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Full Length Research Paper

Using the data envelopment analysis (DEA) model to evaluate the operational efficiency

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The purpose of this study is to implement a measurement of performance methods for the ocean freight forwarder. It also intends to identify various factors that significantly affect the operational efficiency of the operation of ocean freight forwarder. This paper is the first attempt to apply data envelopment analysis (DEA) to develop performance measurement for ocean freight forwarder as an example in the competitive global logistics market. The use of DEA can be easily modified or extended to similar settings for other companies, in other oceanic regions such as short sea and deep sea.

Key words: Operational efficiency, data envelopment analysis, ocean freight forwarder.

INTRODUCTION

The origin of the ocean freight forwarder can be possibly traced to the 19th century, because at that time the specialized knowledge was limited, there was lack of international service network, and the freight forwarder was basically found only in one country. As such, the consignor was used to arrange simple goods, since the freight forwarder did not have the ability to take ships by itself, but only played the role of an agent to the consignor. After combining with the service expansion, there was accumulation of their experience and expansion of their scales; the diversification demand from the consignor increased, and the ocean freight forwarder took up the shippers' service step by step and finally had the function of a shipper.

So far, most industries have experienced globalization; the international transportation community similarly experiences the global competition. With the outsourcing of manufacturer, it becomes more complex for the consignor in the demand of international transportation, delegating the ocean freight forwarder with the roles of third party logistics must mirror the consignor footsteps to provide diverse and global service. John Fossey, the editorial director of Containerization International, pointed out that, shippers'/consignees' requirements is becoming increasingly global and more sophisticated in nature, and with the growing need for these supply chains to be more robust and secure, the advise and expertise that 3PLs offer will become more important (Tseng and Liao, 2010).

The provisions of law explains that a forwarding agent is a person who undertakes, as a business, the forwarding of goods through carriers in his own name but on account of other persons, for remuneration (No. 661 of the Republic of China Civil Law). According to the rules governing the functions of a forwarding agent, unless otherwise provided for by contract, the forwarding agent may himself assume the transportation of the goods, in which case he has the same rights and obligations as a carrier (No. 663 of the Republic of China civil law). However, if a fixed price for the whole of the transportation has been agreed upon, or if the forwarding agent has himself delivered to the sender a bill of lading, the forwarding agent is deemed to have himself assumed the transportation of the goods, in which case he is not entitled to remuneration (No. 664 of the Republic of China civil law). Under this construction, the localized role of forwarding agent is accurate; it has the three kinds of function such as an agent of the shipper, as a shipper for himself, and as the carrier for himself.

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First, when the forwarding agent acts as the agent of the shipper, he acts as the intermediary or middleman of shipper and carrier, he makes contract with carrier on behalf of customer and processes the related matters of transportation, provide the routes of shipment and import/ export information, and prepares all kinds of documents to smoothly ship the cargos to their destination of arrival. He assists the shipper to arrange the delivery service, replaces the shipper with a carrier to sign the scheduled contract and fill the transportation document as the agent of shipper, for the original shipper, the forwarding agent need not undertake the actual shipment responsibility.

Second, when the forwarding agent acts as a shipper for himself, based on the independent legal subject of mainland legal system rules where the forwarding agent is situated between actual carrier and the shipper, when the forwarding agent who would act in his own name concludes and signs a shipment contract, between the contracting parties and then for the forwarding agent and the carrier. When the forwarding agent has status of the shipper that has the responsibility to enjoy and undertake the right and duty of the shipment contract. However, when the forwarding agent acts as a shipper then the shipper and forwarding agent have the ownership of freight transportation contracts.

According to this contract, the forwarding agent signs the freight transportation contract with carrier again. Although there are two related contracts, but they are actually two independent shipping contracts. Third, when the forwarding agent acts as the carrier for himself, the shipper deals directly on contracts with freight forwarder to ship goods, although freight forwarder has no individual or rental vessel, but the freight forwarder will sign and issue the bill of lading to the shipper after cargo is shipped. Hence, the freight forwarder not only functions as an agent of the shipper but also as the carrier for himself, they must undertake the responsibility for the shipper.

To summarize it, the freight forwarder accepts the request of a shipper to complete the various transportation tasks for the shipper. They not only, simply function as an agent of the shipper with freight forwarder to book a ship position but also prepare trade documents, sign the insurance contract, arrange storehouse for goods, declare duty, inland transportation and logistic operation, but also involve in goods transportation by themselves or signing bill of lading and collecting freight fee to become the public carrier undertaking the responsibility and owning the right of carrier in the meanwhile. It is a diverse a flexible service for ocean freight forwarder that is that requires characteristics, such as specialization, ministrant, consistency, complementariness and competitiveness; it is the key role in the international logistics. The ocean freight forwarder being located at the upstream in the overall logistics chain then direct contracts the shipper, so long as there is reasonable demand from the shipper, the ocean freight forwarder has the ability to provide them with what they to want. Now under the total logistics of international transportation environment, the ocean freight forwarder may also provide the coordinated process service for the shipper.

