Engineering Journal issn: 0125-8281

*Article*

# Evaluation and Improvement of the Efficiency of Logistics Companies with Data Envelopment Analysis Model

**Pei Fun Lee[a], Weng Siew Lam[b,*], and Weng Hoe Lam[c]**

Department of Physical and Mathematical Science, Faculty of Science, Universiti Tunku Abdul Rahman, Kampar Campus, Jalan Universiti, Bandar Barat, 31900 Kampar, Perak, Malaysia
E-mail: [a]pflee@utar.edu.my, [b,*]lamws@utar.edu.my (Corresponding author), [c]whlam@utar.edu.my

**Abstract.** The performance of global trade depends on the logistics industry to move products, information, finances, technology and human resources along the supply chain. The current situation during the pandemic relies on the logistics industry particularly in the courier, parcel and express service providers to deliver daily essentials. Product customization, customer demand, technological sophistication, threat of new entrants, border closure, compliance to Covid-19 regulations and global economic crisis have taken the logistics industry by storm. For the sustainment and growth of these companies, strategic decision making shall take place. A huge determinant of these decisions is the financial efficiency of the companies. Therefore, this paper aims to determine the efficiency of the logistics companies in Malaysia by analyzing their financial performances using current ratio, debt to assets ratio, debt to equity ratio, earnings per share, return on assets and return on equity with data envelopment analysis model. The results of this study found that five companies, COMPLET, GDEX, MISC, SURIA and WPRTS are efficient. This study fills the research gap by determining the efficiency scores of these companies and suggesting potential improvements for inefficient companies to enhance and optimize their financial positions.

**Keywords:** Data envelopment analysis, efficiency, linear programming model, potential improvement.

**ENGINEERING JOURNAL** Volume 25 Issue 6
Received 22 January 2021
Accepted 28 May 2021
Published 30 June 2021
Online at https://engj.org/
DOI:10.4186/ej.2021.25.6.45

## 1. Introduction

The ASEAN Economic Community Blueprint 2025 has provided great opportunities for Malaysia to collaborate and integrate with countries in the region to develop the economy to compete in the global market [1-3]. This blueprint aims to allow easier access of products, services, human capital and investments among member countries [4-5]. The logistics industry then serves as a facilitator in delivering the supplies of goods by linking consumers to suppliers and manufacturers in the supply chain in this region [6-7]. Malaysia's economic growth has also been large supported by the logistics industry since the beginning of the pandemic [8]. However, higher consumer expectation for quicker delivery of goods at lower cost, increased product variety, technological modernization and the COVID-19 contingency plan have led to greater financial burden for the logistics companies [9-10].

Therefore, logistics companies need to monitor their financial performance to ensure that they can cope and survive through this period of great uncertainty. Financial performance serves as a key performance indicator which conveys information about a company's financial health. This financial assessment could be used to study a company before any collaboration or partnership takes place. Financial institutions and investors may also use the financial assessment for credit analysis. A financial analysis could also serve as a guide for a company in terms of strategy formulation to leverage business potentials and mitigate risks [11].

Financial analysis can be based on a logistics company's annual report including the profit and loss statement and balance sheet which are historical in nature. They can include analysis on the liquidity, solvency and profitability ratios to measure the ability of a company to satisfy short term and long-term obligations and for-profit generation. Nevertheless, profitability is the main concern of a logistics company to create values, hiring employees, enhance research and development and for the sustainment and expansion of the company [12].

Logistics companies could measure and perform achievement evaluations based on financial analysis such as profitability ratios, debt ratios and current ratio. The analyses of all these financial ratios could provide an insight for logistics companies for decision making in their investments for annual strategic planning, especially in their plans for the procurement, insurance and maintenance of transport units [13].

As logistics companies become increasingly sensitive over capital structures, profit and cost reduction, managerial focus on financial analysis is particularly imperative. Lee et al. [14] performed a financial analysis on shipping companies in Korea and Taiwan with financial ratios such as current ratio, return on asset (ROA), return on equity (ROE), debt to asset ratio and debt to equity ratio.

Woo et al. [15] studied the financial ratios such as debt ratio, current ratio, ROA, ROE and earnings per share (EPS), which affect the credit risks in listed logistics and shipping companies listed. The logistics and shipping companies were chosen because this industry is very prone to the global economic crisis. This study found that current ratio and ROA had the most positive relationships with credit risk in the logistics and shipping companies. Therefore, financial ratio analysis is particularly important to mitigate losses in this sector.

Korneta [16] studied the relationship between financial performance and the growth of road transportation companies in Poland from 2013 to 2017. The road transportation industry was selected as it was the biggest service sector to contribute to the economy of the country. The result of this study showed that profitability affected the growth of sales in road transportation companies while optimum liquidity value also supported sales growth.

Efficiency is an important measurement in the evaluation of financial performance of the companies. The efficiency of the companies can be measured using data envelopment analysis (DEA) model. DEA model aims to create an efficient production frontier using multiple inputs and multiple outputs. DEA is a linear programming model which evaluates the relative efficiency of the decision-making units (DMUs). The entities under evaluation will be the DMU [17]. In DEA model, efficiency score is a measure of how well an organizational unit utilizes the resources to generate outcomes. The efficiency of DEA model is defined as the ratio of the total weighted output to total weighted input. In short, the efficiency of a DMU to produce output by taking in certain input will be determined in comparison with other DMUs under study [18].

Ma et al. [19] studied the efficiency and risk of financial institutions in Taiwan from 2012 to 2017 using super efficiency DEA method. This study extracted data such as fixed assets, employee number and operating expenses as inputs while using financial data such as operating income, earnings per share (EPS), net profit, return on assets and return on equity as outputs. DEA was also used to forecast the future efficiency of these financial institutions.

