# Examining efficiency of ports operated by public listed companies in Malaysia

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**Abstract**

*Port efficiency represents how well port management is in the handling of their resources. So far, issues pertaining to the determining the most appropriate input variables and output variables are relatively inconsistent in the body of knowledge. It is depending on several dynamic characteristics from management and its operations. Thus, the aim of this paper is to fulfil the gap by introducing most appropriate inputs - outputs analysis by using Data Envelopment Analysis (DEA). This study utilised (4) port operating companies which are public listed companies using data stretching for eight-year long period from 2011-2018. The general findings suggest that the efficiency of most ports in Malaysia shows the performance in terms of efficiency level in cost, revenue and profit was relatively low due to possible factors such as the size of ports, productivity and cost efficiency.*

## 1.0 Introduction

In a recent decade, efficiency has becoming one of the most crucial indicators of firm performance not only of private companies but also of public entities. Due to the severe competitive environment in the world economy especially after globalization from 1980's, private companies have had to seek their sources of profits from the optimization of operation in the supply side as well as from the expansion or differentiation of markets in the demand side. The continual trends of privatization, hence the introduction of the market competition system, elaborated by central/local governments, have urged the public corporations to strive for managerial reformation to cope with the imminent competition with the private sectors.

Efficiency is a main issue in contemporary port economics, on grounds of port's strategic position in connecting inside the country. Port efficiency is highly correlated with handling cost. (Cullinane et al, 2002). Countries with inefficient seaports have higher handling costs. The clear negative relationship shows that countries where ports are considered the most efficient are at the same time the ones whose ports charge the least for their services. (Clark et al., 2004).

Competition among port operators had been very intense in the last few decades mainly driven by such factors as increases in globalization trends, containerisation, market integration, and global reallocation of capital and labour forces (Dang & Yeo, 2017). Ports had been competing against each other to attract shipping lines to call at their ports. To attract these main line operators, a lot of investments has been put into the acquisition of mega-size port equipment and facilities along with massive port expansion programmes to enhance port efficiency while maximising returns to the port. However, spending extra millions for the investments in infrastructure might not lead to optimum operations. Poor planning in port improvement programmes might result in costly redundancies (Anwar, 2008). Financial indicators play a vital role in determining the financial efficiency and to enable the management to allocate the resources in an optimal manner. Thus, there is a push amongst port operators to improve their port performance and efficiency due to increasing competition between ports and growing pressure from shippers for lower port and shipping charges (Tongzon, 1995).

Having said that, Port Management programme of the UNCTAD for Trade Programme has developed a port performance measurement component which culminated in the adoption of 26

indicators across six areas namely finance, human resources, gender, vessel operations, cargo operations and environment (UNCTAD, 2016). Despite the wealth of literature in the port performance, the discovery of these areas has been limited to operational efficiency with regards to firm efficiency and very scarce on financial efficiency.

Issues pertaining to financial efficiency of ports has been debated by authors such as Holmberg (2000); Vitale and Mavrinac (1995); MARAD (2003) in Nazery et al (2012). The measurement of efficiency level is different from one another. The reason being ports have different characteristics in terms of size, type of cargo handled etc. as ports are a complex business with many sources of inputs and outputs, making it difficult to treat ports as homogenous. (Valentine and Gray, 2001).

There exists no widely accepted way to measure the performance of Malaysian container ports. Port operators and authorities tend to publicize achievements such as growth of throughput handled (including empty containers) and short berthing time to vessels calling at those ports. (Nazery, et al, 2012).

Many empirical findings provide inconsistent determinants and data as to define input and output to represent firm efficiency. Thus, this paper will highlight the measurement of input and output for port business which focuses on the ports operated by public-listed companies (PLCs) in Malaysia. The financial efficiency results will strengthen the study on port efficiency by complementing the operational efficiency measurement.

Thus, the objective of this paper is to evaluate the efficiency of Malaysian ports operated by PLCs in terms of cost, revenue and profitability.

**Literature Review**

Efficiency signifies a level of performance that describes using the least amount of input to achieve the highest amount of output. It is a measurable concept that can be determined using the ratio of useful output to total input. It minimizes the waste of resources such as physical materials, energy and time while accomplishing the desired output. Efficiency is an important attribute because all inputs are scarce. According to Kim (2016), efficiency can be interpreted as the productivity in terms of physical volumes of inputs and outputs, and as the financial efficiency in terms of monetary inputs and outputs.

