Evaluation on the Preference of Courier Services Using Integrated AHP-TOPSIS Model

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ARTICLE INFO	ABSTRACT
	Courier services are businesses that deliver documents, parcels and heavy products from one place to another. Courier services are gaining popularity nowadays due to their efficient and reliable delivery. However, the existence of many courier service companies today has led to fierce commercial competition both domestically and globally. Since there are many decision alternatives and criteria to consider, consumers face a significant challenge in choosing the best courier service. As a result, selecting the optimal courier service involves a process of Multi-Criteria Decision Making (MCDM). The objective of this study is to determine the preferred courier service based on undergraduates' preferences using an integrated AHP-TOPSIS model. The AHP-TOPSIS model is proposed in this study to tackle the MCDM problem as choosing the optimal courier service involves various decision criteria. In this research, AHP is proposed to identify the priority of decision criteria, whereas TOPSIS is utilized to determine the ranking of the courier service providers. Additionally, this study aims to determine the priority of decision criteria. As a result of this research, GD Express was identified as the most preferred courier service provider, followed by DHL, FedEx, Skynet Express, PosLaju, and City-Link Express. Furthermore, the top three influencing factors are freight rates, timeliness and reliability. The significance of this study lies in identifying the most preferred courier service and the most influential decision criterion in the decision-making process. The study can serve as a reference for the less popular courier service companies, assisting them in identifying weaknesses and making enhancements according to the decision criteria' ranking.

1. Introduction

The courier service of a freight company is an industry that specializes in transporting material goods to predetermined destinations [1]. It can also refer to the outsourcing medium through which a contracting company arranges the transportation of customers' goods from one geographic location to another [2]. Courier services operate on various scales, primarily through large companies such as DHL and FedEx, to handle postal mail and parcel transportation worldwide [1]. The core business of courier services is to provide guaranteed speed and security transportation. According to

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Glysentte [3], PosLaju, Skynet Express, City-Link Express, GD Express, FedEx, and DHL are among the best-performing courier services in Malaysia. It is undeniable that despite the decline in mail volume in April 2020, the Movement Control Order (MCO) accelerated the popularity of e-commerce and online marketplaces [4]. As a result, PosLaju's revenue increased by approximately 25% to RM606.1 million in the second quarter of June, ranking it second on the list of top courier services 2020, followed by Skynet Express, City-Link Express, GD Express, FedEx, and DHL [3,4]. Additionally, online trading, such as buying and selling clothes and products among young people, has become common due to the widespread use of smartphones, convenience and the desire to earn extra money [5]. Courier services have been favored by undergraduates from Universiti Tunku Abdul Rahman (UTAR) located in Kampar, who often use them as a transportation medium for online trading. Therefore, the important factors such as freight rates, customer service, timeliness, reliability, condition or accuracy of order, and insurance and security, which influence undergraduate students' choice of courier services, are considered in this study to explore their preferences.

Courier services have existed in Malaysia for many years. Due to economic expansion, population growth and online shopping trends, the courier services industry continues to grow [6]. Today, courier services are vital to the effective operation of the entire economy and society, as they meet the commercial and social needs of the country [6]. The courier service companies such as PosLaju, Skynet Express, City-Link Express, GD Express, FedEx, DHL and so on can be found throughout Malaysia, which poses a challenge for students when choosing a courier service, as various factors need to be considered. Therefore, after reviewing the literature, six criteria for preferred courier services have been identified to provide students with reference points for making their choice.

Freight rates can refer to the prices or expenses based on the weight of the shipment and the shipping method, paid by customers to the freight company for courier services [7]. The decision to purchase a courier service often depends on customers' perception of freight rates or shipping costs. According to Izadi, Nabipour and Titidezh [7], some customers are willing to pay more for faster and more reliable shipping, as these preferences add value to the cost of freight time. Conversely, Zhang and Li [8] studied customer preferences for courier services before placing online orders. One of the attributes they examined was the delivery price. Their respondents, including diploma students, undergraduate students and employed workers, tended to prefer faster delivery at a lower cost that they could afford [8]. Both studies indicate that freight rates have a significant impact on customer choices, though customers have different perspectives on this factor when selecting courier services. Additionally, Ding *et al.,* [9] considered sub-criteria of freight rates, such as the flexibility and reasonableness of freight rate, to demonstrate the importance of freight rates in the selection of courier service providers.

Timeliness measures the average effectiveness and success rate of a courier provider when they receive orders from customers [10]. It is a crucial factor in selecting courier services, as poor management and complaints about timeliness, such as delivery delays, can lead to customer dissatisfaction and prompt them to switch to competitors [10]. Delivery speed and short administrative processing time are some of the key criteria used to evaluate the timeliness of courier services [11]. In Otsetova's research [12], timeliness is measured by how well the time for order placement aligns with consumer requirements and whether delivery times are adequate given the distance and specific conditions. Delivery time is very important to customers because it allows them to decide on the most convenient collection and delivery point [8]. For students, in particular, knowing the delivery time helps them decide whether to receive the package at home or in their dormitory. For example, if delivery occurs on weekends, they may choose to have parcels sent to their home. Therefore, timeliness is considered an important factor in this study.

Reliability refers to the ability to perform services accurately and consistently in accordance with promises made. It measures the stability of a company's performance and how it can establish itself as dependable [13]. In the study by Meng and Zhou [14], three factors were used to assess a company's reliability. First is the enterprise's commitment to completing tasks on time and being trustworthy. The second is that the express service provided is speed and accuracy, and the last is having a strong after-sales service guarantee system. Indirectly, the effectiveness of a courier service can be evaluated by measuring its reliability. According to Ejdys and Gulc [15], the reliability level can be defined as the degree of trust that the service provider can ensure for the recipient. When customers trust a courier service, they are confident that the service will be delivered as agreed, such as fast delivery within two days, even under changing conditions. Ejdys and Gulc [15] argue that if customers trust the solutions provided by a courier service, their evaluation of the service quality will be higher, which in turn enhances the company's reputation and builds customer loyalty. Therefore, reliability is a key factor in their exploration.