The ocean freight forwarders usually do not invest in large transportation equipment. It is relatively lower than other industries for the cost of physical assets, so they may experience lower operational risk. The success key of operation for ocean freight forwarders; first is human resources while excellent international service network structure is the second.

Basically, the organizational structure of the ocean freight forwarders is distributed in many different department for example, international, sale, operation, documentation, project management, and administration department; the salaries and wages expense always is the main cost category of almost about 70% of total cost. The ocean freight forwarders can be classified as one of the high variable cost structure in the enterprise. In the sales department, salesman is the key person, they provide logistics service for customers such as offering, ship position booking, prepaid, sending shipping order; they are familiar with customers, therefore the customers sometimes follows salesmen to change ocean freight forwarders. The duty of the operation department includes, co-loading with other ocean freight forwarders, communication with customers, keeping operation promotion, and staff training. An Operator is the key person in the operation department; they must make contact with shipping company, container yard, shipper and their customer broker, and co-company.

They also must send the pre-alert to the overseas agent after the cargo has been shipped, then received the bill of lading from shipping company or co-company and inspect whether the goods are correctly mailed, they check the arrival advice and exchange the shipping order, prepare the statement of account for overseas agent, and proposed the goods supply quantity statistics data.

The two key persons usually are arranged with a term work in the ocean freight forwarder company to enhance the operational efficiency and achieve the overall goal. Their cooperation results in mutual advantages. Additionally, ocean freight is an open market. It is intensely competitive for the ocean freight forwarder operating their businesses in this limited market. There are many ways to respond to the situation completely, such as reducing price, providing the transport expense extension for paying up, and accepting the money owed from the customer.

To continually provide the logistics services, the strategy is that they must prepare a huge amount of fund to supply the operational service. It is a known reason that, the more fund and the more capital cost, then the company can obtain the utilization fund as a sample, the relative capital cost also increases, but they can keep the financial leverage, take the best financial backing, the company will expand their business, promote the cargo quantity, increase the operating income, and create profitability.

To expatiate further, this is an important challenge, that there are many resources known as Optimized investment that can result in a high productivity, and create added–value for the company in the daily logistics service implementation for the ocean freight forwarder company. There is also the focus of the management attention on how to control the operational efficiency under multi-logistics services and evaluate fully anticipated target whether they are achievable.

The term refers to a process of getting things done effectively and efficiently through interactions with other people. Robbins et al. (2008) explains that effectiveness and efficiency deals with what we are doing and how we are doing it. Efficiency means doing the task correctly and refers to the relationship between inputs and outputs.

Therefore, management seeks to minimize resource costs. Although, minimizing resource costs is important, it is not enough simply to be efficient. Management is also concerned with completing activities. In management terms, we call this ability effectiveness. Effectiveness means doing the right task, which in an organization translates into goal attainment. Of course, high efficiency is associated more typically with high effectiveness and poor management is most often due to both inefficiency and ineffectiveness or to effectiveness achieved through inefficiency.

Coelli et al. (1998) and Oum et al. (1999) listed and defined four methods for measuring operational performance, such as the index number, the least squares, the data envelopment analysis (DEA), and the stochastic frontier analysis. Gengui et al. (2008) first attempted to utilize DEA to develop performance benchmarks for 3PLs in the emerging foreign market to measure the operational efficiency of ten leading 3PLs in China, relative to prior periods and their key competitors.

The result showed, first, the declining efficiency within some Chinese 3PLs coincided with a steep decline in domestic transportation activities due to the SARS outbreak and the slow adaptation of state-owned enterprise into a more market-based economy. Second, the sales opportunity and the level of technical expertise are directly correlated with the operational efficiency of 3PLs, whereas the size of 3PLs has no direct bearing on the 3PL's performance. Third, in contrast with the 3PL industry in the USA, the Chinese 3PLs tend to focus on traditional service offerings such as port management, transportation, and warehousing rather than play the role of the integrator or the lead service provider. More recently, DEA had been widely patronized for performance evaluation throughout different industries of public and private sectors, especially in the fields of transportations and logistics services, such as urban bus services (Yu and Fan, 2009; Yang et al., 2008), railway national fleet, shipping (Yang, 2009 Yu and Lin, 2008), ports and container ports (Al-Eraqi et al., 2008; Liu, 2008; Cullinane and Wang, 2007; Li et al., 2003, 2005; Cullinane et al., 2004; Barros and Athanassiou, 2004; Zhou et al., 2004; Lin and Lu, 2004; Wang et al., 2003), airport (Barros and Dieke, 2007; Yoshida and Fujimoto, 2004; Bazargan and Vasigh, 2003; Pacheco and Fernades, 2003; Fernades and Pacheco, 2002; Martín and Román, 2001), three-party logistics providers (Gengui et al., 2008).