The efficiency of 17 shipbuilders in the world was also analyzed using financial ratio-based DEA. This study was output-based with variables including return on equity (ROE), return on assets (ROA), inventory turnover, current ratio, quick ratio, debt ratio and solvency ratio. The highest number of efficient companies was recorded in 2008, with 4 shipbuilders scoring 1, which meant that they were financially efficient in that year [20].

Past studies have included a variety of business activities for the logistics companies using DEA model. Chen [21] stated that the logistics industry involved the transportation, storage and postal companies and proceeded to include these three types of companies to evaluate the performances of the logistics industry in China. Zheng et al. [22] analyzed the efficiency of logistics companies in China with DEA model. The logistics companies studied included transportation, warehousing

and postal companies in all the regions in China. Wohlgemuth et al. [23] assessed the Brazilian logistics companies which included the logistics service providers with a variety of business activities along the supply chain. Meanwhile, a study by Thi [24] in Vietnam also evaluated railway, airline, ocean shipping, trucking and freight forwarding companies with DEA model.

DEA has a very wide application in forecasting [25-26], routing problem [27-29], energy [30-32], healthcare [33-35] and construction [36-37]. Based on past studies, there is no comprehensive research done on the efficiency evaluation of logistics companies with financial ratios using DEA model. Therefore, this paper aims to determine the efficiency of logistics companies in Malaysia using DEA model. This paper shall propose a DEA model with financial ratios including current ratio, debt to assets ratio and debt to equity ratio as the inputs while earnings per share (EPS), ROA and ROE shall serve as the outputs. Moreover, the target potential improvements will also be identified for each inefficient company to achieve optimal efficiency.

This study fills the research gap by being the pioneer study in Malaysia to examine the logistics industry by analyzing and evaluating the efficiency scores of the logistics companies and enhancing their performances through benchmarking with DEA model. The efficient and inefficient logistics companies can be identified through DEA model in this study. Moreover, once the reference set is determined, the new target improvements can be identified to allow inefficient logistics companies to be at par with the efficient logistics companies. Benchmarking provided by DEA model in this paper helps the logistics companies to draft for improvement plans to manage their finances well for future business operations and expansions. The next section of this paper shall consist of data and methodology, the third section will be about results and discussions, followed by conclusion to end this paper.

## 2. Data and Methodology

The data of this study consists of the logistics companies listed in the Malaysian stock market from the year 2015 to 2019 [38]. Table 1 presents the proposed research framework to evaluate the efficiency of logistics companies in Malaysia.

Table 1. Proposed Research Framework with DEA Model.

| **Items** | |
|---|---|
| **Objective** | Evaluation of efficiency of logistics companies |
| **Inputs** | Current ratio (CR),<br>Debt to assets ratio (DAR),<br>Debt to equity ratio (DER) |
| **Outputs** | Earnings per share (EPS),<br>Return on asset (ROA),<br>Return on equity (ROE) |
| **Decision-making units (DMUs)** | AIRPORT<br>BIPORT<br>CJCEN<br>COMPLET<br>EATECH<br>FREIGHT<br>GDEX<br>HARBOUR<br>LITRAK<br>MISC<br>MMCCORP<br>POS<br>PRKCORP<br>SEEHUP<br>SURIA<br>TASCO<br>TNLOGIS<br>WPRTS |

As presented in Table 1, the financial ratios used as inputs are current ratio, debt to assets ratio and debt to equity ratio. Earnings per share (EPS), return on asset (ROA) and return on equity (ROE) are applied as the outputs.

The DEA model ranks the DMUs according to their respective efficiency scores which range from 0 to 1. The efficiency score is obtained based on the weighted sum of outputs over the weighed sum of inputs [39-40]. A DMU is classified as an efficient unit if it achieves an efficiency score of 1. On the other hand, the DMU is classified as an inefficient unit if the efficiency score is less than 1 [41-42]. The DEA model is formulated as follows [40,43]:

$$\text{Maximize } h_k = \frac{\sum_{r=1}^{s} t_r y_{rk}}{\sum_{i=1}^{m} w_i x_{ik}} \quad (1)$$

Subject to

$$\frac{\sum_{r=1}^{s} t_r y_{rj}}{\sum_{i=1}^{m} w_i x_{ij}} \leq 1, j = 1,2,3,\dots,n \quad (2)$$

$$w_i \geq \varepsilon, i = 1,2,3,\dots,m \quad (3)$$

$$t_r \geq \varepsilon, r = 1,2,3,\dots,,s \quad (4)$$

where
$h_k$ = relative efficiency of company $k$
$x_{ij}$= observed value of $i$ type input for company $j$
$w_i$= weight for input $i$
$m$= number of inputs
$y_{rj}$= observed value of $r$ type output for company $j$
$t_r$= weight for output $r$
$s$= number of outputs

$n$= number of companies
$\varepsilon$= small positive value

Equation (1) shows the maximization function of the relative efficiency of company $k$. Equation (2) states the constraints to limit the efficiency of every company to be between 0 and 1. $t_r$ and $w_i$ are the weights of the outputs and inputs to maximize the efficiency as in the model. Then, all the equations from Eq. (1) to Eq. (4) are rearranged to transform into linear form in Eq. (5) to Eq. (9) [42-43].

$$\text{Maximize } h_k = \sum_{r=1}^{s} t_r y_{rk} \quad (5)$$

Subject to

$$-\sum_{r=1}^{s} t_r y_{rj} + \sum_{i=1}^{m} w_i x_{ij} \geq 0, j = 1,2,3,\dots,n \quad (6)$$

$$\sum_{r=1}^{m} w_i x_{ik} = 1 \quad (7)$$

$$w_i \geq \varepsilon, i = 1,2,3,\dots,m \quad (8)$$

$$t_r \geq \varepsilon, r = 1,2,3,\dots,s \quad (9)$$

This DEA formulation will then be solved using the LINGO optimization software. This software has been used to solve linear programming, non-linear programming, goal programming and integer programming models [44-50].