Insurance and security refer to the protection provided for cargo during shipment, including the management of cargo handling information, insurance and compensation policies that cover any loss or damage to the products [16]. In the study by Zhou, Zhu and Ma [11], insurance and security are highlighted as significant aspects of service quality because they ensure customer privacy protection, a reliable insurance system, and attention to maintaining parcels in good condition. For example, if a product is lost or damaged during transportation, the issue is typically addressed and resolved through an insurance claim [17]. Valaei, Rezaei and Shahijan [16] also found that information security is positively related to service quality, customer satisfaction and loyalty. Therefore, insurance and security can be considered essential measurement tools in the courier service industry.

Customer service refers to the support provided to customers at various stages, including before, during and after a purchase [18]. It encompasses whether the receptionists can answer customer inquiries, their readiness to assist, the quality of the service personnel, and how well complaints or claims are handled [11,18]. Effective customer service involves providing appropriate information and understanding the unique needs of consumers [18]. Frontline employees play a crucial role in establishing strong relationships between courier service companies and consumers, as customer satisfaction largely depends on their performance [18]. Customer satisfaction refers to how well a product or service meets customer expectations. It can also be described as the inner feeling customers have when they compare their expectations with their actual experience in purchasing courier services [13]. According to Siali, Wong and Hajazi [13], when customers are satisfied with the services provided, they are more likely to use those services again. Therefore, improving customer service can help maintain a good reputation and build customer loyalty in a highly competitive market.

Condition and accuracy of order refer to monitoring the entire process from placing the order to its delivery, including the condition of the delivered products. This is related to the courier service's ability to maintain the condition of goods and prevent potential damage during transit [19]. It also includes whether the express carrier delivers the goods according to the agreed conditions and submission form, as well as the accuracy and correctness of the transportation and financial documents issued by the carrier [12]. In courier operations, service providers must ensure that the quantity matches the delivery order and that the condition of the goods is as good as when they were handed over by the warehouse department. Failure to do so can negatively impact customer and manufacturer satisfaction [17]. Additionally, Valaei, Rezaei and Shahijan [16] emphasized that the accuracy and condition of an order positively contribute to perceived service quality, as they ensure that products are delivered in good condition to the correct address. Therefore, the condition and accuracy of order should be considered in the evaluation of courier services.

The growth of the courier service industry has led to intense competition and rising customer demand, prompting courier companies to seek added value beyond standard services [20]. To assess the satisfaction and preferences of final consumers, an online survey was conducted among undergraduate students who use courier services. Given the multiple factors that undergraduate students must consider when choosing courier services, prioritizing these decision criteria has become crucial. Selecting a high-quality courier service is challenging for undergraduates due to the numerous decision alternatives available, making it a multi-criteria decision making (MCDM) problem. In this context, the Analytic Hierarchy Process-Technique for Order of Preference by Similarity to Ideal Solution (AHP-TOPSIS) model is proposed to study the preferences of undergraduate students at UTAR Kampar. AHP-TOPSIS model simplifies the complex decision structure, helping students gain a clearer understanding of the problem and facilitating easier decision making. The AHP model determines the priority of decision criteria using a pairwise comparison matrix (PCM) [21-24]. Once the weights of the decision criteria are obtained, the TOPSIS model evaluates the performance of courier services by considering the Euclidean distance from the negative ideal solution (NIS) and the positive ideal solution (PIS) [25,26]. Furthermore, courier services can be ranked based on the weights of the decision criteria determined by the AHP model. The AHP model also allows for consistency checking of the PCM. The hybrid of AHP and TOPSIS is a robust and reliable model to be proposed in this study to evaluate and rank courier services based on six key decision criteria.

Given the importance of decision criteria such as freight rates, customer service, timeliness, reliability, condition or accuracy of order, and insurance and security in selecting courier services, this paper considers these six criteria for analysis. Based on previous studies, considering these six crucial decision criteria will yield more comprehensive and meaningful results. The courier services evaluated in this study are GD Express, PosLaju, FedEx, DHL, Skynet Express, and City-Link Express. To the best of our knowledge, no comprehensive studies have used the AHP-TOPSIS model to analyze undergraduate preferences for courier services. Thus, it is a gap that can be filled up by carrying out this study. The significance of the research is twofold: first, to determine the priority of decision criteria among freight rates, customer service, timeliness, reliability, condition or accuracy of order, and insurance and security for courier service by undergraduates at Kampar Campus using the AHP model; and second, to identify and rank the courier services using the TOPSIS model. The findings will provide valuable insights into which courier services are preferred by undergraduates and which decision criteria are most influential. This research can serve as a reference for courier service companies that are less popular among undergraduates, helping them identify weaknesses and make improvements based on the ranking of decision criteria. Understanding these preferences can also enhance customer confidence in specific courier services, potentially boosting sales. By providing information on student preferences, this study offers a competitive advantage to businesses, helping them align with student needs and improve their services. In the context of the growing e-commerce sector, it is crucial for courier services to continually enhance their offerings and develop strategies to attract and retain customers.

The organization of this paper is constructed as follows: Section 2 outlines the materials and methodology used in the study. The empirical results are discussed in the subsequent section. The last section of the paper is the conclusion.