The proposed DEA can be easily modified or extended to similar settings in other 3PLs such as ocean freight forwarder. The purpose of this article is to study the operational efficiency of the ocean freight forwarder and understand adequately how human resources utilization in the company provides the international logistics service to aid the profitability of enterprise and measure the relationship between the variety of relative efficiency, the capital costs, and profitability.

This paper uses an ocean freight forwarder as an example, and proposes an empirical study method to understand the operational efficiency of the ocean freight forwarder.

METHODOLOGY

The DEA model

The DEA is a kind of linear programming technology; the research area involves logistics distribution, management and economics. It was proposed by Farrell (1957) measuring the concept of efficiency by using production efficiency and supposing constant returns to scale condition and to change it under input prices. It is considered through an input aspect that divides the production efficiency into the technical efficiency and the allocation efficiency, and then defines the overall efficiency as the technical efficiency time of allocation efficiency.

DEA using the comparative efficiency concept, it is a one non-parameter statistical method for evaluating the same type's of multi-input and output decision making units (DMU) through efficiency or inefficiency. Basically, it transfers every appraised unit into DMU, after that, the numerous DMU being an appraised group, passes through the summing analysis of the ratio of input and output, and using the weight of input and output for all DMU to carry on appraisal to make sure of frontier efficiency. Based on the range difference of every DMU and efficiency frontier for making sure whether there is efficiency or inefficiency for every DMU, we pointed out the reasons for the non-efficiency unit or weakness unit with projections to attain the objection and level required for improvement for the meantime.

Charnes et al. (1978) proposed a CCR model that is based on the assumption of constant returns to scale; an efficiency frontier is constructed to estimate the operational efficiency for DMU. Banker et al. (1984) then developed the BCC model that extends the definition and applications of efficiency under the CCR model.

The CCR model

The CCR model is based on constant returns to scale to estimate the operation efficiency of DMU. Supposition of DMU for n， $DMU_i\left(i=1,2,.....,n\right)$，used input factor foe m: $X_i\left(i=1,2,.....,m\right)$ to produce output for s : $Y_r\left(r=1,2,.....,s\right)$

, then the kth efficiency evaluating model of DMU_k is as follow:

$$\underset{u,r}{Max}\, h_k = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_j x_{ik}} \quad (1)$$

$$s.t. \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1,\ j = 1, K, n$$

$$u_r \ge \varepsilon > 0, r = 1, k, s$$

$$v_i \ge \varepsilon > 0, i = 1, k, m$$

Where, h_K = the relative efficiency of the kth DMU, y_{rk} = the rth output of the kth DMU, x_{ik} = the ith input of the kth DMU, y_{rj} = the rth output of the jth DMU $(j \ne k)$, x_{ij} = the ith input of the jth DMU $(j \ne k)$, u_r = the virtual multiplier of the rth output, v_i = the virtual multiplier of the ith input, and ε = non-Archimedean quantity.

From the Equation (1), CCR model applies the virtual multiplier of output and input as variables. In this situation, the efficiency value all fit limitations for the ratio of output's weight and input's weight. When the ratio is equal 1, the relative efficiency is compared with other DMU; when the ratio is smaller than 1, there would be relative inefficiency. Consequently, the virtual multiplier helps to create some DMU objective functions of efficiency and value maximization, resulting in the conclusion that the DMU that most advantageous is the most favorable group (u_r, v_i). It points out that the contribution degree, that corresponds with input or output of the overall efficiency had the significance of weight, the more weight value, the more contribution, therefore the weight value was not negative.

