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Efficiency of Courier Service Companies in Malaysia Using Data Envelopment Analysis (DEA) Models

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Abstract: Many organisations in the service industry encounter the issue of unequal efficiency results. Many large corporations, such as banks, hotels and courier companies, are concerned about this issue. In particular, the last decade has seen ongoing changes in law, technology and competition in the global financial services business and Malaysian courier services are no exception. Therefore, it is essential to compare the performance of courier services offering their services in Malaysia to judge the stability of the courier service. An efficient courier service makes a significant contribution to improved economic growth in any nation. Thus, studies of courier service efficiency are critical for policymakers, industry leaders and many others who rely on the logistics sector. This paper examines the efficiency scores of six courier services in Malaysia. The Charnes, Cooper and Rhodes model (CCR) and Slack-Based Measure model (SBM) are applied in this study. There are three inputs and one output to measure the performance of the courier service. The total number of employees, the total number of courier branches and courier service volume as the inputs while the total revenue as the output. As the results show, two out of six courier services are efficient with an efficiency score equal to 1. Meanwhile, the remaining four courier services showed inefficiency score results. Suggestions and improvements to increase the efficiency of courier services in the future have been suggested. To address inefficient courier services, the SBM model gives guidelines for assessing efficiency for improvement for courier services to be more efficient.

Keywords: Charnes, Cooper & Rhodes; Efficiency, Slack based measure model.

1 Introduction

Efficiency is a critical performance metric that measures the ability to achieve maximum output with the minimum required input. It reflects the capacity to avoid wasting resources, such as materials, energy, effort, money, and time, while producing a desired outcome. In mathematical or scientific contexts, efficiency is often defined as the ratio of useful output to the total input required, emphasising minimal waste and maximum productivity. This concept is particularly relevant in service-oriented industries like courier services, where timely and accurate delivery is paramount. Courier companies are specialised delivery firms responsible for transporting packages, documents, and parcels from one location to another, quickly and reliably. These companies play a crucial role in the logistics sector, supporting businesses and consumers by providing flexible and efficient delivery solutions. In Malaysia, several major courier companies, including GD Express (GDex), J&T Express, City-Link Express, Pos Malaysia, Nationwide, and Ninja Van, operate at different scales, offering services ranging

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from local to international deliveries (see Table 1). These firms are integral to the smooth functioning of e-commerce and trade, bridging the gap between sellers and buyers.

Table 1: Courier Services in Malaysia

Courier	Code
GD Express Sdn Bhd	GDex
J&T Express	J&T
City-Link Express	CityLink
Pos Malaysia Berhad	PosMalaysia
Nationwide Berhad	Nationwide
Ninja Van Berhad	Ninjavan

The importance of courier companies has been emphasised as they provide a bridge between businesses and customers. Courier services today emphasise package safety and timely delivery supported by advanced tracking systems. This allows users to monitor shipments throughout the delivery process. By offering doorstep pickup and delivery to nearby locations, these services enhance convenience and reduce the need for in-person visits. Pricing and delivery charges are key factors in customers' choice of provider, with larger firms often receiving discounted rates due to higher volumes. A reliable courier network can play a crucial role in strengthening regional economic activity.

In early 2020, the world faced an unprecedented global health crisis as the novel coronavirus, later named COVID-19, rapidly spread across countries. The pandemic not only caused a surge in infection rates and deaths but also forced individuals and businesses worldwide to adapt to new ways of living and operating. One notable change was the widespread adoption of online shopping, as physical interactions became restricted to curb the virus's spread. This shift led to a significant rise in demand for courier services, resulting in companies working overtime to meet customer needs. However, the pressure to fulfil these demands had sometimes led to inefficiencies and issues within the courier industry. These challenges highlight the importance of measuring and improving efficiency within courier services to ensure that companies can meet customer expectations while maintaining employee satisfaction and operational effectiveness. Inefficiencies can not only harm the reputation of a company but can also impact its overall performance and profitability. Therefore, understanding the efficiency of courier companies is crucial for addressing such issues and enhancing their service delivery.