## 3. Result and Discussion

The efficiency score and ranking of the logistics companies are shown in Table 2.

Table 2. Efficiency Score and Ranking of Transportation and Logistics Companies.

| Companies | Efficiency Score | Rank | Classification |
|---|---|---|---|
| AIRPORT | 0.2781 | 16 | Inefficient |
| BIPORT | 0.5660 | 13 | Inefficient |
| CJCEN | 0.4073 | 14 | Inefficient |
| COMPLET | 1.0000 | 1 | Efficient |
| EATECH | 0.2184 | 18 | Inefficient |
| FREIGHT | 0.5723 | 12 | Inefficient |
| GDEX | 1.0000 | 1 | Efficient |
| HARBOUR | 0.8459 | 8 | Inefficient |
| LITRAK | 0.9486 | 6 | Inefficient |
| MISC | 1.0000 | 1 | Efficient |
| MMCCORP | 0.7992 | 9 | Inefficient |
| POS | 0.2973 | 15 | Inefficient |
| PRKCORP | 0.8700 | 7 | Inefficient |
| SEEHUP | 0.2576 | 17 | Inefficient |
| SURIA | 1.0000 | 1 | Efficient |
| TASCO | 0.5984 | 11 | Inefficient |
| TNLOGIS | 0.5998 | 10 | Inefficient |
| WPRTS | 1.0000 | 1 | Efficient |

From Table 2, logistics companies with efficiency scores of 1.0000 are classified as efficient companies with first ranking. There are five companies which have obtained efficiency score of 1.0000, namely COMPLET, GDEX, MISC, SURIA and WPRTS, based on the optimal solution of DEA model. These companies have maximized the use of their inputs or resources to generate maximum outputs. Therefore, COMPLET, GDEX, MISC, SURIA and WPRTS are classified as efficient companies. These companies are able to serve as benchmarks to other inefficient logistics companies to improve their efficiency.

However, AIRPORT (0.2781), BIPORT (0.5660), CJCEN (0.4073), EATECH (0.2184), FREIGHT (0.5723), HARBOUR (0.8459), LITRAK (0.9486), MMCCORP (0.7992), POS (0.2973), PRKCORP (0.8700), SEEHUP (0.2576), TASCO (0.5984) and TNLOGIS (0.5998) are classified as inefficient companies since their efficiency scores are below 1.0000 based on the optimal solution of DEA model.

LITRAK has an efficiency score of 0.9486 which implies that the company is close to being an efficient company. POS, AIRPORT, SEEHUP and EATECH have efficiency scores of 0.2973, 0.2781, 0.2576 and 0.2184 respectively, which indicate that these companies are very far away from being efficient as their efficiency scores are less than 0.3000. These companies could not fully utilize their resources to generate maximum outputs.

Table 3 shows the summary of efficiency scores based on the optimal solution of DEA model.

Table 3. Summary of Efficiency Scores.

| Items | Efficiency Score |
|---|---|
| Average efficiency | 0.6810 |
| Minimum efficiency | 0.2184 |
| Maximum efficiency | 1.0000 |
| Percentage of efficient companies | 27.78% |
| Percentage of inefficient companies | 72.22% |

As shown in Table 3, 27.78% of the companies are efficient in using their inputs to obtain maximum outputs with efficiency score 1.000. This is in line with the percentage of efficiency in past studies which were between 10.00% and 40.00%. A study by Wang et al. [51] showed that 16.67% of Chinese provinces were efficient from 2008 to 2016. Another study on the efficiency of campuses of a university in Iran using DEA model also yielded a percentage of efficiency of 22.22% [52]. The efficiency of elementary schools in Indonesia found that 35.29% provinces were efficient [53].

Based on the optimal solution of DEA model in this study, Table 4 shows the reference set for inefficient companies. The efficient companies serve as the benchmark to the inefficient companies in determining the potential improvements according to the optimal coefficient as shown in Table 4.

Table 4. Reference Set for Inefficient Companies.

| Inefficient companies | Efficient companies (Optimal coefficient) | | | | |
|---|---|---|---|---|---|
| | COMPLET | GDEX | MISC | SURIA | WPRTS |
| **AIRPORT** | | | 0.3501 | | 0.0389 |
| **BIPORT** | | 0.0544 | 0.5843 | | 0.3062 |
| **CJCEN** | 0.2558 | | | | 0.1443 |
| **EATECH** | | | 0.0106 | | 0.0564 |
| **FREIGHT** | 0.2058 | | | 0.1873 | 0.1992 |
| **HARBOUR** | 0.2209 | | | 0.2479 | 0.3259 |
| **LITRAK** | | 0.0972 | 0.5100 | | 0.9152 |
| **MMCCORP** | | | 0.3813 | | 0.1435 |
| **POS** | | | 0.1177 | 0.0061 | 0.1425 |
| **PRKCORP** | | 0.1688 | | | 0.1752 |
| **SEEHUP** | 0.0587 | | | 0.0776 | 0.0759 |
| **TASCO** | | | 0.1832 | 0.1544 | 0.2885 |
| **TNLOGIS** | | | 0.1412 | | 0.3035 |

AIRPORT, BIPORT, CJCEN, EATECH, FREIGHT, HARBOUR, LITRAK, MMCCORP, POS, PRKCORP, SEEHUP, TASCO and TNLOGIS are grouped under inefficient companies because their efficiency scores are less than 1.000. The efficient companies, namely COMPLETE, GDEX, MISC, SURIA and WPRTS serve as benchmarks for the inefficient companies in achieving optimal efficiency [54].