In view of the fact that, every DMU is made up of subject Equation, the limitations corresponding from subject Equation are all the same, and so they established the same compared basis for the efficiency value. Thus it can be seen, it is fair and relative that the efficiency value is from DEA. It is not easy to solve under Equation, if (u^*, v^*) is the best solution, any $\alpha > 0$ then ($\alpha u^*, \alpha v^*$) is the best solution too, there are many set of solution. So it is transferred to linear programming (Charnes et al., 1978). Let $u_r = tU_r$, $v_i = tV_i$, $t^{-1} = \Sigma_i V_i x_{ik}$, all put t into denominator and numerator in the Equation (1), and added the consistency condition of $t\Sigma_i V_i x_{ik} = 1$, then the Equation (1) can be transferred to the liner model of Equation (2) as follows:

$$\underset{u,r}{Max} = \sum_{r=1}^{s} u_r y_{rk} \quad (2)$$

$$s.t. \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_r x_{ij} \le 1,\ j = 1, K, n$$

$$\sum_{t=1}^{m} v_i x_{ik} = 1$$

$$u_r \ge \varepsilon > 0, r = 1, K, s$$

$$v_i \ge \varepsilon > 0, i = 1, K, m$$

The previous Equation significance in the input resources weight sum was equal 1, resulting in the weight sum that is biggest as far as possible. Owing to the number of limitations (n+m+s) in the subject Equation more than the number of variable (m+s), in order to solve efficiency and convenience, we applied the simplified calculation of dual for the above linear programming pattern. From the result of dual, we may also obtain more information. Therefore let the dual variable of all limitation as θ_k 、 λ_j 、 S_r^+ 、 S_i^-, we can get the dual form as follows:

$$Min\, \theta_k - \varepsilon\left(\sum_{r=1}^{s} S_r^+ + \sum_{i=1}^{m} S_i^-\right) \quad (3)$$

$$s.t. \sum_{j=1}^{n} \lambda_j x_{ij} + S_i^- \le \theta_k x_{ik}, i = 1, K, m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - S_r^+ = y_{rk}, r = 1, K, s$$

$$\lambda_j, S_r^+, S_i^- \ge 0, j = 1, K, n$$

Where, S_r^+: The slack variable of rth output, S_i^-; The slack variable of ith input.

The previous S_r^+ and S_i^- are the slack variables of output (y) and input (x), they can use it to measure the pure technology efficiency for improvement. Subject function is used to search for the minimum value θ_k and θ_k of the intensity factor that indicates the potation degree in equal proportion deflation. Regardless of any question, they can obtain the same information and the optimal solution will be equal in the Equation (2) and (3).

In the Equation (3), S_r^+ and S_i^- are the complementary slack variables of output and input in Equation (2), we can understand the improve degree of input and output from the slack variables. λ is the dual price of slake variable, $\lambda = (\lambda_1, \lambda_2, ...\lambda_n)$ showed a polyhedron vector that connects with all information. $\lambda_j \ne 0$ that corresponded to all DMU_j that is the reference set of DMU_k, in another word, the efficiency of DMU_k is based on the DMU_j. When $\theta = 1$ and $S_r^+ = S_i^- = 0$, then the DMU_k is efficient; on the other hand, then the DMU_k is inefficient and exist to improve space. Through the slack variables, we can know the adjusted direction and amount of all input and output to enhance more efficiency. Consequently, under the dual model we can understand the inefficiency DMU_k .If we want to achieve the relative efficiency that equals 1, then we can adjust the input and output as:

$$S_{ik}^* = \theta_k^* x_{ik} - S_i^{-*}, i = 1, K, m \quad (4)$$

$$y_{rk}^* = y_{rk}^* + S_{rk}^{+*}, r = 1, K, s$$

Where, S_i^{-*}: The slack variable of the ith input of the kth DMU, S_r^{+*}: The slack variable of the rth output of the kth DMU.

The superscript * is the optimum value. From the Equation (4), we can get the efficiency target of DMU_k that can be the managed target and would reveal the difference between the ideal output and actual output as follows:

$$\Delta x_{ik} = x_{ik} - x_{ok}^{*} \quad (5)$$
$$\Delta x_{ik} = x_{ik} - x_{ok}^{*}$$

From the Equation (5), DMU_k should reduce the Δx_{ik} input, and increase the Δy_{rk} output to improve the relative efficiency. When applied to the Equation, in addition to, using the difference between actual input-output and the optimum input-output as basis for improvement, we must also consider the external demand in concert, because selecting the output under the model needs to be embedded on the marketing stagey. In the insufficiency demand, it will be a waste of resources if it only increases the output.