UNCTAD (2016) was the early known international trade monitoring agency to point out the importance of measuring the performance of ports which should be gauged based on six aspects which include the financial aspects. Guner (2015) has differentiated four types of efficiencies in sea-port literature, namely; infrastructure efficiency, super-structure efficiency, operating efficiency and financial efficiency. The existing port efficiency studies have almost exclusively focused on infrastructure efficiency, super-structure efficiency, operating efficiency without concrete studies on financial efficiencies.

A control instrument must be established from which the port management can easily recognise where capacity problems are likely to arise in the future (Anwar, 2008).

Nazery et al. (2012) revealed that Malaysian ports are already facing intense competition from regional ports to attract MLOs and to handle more cargos. In recent years, ports in the region have embarked on aggressive expansion to serve their users better and in anticipation of growing demand for shipping services and global seaborne trade. Not only their operators are offering features and facilities of international standards, they are doing so at very competitive rates. This had pressured the local ports to provide value-adding services to compete with neighbouring ports in Singapore, Indonesia, the Philippines and Thailand.

In this regard, it is important that the performance of Malaysian ports, in particular those operated by public listed companies, which are more business oriented, can be measured in a way that is acceptable to port users, authorities, users and other stakeholders to assess where these ports stand vis a vis other port.

Since there has been no widely accepted way to measure the performance of Malaysian ports, there is a tendency for port operators and authorities to publicize insufficient information such as growth of throughput handled (including empty containers) and short berthing time to vessels calling at those ports. It cannot become a reliable indicator to assess the performance of the ports.

## 3.0 Data and Methodology

Secondary data is used in the study which are collected mainly from the published Annual Reports covering financial years from 2011 to 2018 of the selected port operating companies listed on Bursa Malaysia, the country's stock exchange. The data will be assessed from mainly their respective websites. Public-listed companies are required to publish their annual reports to be easily assessed by the shareholders and external users of business and financial information via on-line.

The population of the data will consist of public companies listed in Bursa Malaysia, which are operating various ports in Malaysia. These companies have been specifically re-categorised under Transportation and Logistics sector as of 24 September 2018. As public-listed entities, they are being subjected to special regulations and requirements and good corporate governance practices.

There is a total of 934 companies listed on the Bursa Malaysia, of which 32 companies are categorised under Transportation and Logistics and out of this only four companies have been involved in port operations. These four companies, in turn, operate 15 ports between them, nine are located at Peninsular Malaysia and six ports in East Malaysia. Among them are the country's major ports.

Literatures on measuring efficiency suggest that Data Envelopment Analysis (DEA) has been commonly applied to measure port efficiency. DEA is one of the most popular methodology used by many researchers to assess the port efficiency. DEA is a well-known statistical technique that is used to measure the relative efficiencies of units where simple efficiency measures are difficult to obtain (Farrell 1957 and Charnes et al 1978).

This approach utilize data on inputs, outputs and production function theory in order to derive the estimation of the most efficient production frontier across a group of ports. Port efficiency measures are then based on deviations from this frontier.

Efficiency can be articulated as a ratio of output to input. The non-parametric DEA method will be employed to measure the financial efficiency of the PLCs operating the Malaysian ports. For the purpose of this study, an input minimization orientation, based on the assumption that during period under study these PLCs strategically focus on reducing (or minimizing) costs. The main appealing aspect to the mechanics of DEA is that it is capable in dealing with multiple inputs and outputs. The usual measure of efficiency is

*Efficiency = Output / Input*

To further discuss the mechanics of DEA in more technical terms, let us assume that there is data on $K$ inputs and $M$ outputs for each $N$ PLC. For the $i$th PLC, these are represented by $xi$ and $yi$ vectors respectively. $\delta\hat{}i = \min \delta\hat{}i,\lambda\ \delta > 0 | \delta\hat{}iyi \leq\ i= n1\ yi\lambda;\ xi \geq\ i= n1\ xi\lambda;\ \lambda \geq 0,\ i = 1, . . . , n$ PLC (1) where $y$ is a vector of port outputs, $x$ is a vector of inputs, $\lambda$ is a $N$ x 1 vector of constants. The value of $\delta\hat{}i$ is the technical efficiency score for the $i$th port. A measure of $\delta\hat{}i = 1$ indicates that the port is technically efficient, while $\delta\hat{}i > 1$ indicates that a port is inefficient.