2. Materials and Methodology

2.1 Research Development

The research is conducted to assess undergraduate preferences for courier services using a hybrid TOPSIS and AHP model. The purpose of this research is to determine the ranking of selected courier services and identify the factors influencing choice based on undergraduate preferences with the proposed AHP-TOPSIS model. The TOPSIS model identifies the optimal solution by finding the alternative with the longest Euclidean distance from the NIS and the shortest Euclidean path to the PIS [27]. Meanwhile, the decision criteria' priority is determined by the AHP model. As a result, the integrated AHP and TOPSIS model is proposed to choose the well-performing courier services. The proposed research framework, which comprises three stages, is depicted in Figure 1.
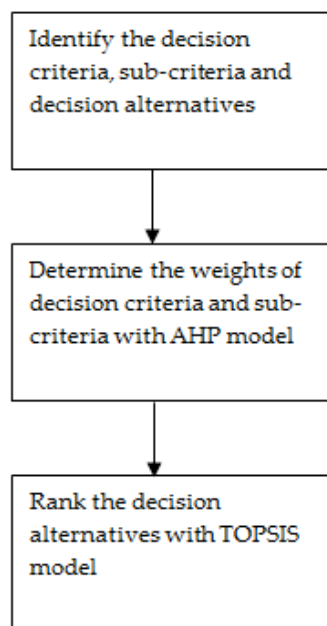

Fig. 1. Proposed framework of research

The proposed framework of research comprises three stages is explained as below:

i.   Stage 1: The decision alternative, decision criteria, and sub-criteria are identified to choose the courier services.
ii. Stage 2: The priorities of the decision criteria and sub-criteria are determined by using the AHP model. Furthermore, the overall ranking of the sub-criteria and decision criteria are identified as well.
iii. Stage 3: Application of TOPSIS methodology to rank the courier services based on their performance. The best courier service will have the longest path to the NIS and the shortest way to the PIS.

Table 1 outlines the hierarchy of decision-making for courier service selection. It starts with the main objective of selecting a courier service and is followed by the six criteria and the alternatives. The decision criteria such as freight rates, timeliness, reliability, insurance and security, customer service, and condition or accuracy of order are taken into consideration in the selection of courier

services platform providers. For this research, GD Express, PosLaju, FedEx, DHL, Skynet Express, and City-Link Express are the six decision alternatives.

Table 1
Proposed hierarchy structure

Level	
Level 1 (Purpose)	Selection of courier services
Level 2 (Decision criteria)	Freight rates
	Timeliness
	Reliability
	Insurance and security
	Customer service
	Condition or accuracy of order
Level 3 (Decision alternative)	GD Express
	PosLaju
	FedEx
	DHL
	Skynet Express
	City-Link Express

Table 2 demonstrates the main decision criteria and sub-criteria used in this research. There are six main decision criteria, eighteen sub-criteria, and six alternatives considered in this research study. In this study, the preferences of 150 undergraduates are taken as the data. The data collected for the information about the preference of courier services is given by the undergraduate students as respondents. The respondents were asked to make human judgments on the comparison and rating of all decision criteria and decision alternatives. During this process, the respondents will make their decisions by giving their responses. After completing the data collection, the preferences of the undergraduates are analyzed by using the proposed AHP-TOPSIS model.

Table 2
Main decision criteria and sub-criteria

Main decision criteria	Sub-criteria
Freight rates	Flexibility
	Reasonableness
Timeliness	Lower administrative processing time
	Delivery speed
	Time for order placement is in line with consumer requirements
	Time delivery of shipments is adequate to distance and the specific conditions of delivery
Reliability	Good after-sales service guarantee system
	Express delivery service quickly and accurately
	Enterprise commitment to customers can be completed in a timely manner, it is worth to trust
Insurance and security	Customer privacy protection
	Insurance system
	Degree of the goods in good condition
Customer service	Ready to help customers
	Service personnel quality
	Complaint claims service satisfaction
	Ability to answer any questions or problems from customers

| Condition or accuracy of order | Courier operator delivers shipments in accordance with the agreed conditions and in the form of submission |
| | Shipping and financial documents issued by the courier operator are accurate and correct |

2.2 AHP

AHP model is a MCDM method that was developed by Thomas L. Saaty in the 1970s [21-24]. It has been widely used to tackle complex and time-consuming decision problems by arranging the decision criteria and sub-criteria in a hierarchical structure in order to simplify the problem [27]. In this study, the AHP model is introduced to identify the priorities or weights of decision criteria and sub-criteria in the selection of courier services at the second stage [28]. The AHP data analysis is carried out in six steps [29].

i.   Step 1: Define the research problem and determine the decision criteria, sub-criteria under each main decision criterion and alternatives.
ii. Step 2: The data is gathered from target respondents based on the fundamental scale of importance [29,30]. Table 3 displays the ratio scale utilized for pairwise comparison.

Table 3
Ratio scale

Intensity of Importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2, 4, 6, 8	Intermediate importance

iii. Step 3: Construct the pairwise comparison matrix (PCM) using the information collected [31,32]. In order to get its degree of importance to the issue, compare each criterion and sub-criterion in pairwise. The PCM for decision factors and sub-criteria appears as beneath Eq. (1):

$$A = \begin{bmatrix} 1 & c_{12} & \cdots & \cdots & c_{1n} \\ 1/c_{12} & 1 & & & c_{2n} \\ \vdots & & \ddots & & \vdots \\ \vdots & & & \ddots & \vdots \\ 1/c_{1n} & 1/c_{2n} & \cdots & \cdots & 1 \end{bmatrix} \quad (1)$$

where c_{ij} represents the relative preference of element i to element j.

iv. Step 4: Compute the weights for each criterion and sub-criterion by using Normalization Method. To construct the normalized matrix, all elements in the column are divided by the sum for each column in the matrices.
v.   Step 5: Construct the weighted normalized decision matrix for decision criteria and sub-criteria. The priorities or weights of the decision criteria and sub-criteria can be represented by calculating the average of each row in the recently shaped normalized matrices. The symbol w is used to indicate the weight score for each decision criterion and sub-criterion.

vi. Step 6: Check for consistency by calculating the Consistency Ratio (*CR*) which is expressed in terms of Consistency Index (*CI*) and Random Index (*RI*). *CI* is used to quantify how consistent the judgments are. The value of *RI* can be obtained from the random index table. The formula is demonstrated as follows in Eq. (2):

$$CR = \frac{CI}{RI} \tag{2}$$

where *CI* is consistency index and *RI* is random index [24].

If the *CR* is smaller than or equal to 0.10 (*CR* ≤ 0.10), the degree of consistency in the PCM is good and trustworthy [33,34]. The AHP outcomes can be accepted. Otherwise, the PCM exhibits a serious inconsistency. The AHP model may not yield meaningful results.