Previous studies have explored various dimensions of courier service efficiency. For instance, Teoh et al. [1] employed Data Envelopment Analysis (DEA) to evaluate the operational efficiency of four major Malaysian courier companies, which are Poslaju, City-Link Express, J&T Express, and GD Express, based on customer satisfaction within the Hulu Terengganu area. This analysis considered six critical service dimensions, including assurance, empathy, reliability, responsiveness, tangibility, and price. The findings highlighted the importance of these factors in influencing customer perceptions of service quality and overall satisfaction. Additionally, Abdul Manaf et al. [2] investigated the factors affecting the profitability of six publicly listed courier companies in Malaysia over an eight-year period (2014-2020). Using the random effects model, the study found that firm size, liquidity, and leverage positively impacted profitability, while inflation had a less significant effect. In contrast, the unemployment rate negatively influenced profitability, underscoring the importance of efficient resource management in maintaining financial stability.

Given the critical role of efficiency in courier operations, this study aims to assess the performance of Malaysian courier companies using two widely recognised efficiency measurement models: the Charnes, Cooper, and Rhodes (CCR) Model and the Slack-Based Measure (SBM) Model.

By comparing these models, this research seeks to provide actionable insights into the performance of the courier industry and identify potential areas for improvement, thereby supporting both customer satisfaction and business sustainability.

2 Methodology

This study applied Data Envelopment Analysis (DEA) to assess the efficiency of Decision-Making Units (DMUs) in a Malaysian courier company. DEA is a non-parametric method that evaluates relative efficiency by comparing multiple inputs and outputs, without assuming a specific functional form. Its flexibility makes it widely used across sectors such as banking, education, healthcare, and transportation. [3]. The CCR model, developed by Charnes, Cooper, and Rhodes in 1978, serves as the foundational DEA model and evaluates technical efficiency under the assumption of constant returns to scale (CRS) [3]. Efficiency is calculated by comparing the weighted sum of outputs to the weighted sum of inputs, resulting in a score between 0 and 1, where a score less than 1 indicates inefficiency. The CCR model has been extensively applied across sectors. For example, Visbal-Cadavid et al. used it to assess the performance of 32 public universities in Colombia, analysing their ability to transform resources into educational outcomes [4].

To account for variable returns to scale (VRS), the BCC model was introduced by Banker, Charnes, and Cooper in 1984 [5]. Unlike the CCR model, it allows for scale heterogeneity among DMUs, enabling a more flexible and accurate assessment of efficiency. The model ensures that the reference (composite) unit used for benchmarking operates at the same scale size as the evaluated DMU, often producing equal or higher efficiency scores than the CCR model. This model has been effectively applied to evaluate institutions with varying operational scales, such as in the study by Abdulmenem on public universities in Saudi Arabia [6]. Furthermore, this study incorporates the Slack-Based Measure (SBM) model, introduced by Tone in 2001, which adopts a non-radial approach by explicitly considering both input excesses and output shortfalls [7]. By incorporating slack variables directly into the efficiency score, this model provides a more accurate reflection of operational inefficiencies. The SBM model has been widely adopted across various industries, including airlines [8], energy efficiency in OECD countries [9], and industrial performance in China [10]. In this research, both the CCR and SBM models were employed to measure efficiency and performance in the Malaysian courier sector. The specific objectives are to calculate the efficiency scores of courier companies using the CCR model and to evaluate slack-based inefficiencies using the SBM model. The methodology employed in this study is summarised in Figure 1.

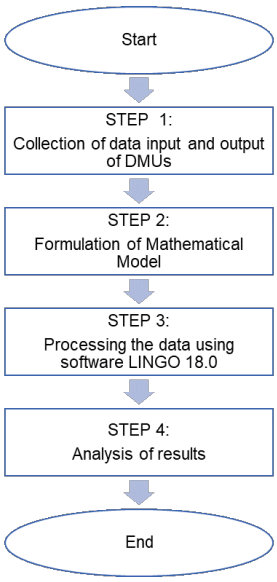

Figure 1: Flowchart of the methodology

In this study, two DEA models were employed to evaluate the efficiency of courier companies in Malaysia: the CCR model and the SBM model. Both models provide different perspectives on efficiency, offering complementary insights into operational performance.

Model 1: CCR model

The CCR model used to evaluate the efficiency of DMU_0 is defined as follows:

$$\text{Min } \tau = t$$
$$\text{subject to}$$
$$\sum_{j=1}^{n} x_{ij} u_j + t_i^- \le t x_{i0}$$
$$\sum_{j=1}^{n} y_{rj} u_j - t_r^+ \le y_{r0}$$
$$u_j \ge 0,\ t_i^- \ge 0,\ t_r^+ \ge 0$$

where n is the number of DMU, y_{r0} is the output of DMU_0, y_{rj} is the output of DMU_j, x_{i0} is the input of DMU0 and x_{rj} is the input of DMU_j.