Due to the unavailability of output and input variables in other studies, the variables are adapted from Bader et al., (2008). Measurements for each inputs and outputs are as follows:

| Variable | Variable Name | Definition |
|---|---|---|
| | Cost Efficiency | |
| Output | Total Costs | Total operating costs |
| Input | Fixed Assets | Non-current Assets |
| | Revenue Efficiency | |
| Output | Total Revenue | Revenue (port operations) |
| Input | Total Funds | Capital Expenditure |
| | Profit Efficiency | |
| Output | Profit after Tax | Total Costs-Taxes |
| Input | Total Cargo Throughput | Port Services |

## 4.0 Results and Analysis

The efficiency level of each PLC's port operators is derived from the Data Envelopment Analysis (DEA) method. The value of efficiency score for this study is generated by using input-orientation with constant return to scale on technical efficiency (crste). The most efficient firm will become the benchmark and deemed as the best operator for the particular year within the same sector which is port operating sector. With regards to this, it is important to note that the DEA approach presumes that the other companies in the same sector will be able to produce the same output with a minimal input. According to Soh (2015), the other companies in the same sector will automatically adjusting their strategy of efficient solution for both input and output to be more efficient as to rival the best producer.

### 4.1 *Cost Efficiency*

Table 1.1 Cost Efficiency Score

| Year | Operator A | Operator B | Operator C | Operator D |
|---|---|---|---|---|
| 2011 | 0.5729 | 0.5180 | 0.9899 | 0.9627 |
| 2012 | 0.7962 | 0.5691 | 1.0000 | 0.9254 |
| 2013 | 0.3489 | 0.4669 | 0.9798 | 1.0000 |
| 2014 | 0.4421 | 0.6984 | 0.9460 | 1.0000 |
| 2015 | 0.2524 | 0.4121 | 0.3244 | 1.0000 |
| 2016 | 0.3470 | 0.5024 | 1.0000 | 0.9534 |
| 2017 | 0.5829 | 0.4940 | 0.6617 | 1.0000 |
| 2018 | 0.6616 | 1.0000 | 0.6266 | 0.9743 |
| Mean | 0.5006 | 0.5827 | 0.8161 | 0.9770 |
| *Rank* | *4* | *3* | *2* | *1* |

Note: The shaded area which is Operator D indicates the port operator has become the benchmark to its counterpart in cost efficiency.

Table 1.1 showcases the results of cost efficiency for each PLC's port operators from the year 2011 until 2018. The results are indicated by how efficient port operators in minimizing the costs of input while producing the same amount of output within a year. It was evident that Operator D (97.7%) is the most efficient in utilizing their existing fixed assets (average amount of RM26,084.92 million at the minimum cost from the year 2011 to 2018 to generate the same level of operating cost (total amount of RM34,304.69 million). This eventually puts Operator D as the benchmark for cost efficiency as compared to its other counterparts.

The result reflects the good reputation held by Operator D which operates among the major and competitive ports in Malaysia. On the contrary, Operator A has recorded the lowest score of cost efficiency which is 50.06%. In other words, Operator A has not utilised 49.94% of its inputs (fixed assets) capacity, or it could have saved 49.94% of its inputs to generate the same level of outputs (operation cost) within the year of 2011 to 2018 in which 2015 reported the lowest efficiency (highest inefficiency) of 25.25% (75.75%) respectively. The inefficiency of Operator A is obvious when there is a drastic increase of operating cost from only RM349,281 in 2012 to RM700,576 in 2013. Additionally, a back-to-back increment of operating costs were documented from the year 2014 to 2015 and finally peaked at the highest point in 2016 with RM965,555. All these costs are due to the inefficient utilization of the fixed assets in operating the port. Meanwhile, Operator C and Operator B recorded 81.61% and 58.27% efficiency respectively. Overall, Operator C only showed inefficiency in 2015 where only 32.44% of the resources or fixed assets have been utilized to produce the same level of output. Finally, with regards to the cost efficiency, Operator B had not utilised 41.73% of their fixed assets in order to produce the same output level.

### 4.2 *Revenue Efficiency*

Table 1.2 Revenue Efficiency Score

| Year | Operator A | Operator B | Operator C | Operator D |
|---|---|---|---|---|
| 2011 | 0.5567 | 0.0800 | 0.0056 | 0.9341 |
| 2012 | 0.1133 | 0.0684 | 0.0032 | 1.0000 |
| 2013 | 1.0000 | 0.0916 | 0.0080 | 0.8682 |

| | | | | |
|---|---|---|---|---|
| 2014 | 1.0000 | 0.1787 | 0.0122 | 0.4426 |
| 2015 | 1.0000 | 0.2410 | 0.0057 | 0.0675 |
| 2016 | 0.6754 | 0.6116 | 1.0000 | 0.1239 |
| 2017 | 0.2856 | 0.1320 | 1.0000 | 0.6920 |
| 2018 | 0.3094 | 0.2334 | 0.3323 | 1.0000 |
| Mean | 0.6176 | 0.2046 | 0.2959 | 0.6411 |
| *Rank* | *2* | *4* | *3* | *1* |

Note: The shaded area which is Operator D indicates the port operator has become the benchmark to its counterpart in revenue efficiency.