2.3 TOPSIS

In 1981, Hwang and Yoon developed the TOPSIS model to address MCDM problem [35,36]. The core concept of this technique is that the chosen decision alternative should be as close as possible to the PIS, which represents the best level for all attributes, and as far away as possible from the NIS, which represents the worst level for all attributes [36-41]. This approach assumes that each criterion has a tendency to either monotonically increase or decrease in utility, making it easier to identify the PIS and NIS. The Euclidean distance approach is utilized to assess the relative closeness of decision alternatives to the ideal solution [37]. Thus, a series of comparisons of these relative distances can be used to derive the preference order of the decision alternatives. In this study, the TOPSIS model is proposed to rank the most preferred courier services. TOPSIS data analysis is performed in seven steps [36].

i. Step 1: Construct a decision matrix which consists of *n* decision criteria and *m* decision alternatives. Each alternative has a score denoted by x_{ij} relative to each criterion and then the structure of the decision matrix $(x_{ij})_{m \times n}$ is demonstrated as below in Eq. (3):

$$(x_{ij})_{m \times n} = \begin{array}{c} \\ L_1 \\ L_2 \\ \vdots \\ \vdots \\ L_m \end{array} \begin{array}{cccccc} c_1 & c_2 & \cdots & \cdots & c_n \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & \cdots & x_{1n} \\ x_{21} & x_{22} & & & x_{2n} \\ \vdots & & \ddots & & \vdots \\ \vdots & & & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & \cdots & x_{mn} \end{bmatrix} \end{array} \tag{3}$$

where L_i = alternative $(i = 1, 2, 3, ..., m)$

c_j = criterion $(j = 1, 2, 3, ..., n)$

j = criterion index $(j = 1, 2, 3, ..., n)$

i = alternative index $(i = 1, 2, 3, ..., m)$

ii. Step 2: Construct the normalized decision matrix *R*. The normalized value r_{ij} of the normalized decision matrix *R* is computed as follows in Eq. (4):

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$
(4)

iii. Step 3: Construct the weighted normalized decision matrix *v* by multiplying the normalized decision matrix *R* with a set of weights *w* = (*w*₁, *w*₂, … , *wₙ*) of the decision criteria. The weighted normalized decision matrix *v* is presented by means of Eq. (5):

$$v_{ij} = r_{ij} \times w_j$$
(5)

where $j = 1, 2, 3, 4, \ldots, n$, $i = 1, 2, 3, 4, \ldots, m$ and w_j is the weights of the criteria

iv. Step 4: Determine the positive ideal solution (A_b) and negative ideal solution (A_w). The A_b is a solution that maximizes beneficial criteria while minimizing the cost criteria. On the one hand, the A_w is to maximize the cost criteria while minimizing the beneficial criteria. The optimal solution is the solution closest to the A_b, and farthest from the A_w. The formula are as follows in Eq. (6) to (7):

$$A_b = \{v_1^+, v_2^+, \ldots, v_n^+\} \text{ where } v_j^+ = \{(\max v_{ij} \mid i \in I), (\min v_{ij} \mid i \in I')\}$$
(6)

$$A_w = \{v_1^-, v_2^-, \ldots, v_n^-\} \text{ where } v_j^- = \{(\min v_{ij} \mid i \in I), (\max v_{ij} \mid i \in I')\}$$
(7)

v. Step 5: Calculate the separation measure or Euclidean distance of each decision alternative from the ideal solution d_i^* and negative ideal solution d_i^-. The formulae include in Eq. (8) and (9):

$$d_i^* = \sqrt{\sum_{j=1}^{n} (v_j^+ - v_{ij})^2} \text{ , } i = 1, 2, 3, \ldots, m$$
(8)

$$d_i^- = \sqrt{\sum_{j=1}^{n} (v_j^- - v_{ij})^2} \text{ , } i = 1, 2, 3, \ldots, m$$
(9)

vi. Step 6: Calculate the relative closeness (RC_i) to the ideal solution for each decision alternative as in Eq. (10):

$$RC_i = \frac{d_i^-}{(d_i^* + d_i^-)}, \text{ } 0 \leq RC_i \leq 1$$
(10)

vii. Step 7: Rank the preference order of decision alternatives based on the descending order of the relative closeness RC_i coefficient which starts from the value that is closest to 1. The best alternative has the highest relative closeness among alternatives.

3. Results

According to the second stage of the proposed MCDM model, the AHP model is used to identify the priority of decision criteria, as depicted in Figure 2. Based on Figure 2, freight rates, with a weight of 0.2013, is the most important criterion that undergraduates are concerned about. Timeliness ranks second with a weight of 0.1916, followed by reliability, insurance and security, and condition or accuracy of order, with weights of 0.1854, 0.1594 and 0.1356, respectively. Customer service is the least preferred factor, with the lowest weight of 0.1267. Freight rates is the primary concern for undergraduates due to their limited income. While some students work part-time, most rely on financial support from their parents and government loans, which is the National Higher Education Fund (PTPTN). To minimize financial strain, students are cautious with their budgets, especially when shipping large or heavy items, as freight costs are based on weight and size. Besides, the second and third most important criteria are timeliness and reliability, respectively. According to the research of Otsetova [42], timeliness and reliability are crucial in evaluating the quality of courier service, impacting customer satisfaction and loyalty. Timely delivery is essential for high satisfaction, especially for time-sensitive items like medical samples or temperature-sensitive goods. In addition, accurate and fast delivery time also facilitates easier package collection for students. Moreover, insurance and security, and condition or accuracy of order are ranked fourth and fifth, respectively. These criteria concern the condition of packages during delivery. Since sellers and service providers often offer free insurance and warranties, these criteria are less influential in students' decision making. Lastly, customer service is the least influential criterion. Students prioritize receiving undamaged products over service quality and personnel attitude, as long as the product meets their expectations.
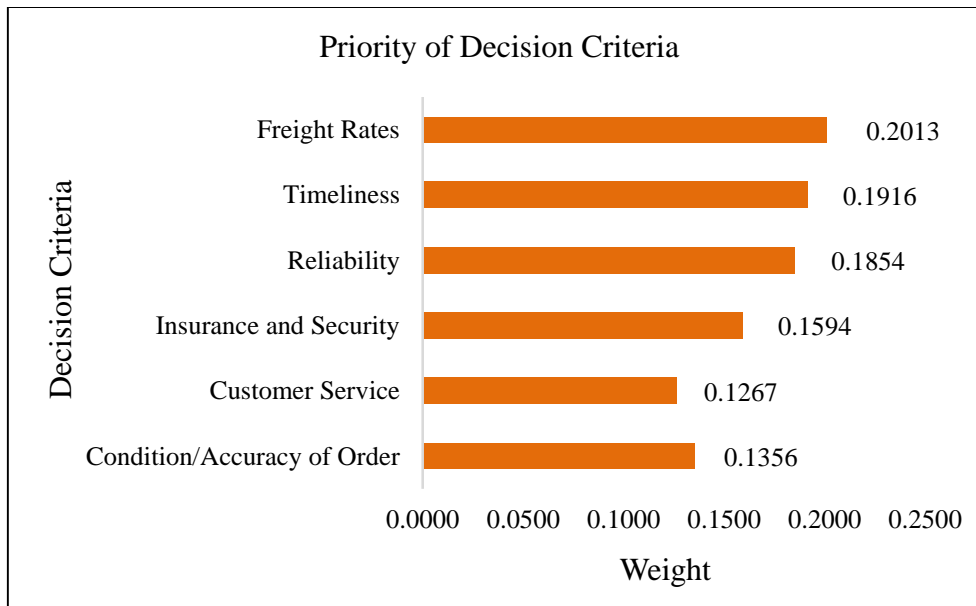