The BCC model

The reason of inefficiency was disinvited into technological inefficiency and scale inefficiency (Banker et al., 1984), to which the CCR model added the convexity limitation $(\lambda_1 + \lambda_2 + ... + \lambda_n = 1)$ of the linear combination, and reduced the BCC model to measure the pure technology efficiency, scale efficiency, and returns to scale. We present the BCC model as follow:

$$Max \sum_{r=1}^{s} u_r y_{rk} + u_k \quad (6)$$
$$s.t. \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} + u_k \leq 0,\ j = 1, K, n$$
$$\sum_{t=1}^{m} v_i x_{ik} = 1$$
$$u_r \geq \varepsilon > 0, r = 1, K, s$$
$$v_i \geq \varepsilon > 0, i = 1, K, m$$

u_k : Unlimited

The BCC model, leads into the corresponding variable of new limitation for u_k, for the calculated convenience, the Equation (6) similarly was dual and got the Equation (7).

$$Min \theta_k - \varepsilon \left(\sum_{r=1}^{s} S_{rk}^{+} + \sum_{i=1}^{m} S_{ik}^{-} \right) \quad (7)$$
$$s.t. \sum_{j=1}^{n} \lambda_j x_{ij} + S_{ik}^{-} = \theta_k x_{ik}, i = 1, K, m$$
$$\sum_{j=1}^{n} \lambda_j y_{rj} - S_{rk}^{+} = y_{rk}, r = 1, K, s$$
$$\sum_{j=1}^{n} \lambda_j = 1, r = 1, K, n$$
$$\lambda_j, S_{rk}^{+}, S_{ik}^{-} \geq 0$$

From the previous Equation, we can see the BCC model has more than one limitation $\sum_{j=1}^{n} \lambda_j = 1$, to the production frontier convexity to the origin that can measure the technology efficiency. To observe the relationship among the three kinds of efficiency, we can find the pure technology efficiency from the BCC model is more than or equals the overall technology efficiency from the CCR model, then the overall technology efficiency divided by pure technology efficiency equaling scale efficiency. If the scale efficiency is smaller than 1, we are required to judge the increase or decrease progressively of the scale efficiency. It can support more and more information to help the management to improve their efficiency as the reference for adjustment scale. The BCC model employed a new variable (u_k) to be the target principles for adjusting the returns of scale that is as follows:

$u_{k.} > 1$, it is the decrease return of scale showing that the DMU is under more optimism to produce, the output increase ratio is smaller than the input increase ratio.

$u_{k.} = 1$, it is the constant returns to scale showing that the DMU is under the optimism to produce; there is the same efficiency in the BCC model and the CCR model.

$u_{k.} < 1$, it is the increase return of scale showing that the DMU is under the smaller optimism to produce, the output increase ratio is more than the input increase ratio.

The interpretation of DEA model

Here, we decrypted the efficiency analysis, slack analysis, sensitivity analysis, and return of scale to understand how to use them to explain the evaluated results of DEA.

The efficiency analysis

By implementing the DEA model, we can achieve the relative efficiency of all individual DMU. In the study of Charnes et al. (1978), J was used as a set of DMU, after which it was separated into four categories, that is, $J = E' \cup E \cup F \cup N$.

(1) E : The set composed by the efficiency DMU that included every DMU for k sufficing for $\theta_k^{*} = 1, \lambda_k^{*} = 1$ $\lambda_j^{*} = 0 (j = 1,....,n, j \neq k)$ the slack variable in the dual model all equal zero. It is the mean that $\lambda = (\lambda_1, \lambda_2, ..., \lambda_n)$ expresses the polyhedron vector connecting with all DMU and all j corresponding with $\lambda_j^{*} \neq 0$ are the reference set of the DMU for k. As soon as the more frequency appears to the set of reference of other DMU for a DMU, this implies the stronger robustness of the relative efficiency of DMU.

(2) E' : The set composed by the efficiency DMU that included every DMU for k sufficing for $\theta_k^{*} = 1, \lambda_k^{*} \leq 1$ and exit j let $\lambda_j^{*} > 0$ but $j \neq k$, the slack variable equal zero.

(3) F : The set includes every DMU that suffice for $\theta_k^{*} = 1$ but one slack variable is more than zero at least. Although the efficiency value is as 1of the DMU in F, but never appear in the reference set of other DMU that implies that the DMU is exiting some out of characters.

(4) N : The set composed by the inefficiency DMU that every DMU for k suffice for $\theta_k^{*} < 1$.

All the DMU must belong to one of the four categories. We can obtain the overall technological efficiency applied to the CCR model and obtain the pure technological efficiency applied to the BCC model. Also we can get the scale efficiency from the overall technology efficiency divided by the pure technology efficiency. There are two terms for measuring the efficiency such as $h_k = 1$ or $\theta_k = 1$ and all slack variables (S_i^- and S_r^+) equal zero. Two terms both come to existence, which are regarded as relative effectiveness. If the DMU efficiency then $h_k = 1$ or $\theta_k = 1$, or when the DMU overall technology efficiency is not equal 1 then according to the pure technology efficiency and scale efficiency we can judge the cause of inefficiency that may be affected by the poor or pure technological efficiency or poor scale efficiency or weaknesses of both of them.