The empirical findings presented in Table 1.2 are the score for revenue efficiency of each PLC's port operators within the year 2011 to 2018. Apparently, Operator D remains at the top tier to benchmark among all port operators in Malaysia by recording 64.11% efficiency in revenue. This means Operator D obtained 64.11% of revenues by using their CAPEX. On the other hand, this port operator had lost 35.89% of possible revenues to be acquired if the CAPEX was utilized at its maximum efficiency. However, by looking at the yearly efficiency score, Operator D has been highly efficient except when there is a notable decline from 86.82% in 2013 to only 44.26% in 2014 which then further deteriorated to only 6.75% and 12.39% in 2015 and 2016 respectively. However, Operator A, which is the least efficient among all ports with regards to its cost efficiency, seems more revenue efficient as it ranked at second place after Operator D with a small deviation of only 2.35%. It is worth mentioning that Operator A has been revenue-efficient by reaching the value of output-oriented technical efficiency equal to one for three consecutive years (2013 to 2015). It indicates that Operator A was technical efficient, when it produced the maximum possible output (revenue) by using a given input (CAPEX). However, there is a continuous declining trend that should be observed by Operator A starting from 2016 until the most recent years where it has become highly inefficient where it lost its opportunity to generate more revenue of 71.44% (2017) and 69.06% (2018) respectively due to inefficient use of its CAPEX.

Meanwhile, both Operator C and Operator B recorded a very low revenue-efficiency (high revenue-inefficiency) which are 29.59% (70.41%) and 20.46% (79.54%) respectively. Operator C experiences the lowest level of inefficiency at the beginning of the observed period back-to-back until 2015 where the lowest point recorded at 0.32% in 2012 which also means Operator C lost an opportunity to acquire a possible maximum revenue which amounted to RM81,902.07 million if this port utilizes all of their CAPEX at full efficiency level. Nevertheless, Operator C managed to achieve full revenue-efficiency in 2016 and 2017 when this port increases the amount of CAPEX from an average of RM5.522 million in earlier years from 2011until 2015) to RM179.104 million in 2016 and RM90.294 million in 2017. This explains why the revenue-efficiency score drop from full efficiency in 2017 to only 33.23% in 2018 which is due to the decreasing amount of CAPEX from RM90.294 million to only RM22.423 million.

Finally, Operator B is ranked as the least efficient in terms of revenue accumulation that revealed that the port operator has been steadily inefficient throughout the entire studied period except for 2016 with 61.16% level of efficiency.

### 4.3 *Profit Efficiency*

Table 1.3 Profit Efficiency Score

| Year | Operator A | Operator B | Operator C | Operator D |
|---|---|---|---|---|
| 2011 | 0.7031 | 0.6988 | 0.9003 | 0.9120 |
| 2012 | 0.5999 | 0.6181 | 0.8005 | 1.0000 |
| 2013 | 0.8061 | 0.7794 | 1.0000 | 0.8240 |
| 2014 | 0.8019 | 0.6098 | 1.0000 | 0.4283 |
| 2015 | 0.6582 | 0.4761 | 0.2844 | 1.0000 |
| 2016 | 0.8416 | 0.6078 | 0.7517 | 1.0000 |
| 2017 | 0.5460 | 0.3221 | 0.6101 | 1.0000 |
| 2018 | 0.5436 | 0.3373 | 0.5501 | 1.0000 |
| Mean | 0.6876 | 0.5562 | 0.7372 | 0.8956 |
| *Rank* | *3* | *4* | *2* | *1* |

Note: The shaded area which is Operator D indicates the port operator has become the benchmark to its counterpart in profit efficiency.

Profit efficiency score of each port operators during the studied period are demonstrated in Table 1.3. Profit efficiency offers more useful information on management efficiency since it considers both the cost and revenue effects on the changes in output scale and scope (Kamarudin et al., 2015). What is apparent, being the most efficient operator in both cost and revenue efficiency has put Operator D as the benchmark in profit-efficiency (89.56%) which also the port's maximization of profit by reducing the cost and increasing the revenue. Operator D has been efficient at maximizing its capacity for the last four years under observation and only inefficient in 2014. At the same time, Operator C comes in second place at high efficiency score in profit maximization which is 73.72% which also means it could have acquired another 26.28% of profit within the studied period if the port fully minimizes the cost and maximize the revenue. Next in the third rank of profit-efficiency, Operator A recorded an average score of 68.76% efficiency in which the highest point is 84.16% in 2016 and the lowest is recorded in the most recent year in 2018 with 54.36% efficiency score. Of the port operators, Operator B recorded 55.62% of the average efficiency which indicate that this operator lost the highest amount of possible profit generation which amounted to 44.38% or RM5,055.97 million.