As an example, AIRPORT is relatively less efficient as compared to MISC and WPRTS based on the optimal solution of DEA model. Therefore, MISC and WPRTS are identified as the benchmarks to AIRPORT for further improvements. In DEA model, the optimal coefficients of MISC (0.3501) and WPRTS (0.0389) are used to set new target values for the inputs and outputs of AIRPORT. The feasible improvement aim for AIRPORT will then be the sum of the products of weights of MISC (0.3501) and WPRTS (0.0389) of AIRPORT multiplied by the financial ratios of MISC and WPRTS respectively.

When compared to GDEX, MISC and WPRTS, BIPORT is considered inefficient. Therefore, GDEX, MISC and WPRTS serve as the reference set for BIPORT to achieve optimal efficiency. The new target values for EPS, ROA, ROE, current ratio, debt to assets ratio and debt to equity ratios shall be based on the optimal coefficient of GDEX (0.054), MISC (0.5843) and WPRTS (0.3062) of BIPORT.

Table 5 describes the potential improvements for all inefficient logistics companies according to reference set in Table 4.

Table 5. Potential Improvements for Inefficient Logistics.

| Inefficient companies | Inputs/ Outputs | Current values | Target values | Potential Improvements (Target– Actual) |
|---|---|---|---|---|
| **AIRPORT** | **CR** | 2.0266 | 0.5637 | -1.4629 |
| | **DAR** | 0.5506 | 0.1209 | -0.4298 |
| | **DER** | 1.2815 | 0.1848 | -1.0967 |
| | **EPS** | 0.1599 | 0.1599 | 0.0000 |
| | **ROA** | 0.0117 | 0.0181 | 0.0064 |
| | **ROE** | 0.0287 | 0.0287 | 0.0000 |
| **BIPORT** | **CR** | 3.3792 | 1.9127 | -1.4665 |
| | **DAR** | 0.5950 | 0.3368 | -0.2582 |
| | **DER** | 1.4785 | 0.5870 | -0.8915 |
| | **EPS** | 0.3087 | 0.3087 | 0.0000 |
| | **ROA** | 0.0470 | 0.0646 | 0.0176 |
| | **ROE** | 0.1167 | 0.1167 | 0.0000 |
| **CJCEN** | **CR** | 2.1956 | 0.8943 | -1.3014 |
| | **DAR** | 0.3574 | 0.1347 | -0.2228 |
| | **DER** | 0.5820 | 0.2371 | -0.3450 |
| | **EPS** | 0.0368 | 0.0442 | 0.0075 |
| | **ROA** | 0.0321 | 0.0321 | 0.0000 |
| | **ROE** | 0.0462 | 0.0561 | 0.0100 |
| **EATECH** | **CR** | 0.5003 | 0.1093 | -0.3910 |
| | **DAR** | 0.7415 | 0.0327 | -0.7087 |
| | **DER** | 3.0128 | 0.0672 | -2.9457 |
| | **EPS** | 0.0143 | 0.0143 | 0.0000 |
| | **ROA** | 0.0074 | 0.0074 | 0.0000 |
| | **ROE** | 0.0000 | 0.0154 | 0.0154 |
| **FREIGHT** | **CR** | 2.3538 | 1.3472 | -1.0066 |
| | **DAR** | 0.3726 | 0.1958 | -0.1768 |
| | **DER** | 0.5952 | 0.3406 | -0.2545 |
| | **EPS** | 0.0929 | 0.0929 | 0.0000 |
| | **ROA** | 0.0457 | 0.0457 | 0.0000 |
| | **ROE** | 0.0730 | 0.0797 | 0.0066 |
| **HARBOUR** | **CR** | 2.0751 | 1.7554 | -0.3198 |
| | **DAR** | 0.3656 | 0.2801 | -0.0856 |
| | **DER** | 0.5967 | 0.5048 | -0.0920 |
| | **EPS** | 0.1297 | 0.1297 | 0.0000 |
| | **ROA** | 0.0653 | 0.0653 | 0.0000 |
| | **ROE** | 0.1075 | 0.1181 | 0.0105 |
| **LITRAK** | **CR** | 3.4492 | 3.2718 | -0.1774 |
| | **DAR** | 0.6773 | 0.6425 | -0.0348 |
| | **DER** | 2.2174 | 1.2432 | -0.9742 |
| | **EPS** | 0.3808 | 0.3808 | 0.0000 |
| | **ROA** | 0.0890 | 0.1408 | 0.0518 |
| | **ROE** | 0.2768 | 0.2768 | 0.0000 |
| **MMCCORP** | **CR** | 0.9792 | 0.7827 | -0.1965 |
| | **DAR** | 0.5708 | 0.1849 | -0.3859 |
| | **DER** | 1.3414 | 0.3139 | -1.0275 |
| | **EPS** | 0.1914 | 0.1914 | 0.0000 |
| | **ROA** | 0.0258 | 0.0323 | 0.0065 |
| | **ROE** | 0.0578 | 0.0578 | 0.0000 |
| **POS** | **CR** | 1.4177 | 0.4215 | -0.9962 |
| | **DAR** | 0.4083 | 0.1102 | -0.2981 |
| | **DER** | 0.7004 | 0.2082 | -0.4921 |
| | **EPS** | 0.0773 | 0.0773 | 0.0000 |
| | **ROA** | 0.0224 | 0.0224 | 0.0000 |
| | **ROE** | 0.0329 | 0.0440 | 0.0112 |
| **PRKCORP** | **CR** | 2.3665 | 2.0589 | -0.3076 |
| | **DAR** | 0.6485 | 0.1172 | -0.5313 |