Additionally, the higher pure technology efficiency means that there is more efficiency in the use of input; the higher scale efficiency means that there is more fitter in the ratio of output and input; a higher overall technology efficiency, shows that there is a higher production efficiency of the producer.

The slack analysis

The slack analysis may provide the information on the resources used condition, besides it may create the basics for setting objection, and also understand the improvement space of DMU. It indicates the reduction on proportions for θ_k of all input variables in the DEA model to achieve the efficiency production frontier. When $S_r^+ > 0$ present here creates no change for λ_j^* then we can increase S_r^+ for r of the output. Similarly, when $S_i^- > 0$ present here reflects no change for λ_j^* then we can decrease S_i^- for i of the input. Even though $\theta_k = 1$ there is always inefficiency for the DMU under any one condition of $S_r^+ > 0$ and $S_i^- > 0$.

The inefficiency of DMU can reduce the time of $(1-\theta_k^*)$ for every input to become $\theta_k^* x_{ik}$ that is, it must have the same output. Now if exiting the slack variable S_i^-, it can be reduced S_i^- with no effect for output. Even though reducing to the maximum for all input, the output still can increase the mount of S_r^+. Only after adjusting the process for the input and output, then the inefficiency DMU can be moved to the production frontier to become the efficiency DMU. The ideal suitable solution of input and output are X_{ik}^* and Y_{rk}^*.

$$X_{ik}^* = \theta^* X_{ik} - s_i^{-*}, i = 1,.....,m$$
$$Y_{rk}^* = Y_{rk} + s_r^{+*}, r = 1,.....,s$$

The comparison object of DMU for k from the foregoing model is the goal of management control. When it is adjusted, the input decreases to ΔX_{ik} and the output increases to ΔY_{rk}.

$$\Delta X_{ik} = X_{ik} - X_{ik}^*, i = 1,.....m$$
$$\Delta Y_{rk} = Y_{rk}^* - Y_{rk}, r = 1,.....,s$$

The sensitivity analysis

For the efficiency of DMU, the input-output change value must be kept in a sufficient condition. In the CCR model, the u_r and v_i are the virtual multiplier of input and output that are produced from linear programming without artificial factor and suffice for the fair principle of standpoint. Under the setting evaluated model, any one of the DMU cannot depend on subjective judgment to take another set of weight to let the efficiency value greater than the evaluated result by DEA model. It is said that the bigger the virtual multiplier, the more the contribution to the production efficiency of variables. In another word, u_r is expressed, as the bigger of the relative efficiency contribution to increase per unit output; v_i is expressed, the better of the relative efficiency effectiveness to decrease per unit input. Additionally, the efficiency frontier of DMU is compared with the best efficiency organization with measured subject, consequently, the variable of measured subject, the selection of input-output item, and the change or error of the variable may affect the appearance and location of the efficiency frontier. We can use the crosswise and vertical method to study the sensitivity analysis of DEA. The change in the crosswise is to analyze the effect of increasing or decreasing input-output item, the change in the vertical is to analyze the effect of adding or deducting the DMU.

The analysis of return on scale

The return on scale is the average production of per unit and the most suitable scale is the maximum productive scale with the maximum average production of per input unit in the efficiency frontier. In the model, we can calculate $\Sigma\lambda$ of per unit to express the index of return on scale per DMU. When $\Sigma\lambda < 1$, the DMU is as increasing return on scale. When $\Sigma\lambda = 1$, the DMU is at the best productive scale. When $\Sigma\lambda > 1$, the DMU is at diminishing return on scale. It is said that If $\Sigma\lambda = 1$ then the scale efficiency of the production unit must be equal 1; if $\Sigma\lambda \neq 1$ then the scale efficiency of the production unit must be small than 1. If there is more difference between $\Sigma\lambda$ and 1 then it expresses more significance between increasing return on scale and diminishing return on scale.

The illustrated example description and data selection

Ocean freight forwarder example description

Here, we simply introduce the illustration. Our illustrative case is an international ocean freight forwarder in Taiwan. Her head office is located in Taipei and has been in the business for more than 16 years. There are more than 1,000 employees in the overall company. In order to operate the international logistics service, she has covered more than 30 countries in the world to provide her services network. She has agencies in major seaports throughout the world to coordinate with several main shipping carriers, such as Evergreen Marine Corporation, Wan Hai Lines, Yang Ming Marine Transportation Corporation, CNC Line, Hyundai, KMTC AIR-

SERVICE LTD., P&O Nedlloyd, and OOCL line, Hanjin, Maersk Sea Land and APL etc. For offering the international logistics service the network covers the major seaports in many countries of the world. In addition, she provides domestic logistics services for the customer located in the primary cities within her country. She owns large-scale global operations and provides a high-quality service for her customers. Based on her excellent operating service in Asia, the company's target strategy will expand the share of oceanic market to provide more global logistic services.