The above findings illustrate the comparison of cost-efficiency, revenue-efficiency and profit-efficiency for each of PLC's port operators within the period of 2011 until 2018. Apart from looking at the competitive perspective of each port by putting each of the port in the efficiency ranking with regards to cost, revenue and profit maximization aspects, it is also worth to know the internal strength of each port operator in order to improve their level of competitiveness.

Table 1.4 The Efficiency Pattern for Each Respective Operators

| Year/ Operator | Operator A | | | Operator B | | | Operator C | | | Operator D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Efficiency | *C* | *R* | *P* | *C* | *R* | *P* | *C* | *R* | *P* | *C* | *R* | *P* |
| 2011 | 0.5729 | 0.5567 | 0.7031 | 0.5180 | 0.0800 | 0.6988 | 0.9899 | 0.0056 | 0.9003 | 0.9627 | 0.9341 | 0.9120 |
| 2012 | 0.7962 | 0.1133 | 0.5999 | 0.5691 | 0.0684 | 0.6181 | 1.0000 | 0.0032 | 0.8005 | 0.9254 | 1.0000 | 1.0000 |
| 2013 | 0.3489 | 1.0000 | 0.8061 | 0.4669 | 0.0916 | 0.7794 | 0.9798 | 0.0080 | 1.0000 | 1.0000 | 0.8682 | 0.8240 |
| 2014 | 0.4421 | 1.0000 | 0.8019 | 0.6984 | 0.1787 | 0.6098 | 0.9460 | 0.0122 | 1.0000 | 1.0000 | 0.4426 | 0.4283 |
| 2015 | 0.2524 | 1.0000 | 0.6582 | 0.4121 | 0.2410 | 0.4761 | 0.3244 | 0.0057 | 0.2844 | 1.0000 | 0.0675 | 1.0000 |
| 2016 | 0.3470 | 0.6754 | 0.8416 | 0.5024 | 0.6116 | 0.6078 | 1.0000 | 1.0000 | 0.7517 | 0.9534 | 0.1239 | 1.0000 |
| 2017 | 0.5829 | 0.2856 | 0.5460 | 0.4940 | 0.1320 | 0.3221 | 0.6617 | 1.0000 | 0.6101 | 1.0000 | 0.6920 | 1.0000 |
| 2018 | 0.6616 | 0.3094 | 0.5436 | 1.0000 | 0.2334 | 0.3373 | 0.6266 | 0.3323 | 0.5501 | 0.9743 | 1.0000 | 1.0000 |

The efficiency patterns in Table 1.4 suggest that Operator D is the most efficient among the operators in terms profit and cost and to some extent revenue in 2012 and 2018. Operator B, Operator C and Operator D are more cost-efficient as compared to Operator A, which is proven to be more revenue efficient. Specifically, Operator B and Operator C depend heavily on minimizing cost of utilizing their fixed assets in order to generate the same level of operational costs since both port operators have been highly inefficient in acquiring revenue through the utilization of CAPEX. In addition, Operator D proves that both cost-efficiency and profit-efficiency play significant role in assisting the port operator to maximize profit. On another note, Operator A provides a different view in which revenue-efficiency is the main contributor for the port operator's profit maximization.

## 6.0 Conclusion and recommendation

The DEA findings show that there are mixed results in the efficiency level among the ports. However, it can be concluded that generally port operations managed by these public-listed companies have been operating below their efficiency levels during the 2011-2018 period. To improve the efficiency level, measures can be initiated and considered for these operators to utilise and manage their resources and cost-cutting measures in respective areas.

Managing resources efficiently has important implications on operators of port as running a port is very capital-intensive but return of investment takes very long period. The scarcity of resources should be utilised for other necessities or could be spent on other critical areas to improve performance. The

comparison of efficiency could be used to improve the firm's effective management and provide control abilities of the firm.

Future studies could be further extended to identify the determinants of port financial efficiency as part of the management strategies. The determinants could help solve the operators to initiate reforms or improvement to enhance efficiency and performance of their ports.

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