| | | | | |
|---|---|---|---|---|
| | **DER** | 0.2591 | 0.2254 | -0.0337 |
| | **EPS** | 0.0000 | 0.0316 | 0.0316 |
| | **ROA** | 0.0000 | 0.0356 | 0.0356 |
| | **ROE** | 0.0627 | 0.0627 | 0.0000 |
| **SEEHUP** | **CR** | 1.8598 | 0.4790 | -1.3807 |
| | **DAR** | 0.3248 | 0.0715 | -0.2533 |
| | **DER** | 0.4883 | 0.1258 | -0.3625 |
| | **EPS** | 0.0353 | 0.0353 | 0.0000 |
| | **ROA** | 0.0166 | 0.0166 | 0.0000 |
| | **ROE** | 0.0228 | 0.0294 | 0.0066 |
| **TASCO** | **CR** | 1.9144 | 1.1457 | -0.7688 |
| | **DAR** | 0.4017 | 0.2404 | -0.1613 |
| | **DER** | 0.7421 | 0.4427 | -0.2994 |
| | **EPS** | 0.1651 | 0.1651 | 0.0000 |
| | **ROA** | 0.0506 | 0.0506 | 0.0000 |
| | **ROE** | 0.0807 | 0.0958 | 0.0152 |
| **TNLOGIS** | **CR** | 1.1800 | 0.7078 | -0.4722 |
| | **DAR** | 0.6008 | 0.2003 | -0.4006 |
| | **DER** | 1.5084 | 0.3952 | -1.1132 |
| | **EPS** | 0.1138 | 0.1137 | 0.0000 |
| | **ROA** | 0.0353 | 0.0430 | 0.0076 |
| | **ROE** | 0.0871 | 0.0871 | 0.0000 |

Based on the optimal solution of DEA model, there are rooms of improvement for inefficient companies with regards to the optimal coefficients of efficient companies as computed in Table 5. The inefficient logistics companies are AIRPORT, BIPORT, CJCEN, EATECH, FREIGHT, HARBOUR, LITRAK, MMCCORP, POS, PRKCORP, SEEHUP, TASCO and TNLOGIS. Inefficient companies need to perform reduction to their inputs and increment to their outputs to become efficient.

From the potential improvement in DEA model generation, AIRPORT shall reduce its current ratio by 1.4629 from 2.0266 to 0.5637, bring down the debt to assets ratio from 0.5506 to 0.1209 and lower the debt-to-equity ratio from 1.2815 to 0.1848. On the other hand, ROA of AIRPORT should be increased from 0.0117 to 0.0181 in order to be efficient. The target values of EPS and ROE remain the same respectively. The potential improvements for current ratio, debt to assets ratio, debt to equity ratio, EPS, ROA and ROE for AIRPORT are therefore -1.4629, -0.4298, -1.0967, 0.0000, 0.0064 and 0.0000 respectively.

AIRPORT should reduce its current ratio by focusing more on short term liabilities. AIRPORT may also use its current assets such as cash to pay off some long-term obligations and manage the company's working capital. To increase its ROA, AIRPORT may choose to reduce the cost of assets such as better management of inventory to reduce inventory carrying cost [55].

The second inefficient company is BIPORT. BIPORT should reduce its current ratio from 3.3792 to 1.9127, bring down its debt to assets ratio from 0.5950 to 0.3368 and lower its debt-to-equity ratio from 1.4785 to 0.5870. At the same time, BIPORT's ROA has to rise from 0.0470 to 0.0646 while the EPS and ROE remain constant. The potential improvements for current ratio, debt to assets ratio, debt to equity ratio, EPS, ROA and ROE are -1.4665, -0.2582, -0.8915, 0.0000, 0.0176 and 0.0000 respectively.

BIPORT's debt to equity ratio is rather high which means that the company has high leverage as the company may finance its operations by debt and loans which is risky to investors. Restructuring debt, improving sales and lowering costs are some actions which may be taken by BIPORT to reduce its debt-to-equity ratio.

For CJCEN, the potential improvement for current ratio is -1.3014, which means that CJCEN shall reduce its current ratio from 2.1956 to 0.8943. CJCEN's debt to assets ratio shall reduce from 0.3574 to 0.1347, with a potential improvement of -0.2228. Debt to equity ratio of CJCEN shall be lowered from 0.5820 to 0.2371 as the potential improvement is -0.3450. CJCEN's EPS shall rise from 0.0368 to 0.0442, by a potential improvement of 0.0075. ROE of CJCEN shall increase by 0.0100 from 0.0462 to 0.0561.

EPS of CJCEN may rise by increasing revenue from higher volume of sales, reduction in cost such as materials, production, marketing and administrative costs. CJCEN may also consider reducing share count by share repurchase. CJCEN may also manage the company's capital well to maximize profit from the shareholders' equity to increase the ROE [56]. Companies with high efficiency especially with high EPS, ROA and ROE shall contribute to shareholders' value creation which is an important attribute in the capital market of the logistics industry, therefore, companies should work on increasing their outputs with similar or even fewer inputs [57].

## 4. Conclusion

The efficiency and potential improvements of logistics companies in Malaysia have been determined in this study using DEA model. The efficient companies with score of 1.000 are COMPLET, GDEX, MISC, SURIA and WPRTS. This implies that 27.88% of logistics companies are efficient. These efficient companies have successfully utilized their resources to maximize the outcomes. On the contrary, AIRPORT, BIPORT, CJCEN, EATECH, FREIGHT, HARBOUR, LITRAK, MMCCORP, POS, PRKCORP, SEEHUP, TASCO and TNLOGIS are classified as inefficient companies in this study. The potential improvements for these inefficient companies have also been found with references to the efficient companies. This study is significant because the analysis of the financial performances of the logistics companies with DEA model provides meaningful information and insights for their decision making. Future studies may be done with the application of this proposed research framework with DEA model in other countries. Moreover, this proposed framework may also be applied in other fields such as the information and technology industry, healthcare sector and the oil and gas industry.