Model 2: SBM model

The SBM model used to evaluate the efficiency of DMU_0 is defined as follows:

$$\text{Min } \tau = t - \frac{1}{m}\sum_{i=1}^{m} \frac{S_i^-}{x_{i0}}$$
$$\text{subject to}$$
$$1 = t + \frac{1}{s}\sum_{r=1}^{s} \frac{S_r^+}{y_{r0}}$$
$$t x_{i0} = \sum_{j=1}^{n} x_{ij} L_j + S_i^-$$
$$t y_{r0} = \sum_{j=1}^{n} y_{ij} L_j - S_r^+$$
$$L \ge 0,\ S^+ \ge 0,\ S^- \ge 0,\ t \ge 0 \text{ with } S^- = ts^-,\ S^+ = ts^+ \text{ and } tL = tl$$

Where S_i^- the slack in the i^{th} input and S_r^+ is the slack in the r^{th} output. Efficiency is measured by additional variables s^+ and s^-. The researcher demonstrated that the SBM efficiency rate is always less than or equal to the efficiency rate of the CCR model [11]. This means that a unit rated as SBM efficient is CCR efficient at the same time. In this model, n is the number of DMU, $r = 1,\ldots,s$ is the total number of the output, and $i = 1,\ldots,m$ is the total number of the input. Hence, x_{i0} and y_{r0} are the input and the output for a particular DMU, respectively.

3 Findings

Data from the DMU is secondary data that is referenced in the annual report and website of the courier company for the year 2023. DEA is used to compare the CCR model and the SBM model, as well as to determine the logistics industry's efficiency. The efficiency of the courier service was evaluated using three inputs and one output. The data from six courier services are included in Table 2, indicating the DMUs of Data Acquisition. This table is used to demonstrate which courier services will perform well and how efficient they are.

Table 2: The DMUs of Data Acquisition

DMUs	INPUT			OUTPUT
	Total Number Employee	Total Number of Courier Branches	Courier Service Volume	Total Revenue (RM)
GDex	4384	100	72,280,000	363,000,000
J&T	11400	14	8,000,000	212,761,695
CityLink	2727	11	78,200,000	391,000,000
Pos Malaysia	22,000	681	600,000,000	2, 330,000,000
Nationwide	1074	11	956,318	65,986,000
Ninja Van	1000	28	50505051	282,828,285

4 Methodology

This section divides the discussion into two parts: (1) The efficiency scores of CCR and SBM; and (2) the suggestions for improving inefficient courier services. The detailed discussion is as follows:

A The Efficiency Scores of CCR and SBM

Measuring efficiency is a means rather than an end, and its goal is to find the direction for each DMU to make improvements. The efficiency scores of six DMUs in this study were measured using the CCR and SBM models. Table 3 shows the efficiency scores obtained using CCR and SBM models.

Table 3: CCR and SBM scores for six courier companies in Malaysia

DMUs	Code	CCR Score	SBM Score
1	GDex	0.3545848	0.1957676
2	J&T	0.7241104	0.3781778
3	CityLink	0.6485481	0.4510587
4	PosMalaysia	0.4250809	0.2181655
5	Nationwide	1.000000	1.000000
6	Ninja Van	1.000000	1.000000

From the results, there are two DMUs that are efficient, with the efficiency scores of the DMUs being equal to 1, and it has no input excess and no output shortfall. Based on [7], a DMU is SBM efficient if and only if it is CCR efficient. The list of efficient couriers contains NationWide and Ninja van with efficiency scores equal to 1. The remaining four inefficient couriers with a score efficiency below 1 are GDex, J&T, CityLink and PosMalaysia, as shown in Figure 2. Both models indicate the same results whereby two couriers are efficient while another four couriers are inefficient.