Fig. 2. Weights of the decision criteria

Figure 3 to 8 display the priority of each criterion across the six courier services evaluated. The results reveal that GD Express scores highest for all decision criteria, including freight rates, timeliness, reliability, insurance and security, customer service, and order conditions or accuracy. Consequently, GD Express ranks first in each decision criterion, indicating its overall excellence compared to other courier services. GD Express outperforms its competitors in all aspects considered. In contrast, City-Link Express performs poorly across all decision criteria.
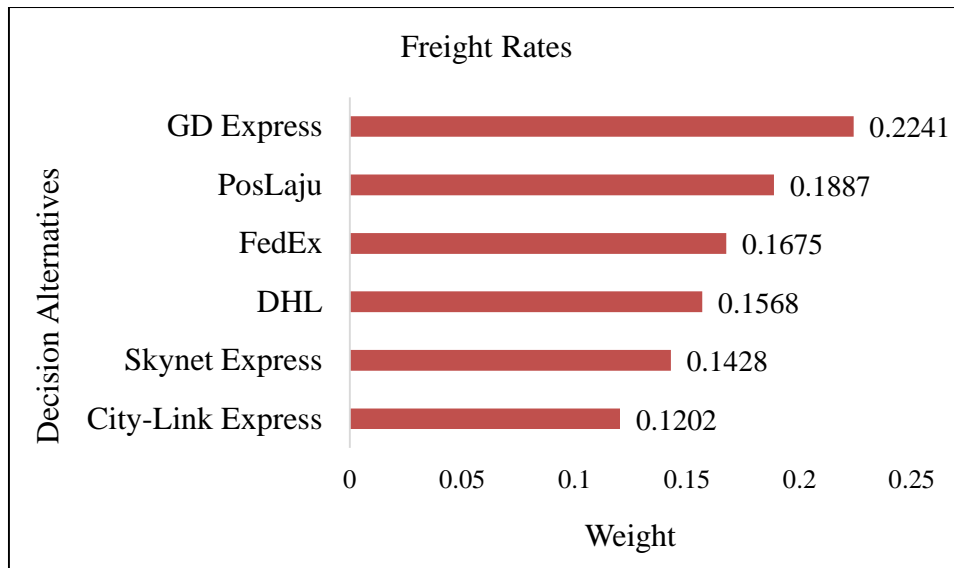
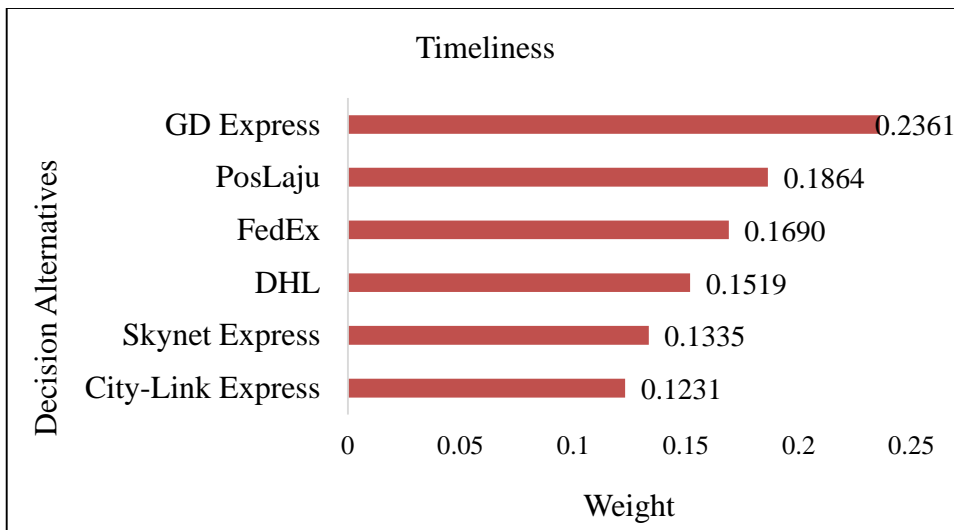**Fig. 3.** Preference of courier services based on freight rates