## Acknowledgement

This study is supported by Universiti Tunku Abdul Rahman, Malaysia.

## References


[1] A. H. Ayob, "E-commerce adoption in ASEAN: Who and where?," *Future Business Journal*, vol. 7, no. 4, pp. 1-11, 2021.

[2] N. Suksuwan, "The conceptual framework of the government-sponsored rural road improvement project evaluation and selection," *Engineering Journal*, vol. 22, no. 1, pp. 109-129, Jan. 2018.

[3] O. Gracia and S. V. Siregar, "Sustainability practices and the cost of debt: Evidence from ASEAN countries," *Journal of Cleaner Production*, vol. 300, p. 126942, Apr. 2021.

[4] K. Ishikawa, "The ASEAN economic community and ASEAN economic integration," *Journal of Contemporary East Asia Studies*, pp. 1-19, Mar. 2021.

[5] P. Pasierbiak, "Causes, origins and possible effects of the ASEAN Economic Community (AEC)," *Journal of ASEAN Studies*, vol. 6, no. 1, pp. 1-23, 2018.

[6] W. Meethom and N. Koohathongsumrit, "Design of decision support system for road freight transportation routing using multilayer zero one goal programming," *Engineering Journal*, vol. 22, no. 6, pp. 185-205, Dec. 2018.

[7] H. T. Phong and P. Yenradee, "Vendor managed inventory for multi-vendor single-manufacturer supply chain: A case study of instant noodle industry," *Engineering Journal*, vol. 24, no. 6, pp. 91-107, Nov. 2020.

[8] D. Dhesi. (2020). *Malaysia GDP set to rebound by 6.6% in 2021* [Online]. Available: https://www.thestar.com.my/business/business-news/2020/12/31/malaysia-gdp-set-to-rebound-by-66-in-2021 [Accessed: 19 January 2021]

[9] E. Hofmann and F. Osterwalder, "Third-party logistics providers in the digital age: Towards a new competitive arena?" *Logistics*, vol. 1, no. 9, pp. 1-28, Nov. 2017.

[10] Centers for Disease Control and Prevention. (2020). *What long haul truck driver employees need to know about COVID-19* [Online]. Available: https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/long-haul-trucking-employees.html [Accessed: 19 January 2021]

[11] E. Hofmann and K. Lampe, "Financial statement analysis of logistics service providers: Ways of enhancing performance," *International Journal of Physical Distribution & Logistics Management*, vol. 43, no. 4, pp. 321-342, Apr. 2013.

[12] P. Anthony, B. Behnoee, M. Hassanpour, and D. Pamucar, "Financial performance evaluation of seven Indian chemical companies," *Decision Making: Applications in Management and Engineering*, vol. 2, no. 2, pp. 81-99, May 2019.

[13] M. Vochozka, Z. Rowland, and J. Vrbka, "Financial analysis of an average transport company in the Czech Republic," *Nase More International Journal of Maritime Science & Technology*, vol. 63, no. 6, pp. 227-236, Mar. 2016.

[14] P. T. Lee, C. Lin, and S. Shin, "Financial performance evaluation of shipping companies using entropy and grey relation analysis," in *Multi-Criteria Decision Making in Maritime Studies and Logistics Applications and Cases*. Cham, Switzerland: Springer Nature, 2018, ch. 9, pp. 219-248.

[15] S. Woo, M. Kwon, and K. F Yuen, "Financial determinants of credit risk in the logistics and shipping industries," *Maritime Economics & Logistics*, pp. 1-23, Apr. 2020.

[16] P. Korneta, "Growth, profitability and liquidity of Polish road transportation companies," in *20th International Scientific Conference Business Logistics in Modern Management*, Osijek, Croatia, 2020, pp. 75-88.

[17] T. Xu, J. You, H. Li, and L. Shao, "Energy efficiency evaluation based on data envelopment analysis: A literature review," *Energies*, vol. 13, no. 3548, pp. 1-20, Jul. 2020.

[18] A. Mardani, E. K. Zavadskas, D. Streimikiene, A. Jusoh, and M. Khoshnoudi, "A comprehensive review of data envelopment analysis (DEA) approach in energy efficiency," *Renewable and Sustainable Energy Reviews*, vol. 70, pp. 1298-1322, 2017.

[19] L. Ma, J. Hsieh, and Y. Chiu, "A study of business performance and risk in Taiwan's financial institutions through resampling data envelopment analysis," *Applied Economics Letter*, vol. 27, no. 11, pp.886-891, Aug. 2020.

[20] A. Merendino, E. D. Gagliardo, and S. Coronella, "The efficiency of the top mega yacht builders across the world: A financial ratio-based data envelopment analysis," *International Journal of Management and Decision Making*, vol. 17, no. 2, pp. 125-147, 2018.

[21] J. Chen, "A new approach to overall performance evaluation based on multiple contexts: An application to the logistics of China," *Computers & Industrial Engineering*, vol. 122, pp. 170-180, Jun. 2018.

[22] W. Zheng, X. Xu, and H. Wang, "Regional logistics efficiency and performance in China along the Belt and Road Initiative: The analysis of integrated DEA and hierarchical regression with carbon constraint," *Journal of Cleaner Production*, vol. 276, p. 123549, Aug. 2020.

[23] M. Wohlgemuth, C. E. Fries, A. M. O. Sant'Anna, R. Giglio, and D. C. Fettermann, "Assessment of the technical efficiency of Brazilian logistic operators using data envelopment analysis and one inflated beta regression," *Annals of Operations Research*, pp. 1-15, Nov. 2018.