In 1998, she first entered the market of Hong Kong and Mainland China. In 2004, she was certified as an eligible enterprise with the registration certification of the Chinese government's newly regulated rule. Presently, there are more than 30 branches and representative offices in major seaports across the People's Republic of China. Then also continuous expansion in overseas countries on track and strategic alliance with her agent to provide the logistics service in Indonesia, Singapore, Dubai, and other foreign spots in 2005. Afterwards, the company again established her branch offices in the United States and Vietnam in 2006. As a global enterprise, she provides a high-quality and high-competitive international logistics services in the five continents of the world.

In the transportation research area, Fielding (1987) proposes an appraisal of construction for both the effect of production efficiency service and production. Operational performance contained the effect of service and production of the entrepreneur and consumer. Therefore, it more than presented the actual overall performance when we implemented performance evaluation from the aspect of transport industry. According to prior research, that applied the different input, output, and consumer items to evaluation. According to the state in front of articles, different outcome are produced under the factors in their research, so we must be careful to appraise the input and output variables.

Taking the shipping company's transport services as an example, once the transport outputs (in terms of shipping space) are transformed from such inputs as ship, fuel and labor, the shipping space must be consumed concurrently by the goods, otherwise all vacant shipping space are exhausted and wasted. There are four inputs variable (in term of net fixed asset, salaries and wages, operating expense, current liabilities) and one output variable(in terms of operating income) that can be used for evaluating the performance (Gengui et al., 2008).

In accordance with evaluation efficiency for transportation-related industries, different input and output factors can be used to determine the relative efficiency, different inputs and outputs may yield different results, different industries posses' different characteristics. Ocean freight forwarder provides international logistics services for the shipper and carrier; they own their individual characters and had non-storable ship's space.

Input and output variables selection

DEA uses input and output variances to calculate the relative efficiency for each DMU. The result will be affected by the correction and appropriateness of variances. At the time of the research, we had not searched the related reference about evaluating the operational efficiency for ocean freight forwarder; we adopted the grounded theory with depth interview and focal observation to understand the operational process from the illustrated example.

An alternative way to implement the performance benchmarks is to select input and output variables. This process followed five steps.

Step 1: Collect the related information. First, visit the chairman to expound company's philosophy and express objective or goal to be maximized (say, operating income) or minimized (say, operating costs). Then communicate with the relative department leader about how conflicts can arise between the decision model used by a manager and the performance evaluation model used to evaluate that manager.

Step 2: Analyze operational process. After reading the document from the supporting, we continued to analysis the service character and operational process to understand the organizational structure, service lines and the task of the salesmen and operators.

Step 3: Arrange on-the-spot observation. Establish a database, based on step 1 and step 2 that gathered together a set of annual data, and furthermore arranged on-the-spot observation to enhance the validity of those figures.

Step 4: Classify different Oceanic region and lines. Under the objective or goal, checked and classified the database information to divide all logistics service into 16 lines, such as China, Singapore, Malaysia, Philippines, Indonesia, Thailand, Japan, Korea, Vietnam, Middle East, Europe, North America, New Zealand-Australia, Africa, Mediterranean Sea and triangular trading entity. The 16 lines separated into three major oceanic regions and areas such as short sea, deep sea and the others.

Step 5: Determine the input and output variables. Finally, a set of input and output variable was accomplished. There are three variables in the input item such as working hours of salesmen, working hours of operators and operating costs and there are only two variables in the output item such as Total shipping load and revenues.

The statistics and correlation of input and output variables presented in Table 1.

RESULTS

The relative efficiency analysis

We obtained the DEA scores with constant returns to scale for the selected company and the BCC model to calculate the technical efficiency under the assumption of variable returns to scale. The DEA scores were from the DEA Solver PRO 6.0 (2007) and summarized in the Table 2. The results indicate that in addition to the line of China, Indonesia, Thailand, Europe, and North America, the operational efficiency of the entire company line extend for the first three seasons (Q1-Q3) of the evaluation period as expected, although it rebounded in Q4.

In the technology efficiency, there were just only nine DMUs presented as relatively efficient among all DMUs (for example, Singapore and Japan's Q4, Thailand's Q1, Africa's Q3 and Q4, and Vietnam's in all seasons). Particularly, the North American and triangular trading lines were noted for the lowest performance. In the constant returns to scale, Thailand's Q1, Singapore and Japans' Q4, Africa's Q3 and Q4, and Vietnam's in all season, their inputs, scale of operation, and general operations are of exceptional performance.

