$$y_j^+ = \begin{cases} \max y_j ; j & \text{Is the value of the profit attribute} \\ \min y_j ; j & \text{Is the value of the Cost attribute} \end{cases}$$

$$y_j^- = \begin{cases} \min y_j ; j & \text{Is the value of the profit attribute} \\ \max y_j ; j & \text{Is the value of the Cost attribute} \end{cases}$$

The results of the calculation of the value of the ideal solution are positive and negative shown in the following table:

Table 5. Positive Ideal Solution and Negative Ideal Solution

Criterion	Y^+	Y^-
Price	6,527558489	6,813767538
Promos/Discounts	5,123819688	4,950905141
Product Variations	5,123819688	4,950905141
Payment Methods	5,123819688	4,950905141
Comfort	6,813767538	6,527558489
Timeliness	5,123819688	4,950905141

The next step is to calculate the distance between the positive (S^+) and negative (S^-) ideal solution values for each alternative,

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_1^+ - v_{ij}\right)^2}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_i^-\right)^2}$$

as shown in the table below.

Table 6. The Distance Between Positive and Negative Ideal Solution Values

Alternatif	S^+	S^-
Gojek	0,286209049	0,448902420
Grab	0,334387590	0,414263131
Maxim	0,448902420	0,286209049
InDrive	0,376449865	0,376449865

Next, the preference value (Vi) for each alternative is calculated using the TOPSIS formula:

$$V_i = \frac{S_i^-}{S_i^- + S_i^+}$$

with 0 < Ci < 1 and i = 1, 2, 3, ..., m

Based on these calculations, the following results were obtained:

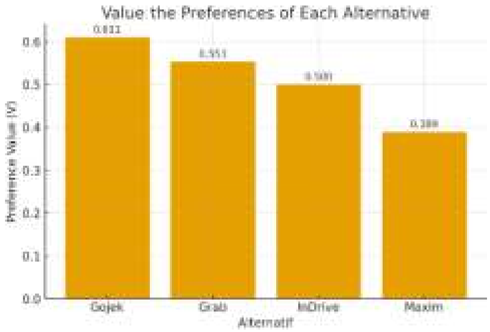

Figure 1. Value The Preferences of Each Alternative

From these results, it can be concluded that Gojek obtained the highest preference value of 0.61065898. Gojek achieved the highest score because it received the top ratings across almost all evaluation criteria, with a score of 5 for all aspects (C1–C6). In the Weighted Product (WP) and TOPSIS methods, each criterion is assigned a weight that reflects its level of importance in the final decision. The highest weights in this study are found in price (C1) and comfort (C5), each with a normalized weight of 0.1923, indicating that these two criteria contribute the most to the final preference value. Grab ranks second with a value of 0.553346333, followed by InDrive in third place (0.5) and Maxim in fourth place (0.38934101).

4. CONCLUSION

Based on the integration of the Weighted Product (WP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods within the decision-support framework for selecting the most appropriate online transportation service, it can be concluded that this combined approach yields decision outcomes that are accurate, consistent, and computationally efficient.

From a methodological perspective, this study contributes by developing a unified mathematical model that systematically combines the multiplicative weighting mechanism of WP with the distance-based ranking logic of TOPSIS. The synergy between these two well-established Multi-Criteria Decision-Making (MCDM) methods enhances computational stability and ranking precision, demonstrating that hybridisation can significantly strengthen analytical robustness in multi-criteria evaluations. Furthermore, the proposed framework establishes a flexible and replicable approach that can be adapted to various decision-making contexts requiring quantitative assessment.

The model evaluates six quantitative indicators—price, promotion or discount, service variety, payment method, comfort, and punctuality—using data collected from one hundred respondents with prior experience using multiple online transportation platforms. The integrated analysis reveals that Gojek achieves the highest preference score, followed by Grab, InDrive, and Maxim, confirming that Gojek represents the optimal alternative based on the evaluated criteria.

Although this research provides strong analytical insights, it is limited by the subjective nature of the weighting process and the relatively small sample size of respondents. Future research should consider expanding the dataset and incorporating machine learning–based weighting optimisation, as well as applying sensitivity or uncertainty analysis to further assess the robustness of the hybrid WP–TOPSIS model across diverse decision-making scenarios.

From the standpoint of applied mathematics and computational modelling, this study demonstrates how hybrid MCDM algorithms can be systematically implemented to solve real-world optimisation problems. By integrating theoretical mathematical formulation with computational implementation, the study provides a quantitative, scalable, and reproducible framework for optimal decision analysis, applicable not only to service evaluation but also to a wide range of multi-criteria optimisation contexts.

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