[24] H. X. H. Thi, "Application of DEA model to evaluate the performance of logistics enterprises in Vietnam," *International Research Journal of Advanced Engineering and Science*, vol. 4, no. 4, pp. 146-149, 2019.

[25] A. Emrouznejad, B. Rostami-Tabar, and K. Petridis, "A novel ranking procedure for forecasting approaches using data envelopment analysis," *Technological Forecasting & Social Change*, vol. 111, pp. 235-243, 2016.

[26] D. Lim, T. R. Anderson, and O. L. Inman, "Choosing effective dates from multiple optima in technology forecasting using data envelopment analysis (TFDEA)," *Technological Forecasting & Social Change*, vol. 88, pp. 91-97, 2014.

[27] B. Liu, J. Sheu, X. Zhao, Y. Chen, and W. Zhang, "Decision making on post-disaster rescue routing problems from the rescue efficiency perspective," *European Journal of Operational Research*, vol. 286, pp. 321-335, 2020.

[28] N. Koohathongsumrit and W. Meethom, "An integrated approach of fuzzy risk assessment model and data envelopment analysis for route selection in multimodal transportation networks," *Expert Systems with Applications*, vol. 71, p. 114342, 2021.

[29] C. Lu and V. Yu, "Data envelopment analysis for evaluating the efficiency of genetic algorithms on solving the vehicle routing problem with soft time windows," *Computers & Industrial Engineering*, vol. 63, pp. 520-529, 2012.

[30] P. Sefeedpari, Z. Shokoohi, and S. H. Pishgar-Komleh, "Dynamic energy efficiency assessment of dairy farming system in Iran: Application of window data envelopment analysis," *Journal of Cleaner Production*, vol. 275, p. 124178, 2020.

[31] R. Davoudabadi, S. M. Mousavi, and V. Mohagheghi, "A new decision model based on DEA and simulation to evaluate renewable energy projects under interval-valued intuitionistic fuzzy uncertainty," *Renewable Energy*, vol. 164, pp. 1588-1601, 2021.

[32] M. Mohsin, I. Hanif, F. Taghizadeh-Hesary, Q. Abbas, and W. Iqbal, "Nexus between energy efficiency and electricity reforms: A DEA-based way forward for clean power development," *Energy Policy*, vol. 149, p. 112052, 2021.

[33] E. K. Maragos, P. E. Maravelakis, and A. I. Linardis, "A DEA evaluation of the successful implementation of HEALTH2020 policies," *Socio-Economic Planning Sciences*, vol. 76, p. 100968, 2021.

[34] M. Top, M. Konca, and B. Sapaz, "Technical efficiency of healthcare systems in African countries: An application based on data envelopment analysis," *Health Policy and Technology*, vol. 9, pp. 62-68, 2020.

[35] Y. Sun, X. Chen, X. Zhou, and M. Zhang, "Evaluating the efficiency of China's healthcare service: A weighted DEA-game theory in a competitive environment," *Journal of Cleaner Production*, vol. 270, p. 122431, 2020.

[36] M. Nahangi, Y. Chen, and B. McCabe, "Safety-based efficiency evaluation of construction sites using data envelopment analysis (DEA)," *Safety Science*, vol. 113, pp. 382-388, 2019.

[37] J. Zhang, H. Li, B. Xia, and M. Skitmore, "Impact of environment regulation on the efficiency of regional construction industry: A 3-stage data envelopment analysis (DEA)," *Journal of Cleaner Production*, vol. 200, pp. 770-780, 2018.

[38] Bursa Malaysia. (2021). *Company announcements*. [Online]. Available: https://www.bursamalaysia.com/market_information/announcements/company_announcement [Accessed: 22 January 2021].

[39] F. M. Othman, N. A. Mohd-Zamil, S. Z. A. Rasid, A. Vakilbashi, and M. Mokhber, "Data envelopment analysis: A tool for measuring efficiency in banking sector," *International Journal of Economics and Financial Issues,* vol. 6, no. 3, pp. 911-916, 2016.

[40] G. Fancello, M. Carta, and P. Serra, "Data envelopment analysis for the assessment of road safety in urban road networks: A comparative study using CCR and BCC models," *Case Studies on Transport Policy*, vol. 8, pp. 736-744, Jul. 2020.

[41] B. Fathi, M. Ashena, and A. R. Bahari, "Energy, environmental and economic efficiency in fossil fuel exporting countries: A modified data envelopment analysis approach," *Sustainable Production and Consumption*, vol. 26, pp. 588-596, 2021.

[42] M. Zahedi-Seresht, S. Khosravi, J. Jablonsky, and P. Zykova, "A data envelopment analysis model for performance evaluation and ranking of DMUs with alternative scenarios," *Computers & Industrial Engineering*, vol. 152, p. 107002, pp. 1-7, 2021.

[43] P. Hu, N. Chen, Y Li, and Q. Xie, "Efficiency evaluation of water consumption in a Chinese province-level region based on data envelopment analysis," *Water*, vol. 10, no. 793, pp. 1-21, 2018.

[44] W. S. Lam, H. J. Saiful, and I. Hamizun, "The impact of human behavior towards portfolio selection in Malaysia," *Procedia – Social and Behavioral Sciences*, vol. 172, pp. 674-678, 2015.

[45] W. S. Lam, H. J. Saiful, and I. Hamizun, "An empirical comparison of different optimization models in enhanced index tracking problem," *Advanced Science Letters*, vol. 21, no. 5, pp. 1278-1281, 2015.

[46] W. S. Lam, H. J. Saiful, and I. Hamizun, "The impact of different economic scenarios towards portfolio selection in enhanced index tracking problem," *Advanced Science Letters*, vol. 21, no. 5, pp. 1285-1288, 2015.

[47] S. S. M. Saleh, N. H. Jamian, and N. A. Ali, "Team teaching load using linear programming," *Journal of Computing Research & Innovation*, vol. 4, no. 1, pp. 8-15, 2019.