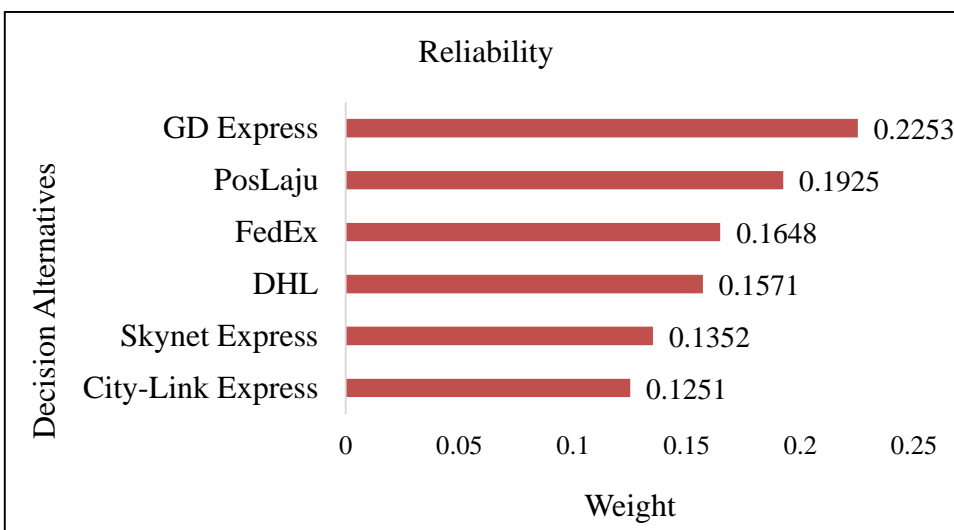**Fig. 4.** Preference of courier services based on timeliness

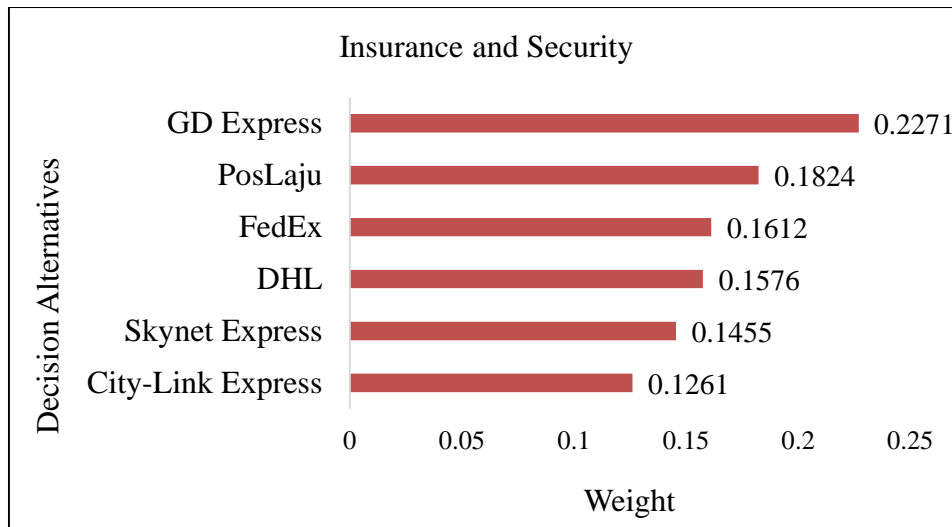**Fig. 5.** Preference of courier services based on reliability

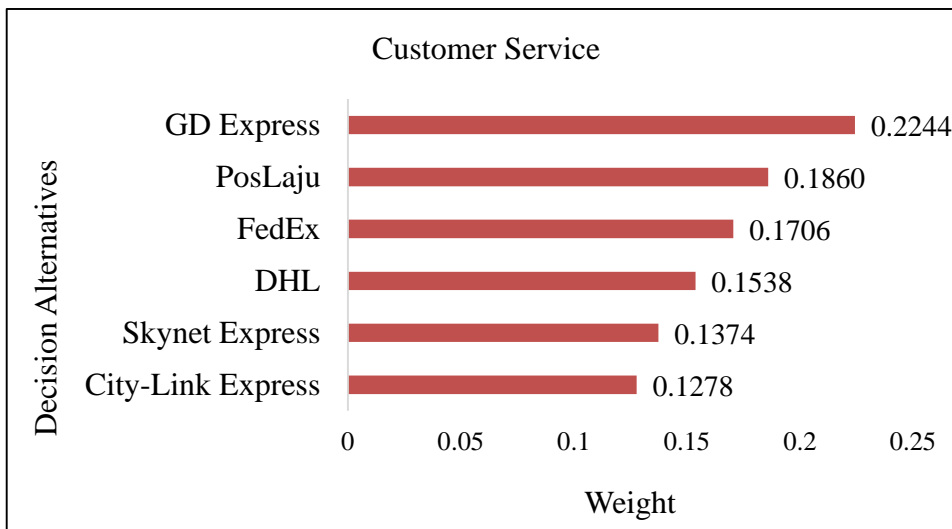**Fig. 6.** Preference of courier services based on insurance and security

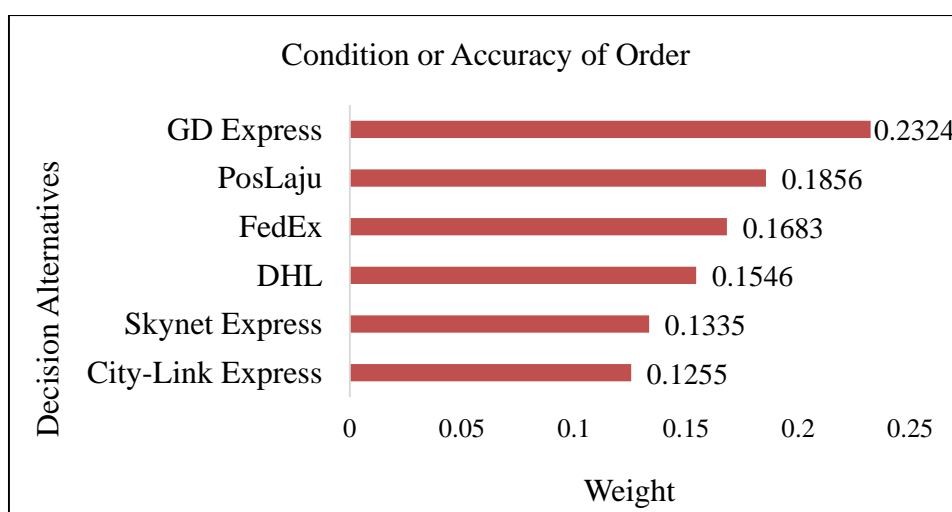**Fig. 7.** Preference of courier services based on customer service

Fig. 8. Preference of courier services based on condition or accuracy of order

The priority weights among criteria and sub-criteria are provided in Table 4. According to Table 4, the weight within the criteria and the ranking within the criteria are presented in the third and fourth columns, respectively. Furthermore, the weight among sub-criteria and the overall ranking of the sub-criteria have also been determined as shown in the last two columns of Table 4. Figure 9 demonstrates the normalized weight of sub-criteria.