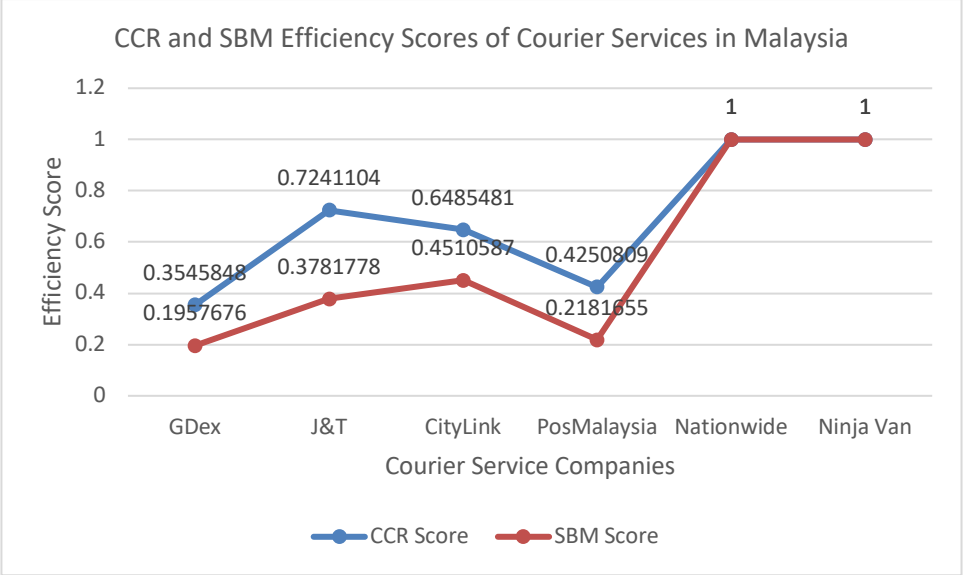

Figure 2: Graph of CCR and SBM scores for six courier companies in Malaysia

However, the SBM model provides more detailed and accurate results for inefficiency scores from the perspective of input excess and output shortfall. The results above can be used as suggestions for the courier services in the decision process. The SBM model can be used to assess input excess and output shortfall. For the courier services to become efficient, the SBM model can advise and make suggestions for improvements that should be made. This is a result of the courier service's inefficiency caused by non-zero input and output slacks. To ensure that DMU1: GDex, DMU2: J&T, DMU3: CityLink, and DMU4: PosMalaysia function become more efficient as courier services in the future, improvements must be made to address the inefficiencies in each DMU.

B The Suggestion for Improvements of Inefficient Courier Services

For example, DMU1 was inefficient with an efficiency score of 0.1957676 measured by using the SBM model. Table 4 shows the recommendation to improve the efficiency of DMU1. To be efficient, GDex should minimise the input excess and maximise the output shortfall as illustrated in Table 4. The number of courier branches should be decreased by 85.22% and courier service volume by 59.18% of input excess. On the other hand, the output shortfall of the total revenue should be increased by 164.94%.

Table 4: Result of score efficiency with input excess and output shortfall in courier services

DMU1: GDex $\rho =$ 0.1957676				
Slack	Values	Percentage%		
S_1^- S_2^- S_3^-	0.000 32.16690 16144960	0.00% (−85.22%) (-59.18%)	Total Number of Employee Total Number of Courier Branches Courier Service Volume	Input excess
S_1^+	22598700	(+164.94%)	Total Revenue (RM)	Output shortfall

The SBM model is effective in identifying specific areas where improvements are needed in both inputs and outputs to enhance the efficiency of courier services. For a more in-depth analysis of the underperforming DMUs, Table 5 presents the percentage improvements required, along with a detailed evaluation of their input and output variables.

Table 5: Result of score efficiency with input excess and output shortfall in courier services

No	DMUs	ρ	s_1^-	s_2^-	s_3^-	s_1^+
1	GDex	0.1957676	0	85.22%	59.18%	164.94%
2	J&T	0.3781778	89.57%	71.38%	0	22.56%
3	CityLink	0.4510587	0	16.44%	76.53%	53%
4	PosMalaysia	0.2181655	0	89.11%	75.32%	107.13%
5	Nationwide	1.000000	0	0	0	0
6	Ninja Van	1.000000	0	0	0	0

5 Conclusion

DEA is used to measure the efficiency of comparable DMUs relative to one another. In this study, the CCR and SBM models are employed to evaluate the performance of courier services in Malaysia. The findings aim to analyse both performance levels and productivity changes within the courier industry. This is significant as it offers valuable insights into improving service quality, enhancing workforce skills, and supporting the nation's goal of becoming a developed country. Additionally, the study provides practical benefits for courier service management by highlighting performance measurement, thereby enabling better strategies to maintain efficiency and optimise overall performance. For the efficiency evaluation, this study uses the SBM model rather than the more conventional CCR model. A complete evaluation of the efficiency of courier services is possible using both the SBM and CCR models. This innovative approach can address critical issues using a new application efficiency tool, especially for societal problems, as well as in private, public, and profit sectors. It is also crucial in helping firms to maintain relevance in a competitive market by improving efficiency. Future studies should explore different fields, such as universities, hospitals, banks, hotels, and others to evaluate performance.

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Conflict of Interest Statement

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

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