[48] Z. Fan, S. Li, and Z. Gao, "Multiobjective sustainable order allocation problem optimization with improved genetic algorithm using priority encoding," *Mathematical Problems in Engineering*, vol. 2019, pp. 1-12, 2019, Art no. 8218709.

[49] S. Choirunnisa, R. Sarno, and A. C. Fauzan, "Optimization of forecasted port container terminal performance using goal programming," in *2018 International Conference on Information and Communications Technology (ICOIACT)*, Yogyakarta, Indonesia, 2018, pp. 332-336.

[50] I. Indrawati, F. M. Puspita, S. Erlita, I. Nadeak, and B. Arisha, "LINGO-based optimization problem of cloud computing of bandwidth consumption in the

Internet," in *2018 International Conference on Information and Communications Technology (ICOIACT)*, Yogyakarta, Indonesia, 2018, pp. 436-441.
[51] S. Wang, L. Zhou, H. Wang, and X. Li, "Water use efficiency and its influencing factors in China: Based on the data envelopment analysis (DEA)-Tobit Model," *Water*, vol. 10, no. 832, pp. 1-16, Jun. 2018.
[52] N. Ghasemi, E. Najafi, F. H. Lotfi, and F. M. Sobhani, "Assessing the performance of organizations with the hierarchical structure using data envelopment analysis: An efficiency analysis of Farhangian University," *Measurement*, vol. 156, no. 107609, pp. 1-19, Feb. 2020.
[53] S. Fatimah and U. Mahmudah, "Two-stage data envelopment analysis (DEA) for measuring the efficiency of elementary schools in Indonesia," *International Journal of Environmental & Science Education*, vol. 12, no. 8, pp. 1971-1987, Oct. 2017.
[54] J. H. Ablanedo-Rosas, H. Gao, X. Zheng, B. Alidaee, and H. Wang, "A study of the relative efficiency of Chinese ports: A financial ratio-based data envelopment analysis approach," *Expert Systems*, vol. 27, no. 5, pp. 349-362, Nov. 2010.
[55] G. Zimon and D. Zimon, "Quality management systems and working capital SMEs in GPO – A case of Poland," *Administrative Sciences*, vol. 10, no. 76, pp. 1-13, Oct. 2020.
[56] Y. Zhong, Y. Wen, and J. Zhong, "A study on the financial effect of share repurchase of listed companies based on factor analysis," *Advances in Intelligent Systems Research*, vol. 156, pp. 453-458, 2017.
[57] J. H. Hall, "Industry-specific determinants of shareholder value creation," *Studies in Economics and Finance*, vol. 33, no. 2, pp. 190-208, 2016.

**Pei Fun Lee** was born in Perak, Malaysia. She received the B.S. in logistics and international shipping from Universiti Tunku Abdul Rahman (UTAR), Perak, Malaysia. She is currently pursuing her M.S. degree in UTAR.

She is a Graduate Assistant at the Department of Physical and Mathematical Science, Faculty of Science, UTAR. Her research interests include data envelopment analysis, logistics and transportation.

Ms. Lee was a recipient of the President's list and Dean's list award in recognition of her outstanding academic performance during her study for B.S. degree.

**Weng Siew Lam** was born in Perak, Malaysia. He received the B.Eng degree in mechanical engineering from the Universiti Sains Malaysia, Penang, Malaysia in 2004. He received the M.S. and Ph.D. degrees in mathematics from Universiti Kebangsaan Malaysia, Selangor, Malaysia.

He is an Assistant Professor at the Department of Physical and Mathematical Science, Faculty of Science, Universiti Tunku Abdul Rahman (UTAR), Perak, Malaysia. He is also a Head of Programme for the postgraduate programmes in Faculty of Science, UTAR. His research interests include optimization, data analytics, mathematical and statistical modeling, multi-criteria decision making, data envelopment analysis, logistics and transportation.

Ts. Dr. Lam was a recipient of the International Symposium on Research in Innovation and Sustainability Best Paper Award in 2019. Ts. Dr. Lam is a Fellow Member of SAS Society (FSASS). Ts. Dr. Lam is a Professional Technologist (Malaysia Board of Technologists), HRDF Certified Trainer, SAS Certified Statistical Business Analyst, Certified Trainer on Machine Vision for Smart Manufacturing, Graduate Engineer (Board of Engineers Malaysia) and Associate Logistician (The Society of Logisticians, Malaysia). Ts. Dr. Lam is also a member of Malaysian Mathematical Sciences Society, Malaysian Institute of Statistics, Management Science/Operations Research Society of Malaysia as well as International Society of Development and Sustainability.

**Weng Hoe Lam** was born in Perak, Malaysia. He received the B.S. degree in actuarial science, M.S. and Ph.D. degrees in mathematics from Universiti Kebangsaan Malaysia, Selangor, Malaysia.

He is an Assistant Professor and Head of Department of Physical and Mathematical Science in Faculty of Science, Universiti Tunku Abdul Rahman (UTAR), Perak, Malaysia. His research interests include optimization, data analytics, mathematical and statistical modeling, multi-criteria decision making, data envelopment analysis, logistics and transportation.

Ts. Dr. Lam was a recipient of the International Symposium on Research in Innovation and Sustainability Best Paper Award in 2019. Ts. Dr. Lam is a Fellow Member of SAS Society (FSASS).

Ts. Dr. Lam is a Professional Technologist (Malaysia Board of Technologists) and Associate Logistician (The Society of Logisticians, Malaysia). Ts. Dr. Lam is also a member of Malaysian Mathematical Sciences Society, Malaysian Institute of Statistics, Management Science/Operations Research Society of Malaysia as well as International Society of Development and Sustainability.