Table 4
Priority weights in the AHP decision tree

| Criteria	Weight between the criteria (%)	Weight within the criteria (%)	Ranking within the criteria	Weight among sub-criteria (%)	Overall ranking
Freight rates	0.2013				
• Flexibility		0.5779	1	0.1163	1
• Reasonableness		0.4221	2	0.0849	2
Timeliness	0.1916				
• Lower administrative processing time		0.2600	2	0.0498	9
• Delivery speed		0.3174	1	0.0608	7
• Time for order placement is in line with consumer requirements		0.2173	3	0.0416	13
• Time delivery of shipments is adequate to distance and the specific conditions of delivery		0.2053	4	0.0393	14
Reliability	0.1854				
• Good after-sales service guarantee system		0.3810	1	0.0707	4
• Express delivery service quickly and accurately		0.3554	2	0.0659	6
• Enterprise commitment to customers can be completed in a timely manner, it is worth to trust		0.2636	3	0.0489	10
Insurance and security	0.1594				
• Customer privacy protection		0.4164	1	0.0664	5
• Insurance system		0.2832	3	0.0451	12
• Degree of the goods in good condition		0.3004	2	0.0479	11
Customer service	0.1267				
• Ready to help customers		0.2901	1	0.0368	15
• Service personnel quality		0.2722	2	0.0345	16
• Complaint claims service satisfaction		0.2296	3	0.0291	17
• Ability to answer any questions or problems from customers		0.2081	4	0.0264	18
Condition or accuracy of order	0.1356				
• Courier operator delivers shipments in accordance with the agreed conditions and in the form of submission		0.6110	1	0.0829	3
• Shipping and financial documents issued by the courier operator are accurate and correct		0.3890	2	0.0527	8
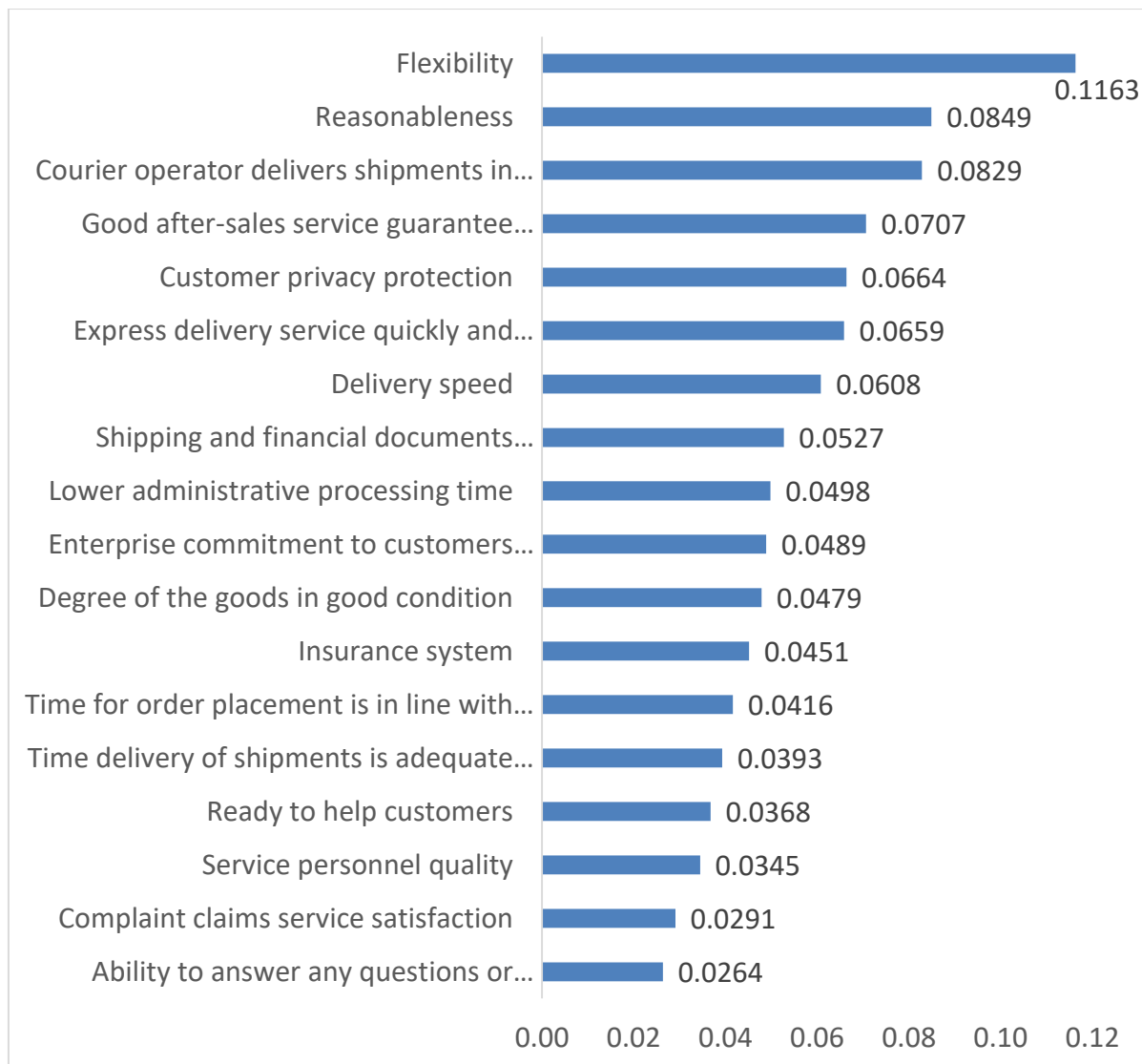
Fig. 9. The normalized weight of sub-criteria

The performance and ranking of the courier services are determined at the last stage of the proposed MCDM model with TOPSIS. The weighted normalized decision matrix *v* is constructed by multiplying the normalized decision matrix with a set of weights of the decision criteria that are outcomes of the AHP model at the second stage. The weighted normalized decision matrix is shown in Table 5.

Table 5
The weighted normalized decision matrix

Courier service	Freight rates	Timeliness	Reliability	Insurance and security	Customer service	Condition or accuracy of order
GD Express	0.0830	0.0850	0.0808	0.0678	0.0540	0.0579
PosLaju	0.0821	0.0750	0.0749	0.0638	0.0502	0.0553
FedEx	0.0820	0.0780	0.0740	0.0637	0.0510	0.0556
DHL	0.0836	0.0794	0.0766	0.0660	0.0514	0.0552
Skynet Express	0.0826	0.0767	0.0743	0.0642	0.0517	0.0545
City-Link Express	0.0797	0.0747	0.0734	0.0648	0.0519	0.0535

Since all decision criteria are beneficial, the positive ideal solutions, A_b are obtained by maximizing each column of the weighted normalized decision matrix, while the negative ideal solutions, A_w are obtained by minimizing each column of the weighted normalized decision matrix. The results are depicted in Table 6. The A_w for freight rates, timeliness, reliability, insurance and security, customer service, and condition or accuracy of order are 0.0797, 0.0747, 0.0734, 0.0637, 0.0502, and 0.0535, respectively. The A_b for freight rates, timeliness, reliability, insurance and security, customer service, and condition or accuracy of order are 0.0836, 0.0850, 0.0808, 0.0678, 0.0540, and 0.0579, respectively.

Table 6
NIS and PIS of the decision criteria

Decision criteria	Negative ideal solution (A_w)	Positive ideal solution (A_b)
Freight rates	0.0797	0.0836
Timeliness	0.0747	0.0850
Reliability	0.0734	0.0808
Insurance and security	0.0637	0.0678
Customer service	0.0502	0.0540
Condition or accuracy of order	0.0535	0.0579

Based on Table 6, the Euclidean distance from the positive ideal solution (A_b) and the negative ideal solution (A_w) for each courier service can be determined, and then the relative closeness to the ideal solution can be computed. The results are displayed in Table 7.

Table 7
Euclidean distance of each courier service from PIS and NIS

Courier service	d_i^-	d_i^*
GD Express	0.0149	0.0005
PosLaju	0.0033	0.0132
FedEx	0.0045	0.0114
DHL	0.0075	0.0082
Skynet Express	0.0041	0.0119
City-Link Express	0.0020	0.0144

According to the outcomes presented in Table 8, GD Express is the most preferred alternative, with a relative closeness value significantly higher than that of other courier services. Although DHL ranks fourth in all decision criteria, its overall performance is better than other express services, placing it second overall. FedEx, which ranks third across all criteria, maintains its third-place position in overall performance. Skynet Express, ranking fifth in all criteria, comes fourth in overall performance. PosLaju, despite ranking second in all decision criteria, has a lower overall performance compared to other services, except City-Link Express, making it the fifth choice for students. City-Link Express, which consistently ranks lowest, has the lowest overall performance. In conclusion, the preferred courier services for students are ranked as follows: GD Express (0.9656), DHL (0.4787), FedEx (0.2852), Skynet Express (0.2552), PosLaju (0.2003) and City-Link Express (0.1206). The calculated *CR* value is 0.0172, which is below the threshold of 0.1000, indicating that the PCM has minimal inconsistency. Therefore, the AHP results are reliable, which freight rates being the most significant factor for students. The findings of the study indicate that the AHP-TOPSIS is a robust model for evaluating courier service preferences.

Table 8
Ranking of courier services

Courier service	Relative closeness value (RC_i)	Rank
GD Express	0.9656	1
PosLaju	0.2003	5
FedEx	0.2852	3
DHL	0.4787	2
Skynet Express	0.2552	4
City-Link Express	0.1206	6

4. Conclusions

In conclusion, the focal point of this research study is to determine the most preferred courier services among GD Express, PosLaju, FedEx, DHL, Skynet Express and City-Link Express. Besides, the research also aims to determine the priority decision criteria that undergraduates should consider when selecting courier services. This study proposed the AHP-TOPSIS model to investigate undergraduate students' preferences for courier services. There are some important findings are discovered in this study. Based on the results, GD Express is the most preferred courier service among undergraduates, followed by DHL, FedEx, Skynet Express, PosLaju and City-Link Express with respect to freight rates, timeliness, reliability, insurance and security, customer service and condition or accuracy of order. GD Express excels due to its competitive pricing, which considers freight and package size, as well as its rapid delivery service. The top three criteria influencing courier service selection are freight rates, timeliness, and reliability, with insurance and security, condition or accuracy of order and customer service following in importance. Among these, the most critical sub-criteria are the flexibility of freight rates, delivery speed, and good after-sales service guarantee system.

The significance of this study lies in determining the preferred courier services and identifying the most crucial decision criteria among undergraduate students in the decision-making process. The hybrid of AHP and TOPSIS model proposed in this research not only assists in identifying the favoured courier services, but also serves as a reference for recognizing areas for improvement and potential enhancements based on the most influential criteria identified in this research. Courier services that are less favoured should focus on addressing the main factors highlighted in this study while developing competitive strategies to better attract consumers. By concentrating on these key criteria, they can enhance their appeal and improve their market position. In conclusion, the AHP-TOPSIS model provides a robust framework for evaluating and selecting the most suitable options in complex decision-making scenarios. It supports decision-makers by visualizing the impact of various criteria on the final choice. The model's adaptability makes it a valuable tool for different market segments, allowing for modifications to meet specific goals and achieve better outcomes.

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