Just like China and triangular trading three line's Q3 and Q4, Korea's Q2, Philippines and Thailand's Q3, and New Zealand-Australia and Mediterranean Seas' Q4 exhibited a decrease returns to scale, there should be increased resources to expand production scale for improved performance. For the other lines are at increase returns to scale, they should continue to adjust input resources for better outcome.

Table 1. Descriptive statistics and correlation among working hours of salesmen, working hours of operators, operating cost, total shipping load and revenues.

Panel A: Descriptive statistics (N=64)					
Variable[a]	**Mean**	**Std. Dev.**	**Min.**	**Median**	**Max.**
WHS	447.4	613.8	15.10	295.6	3064.20
WHO	403.2	588.7	0.01	314.8	2898.10
OC	3729770.4	1510771.6	1585713.00	3643084.5	8971477.00
TSL	264.6	271.7	19.00	204.0	1340.00
R	4650671.1	2163574.5	2138155.00	4045004.5	12906741.00
Panel B: Contemporaneous Pearson correlations[b]					
	WHS	WHO	OC	TSL	R
WHS	1.000	0.944 ***	0.598 ***	0.477 ***	0.556 ***
WHO		1.000	0.679 ***	0.399 ***	0.558 ***
OC			1.000	0.289 **	0.752 ***
TSL				1.000	0.603 ***
R					1.000

a: WHS = Working hours of salesmen. WHO = Working hours of operators. OC = Operating costs. TSL = Total shipping load. R = Revenue. b: The test is significant at 10 (*), 5 (**), and 1% (***) level.

Table 2. Descriptive technology efficiency analysis.

Oceanic region	**Lines**	**Q1**	**Q2**	**Q3**	**Q4**
	China	0.441 irs[a]	0.682 irs	0.483drs[b]	0.561drs
	Singapore	0.907 irs	0.875 irs	0.879 irs	1.000--[c]
	Malaysia	0.473 irs	0.457 irs	0.498 irs	0.569 irs
	Philippines	0.505 irs	0.511 irs	0.546 drs	0.680 irs
Short sea	Indonesia	0.554 irs	0.343 irs	0.307 irs	0.332 irs
	Thailand	1.000 --	0.833 irs	0.715 drs	0.848 irs
	Japan	0.419 irs	0.557 irs	0.863 irs	1.000 --
	Korea	0.600 irs	0.511 drs	0.685 irs	0.723 irs
	Vietnam	1.000 --	1.000 --	1.000 --	1.000 --
	Middle East	0.414 irs	0.444 irs	0.434 irs	0.433 irs
	Europe	0.374 irs	0.403 irs	0.445 irs	0.435 irs
	North America	0.369 irs	0.367 irs	0.203 irs	0.297 irs
Deep sea	New Zealand-Australia	0.456 irs	0.487 irs	0.585 --	0.632 drs
	Africa	0.782 irs	0.760 irs	1.000 --	1.000 --
	Mediterranean Sea	0.427 irs	0.566 irs	0.486 irs	0.492 drs
The others	Triangular trading	0.318 irs	0.380 irs	0.370 drs	0.434 drs
Average per season		0.565	0.574	0.594	0.652

[a:]increase returns to scale. [b:]decrease returns to scale. [c:]constant returns to scale.

To further understand the reason for the technological inefficiency in the previous section, the study may subdivide technical efficiency into the pure technical efficiency and the scale inefficiency for analyzes. If the technical efficiency is due to the inefficiency or pure technical inefficiency, this may be as a result of improper superintendent decision-making that results in an uneven utilization of resources. If the technical inefficiency comes from the scale inefficiency, then it may utilize the scale reward analysis to judge the scale management whether it should expand or deflate. Table 3 presents the result. There were fourteen DMU that were relatively efficient, the pure technology efficiency value is 1, such as Indonesia and Thailand's Q1, China and Japan's Q4, Singapore's Q1 and Q4, Vietnam and Africa in all seasons.

Half of the unit failed to meet the total average, which limited logistics activity services and led to an under or over utilization of human resources, such as working hours of salesmen and working hours of operators which affected the company such that it did not achieve the optimum performance level. Thirty-nine DMU reached the total average in scale efficiency, which account for 60.9% of investigated object. Among the thirty-nine DMU, about ten DMU reached the efficiency level (e.g. Thailand's Q1, New Zealand-Australia and Africa's Q3, Singapore and Japan's Q4, and Vietnam's in all seasons). Those lines achieved the optimal level of scale in the specified seasons as well as maximized productivity. With regard to the inefficient DMU, the company must be improved by justifying and modifying the input-output portfolios.

The analysis of oceanic region

In Table 4, we can see that the result of short sea region were all above average. There are seven DMU (for example, Thailand's Q1, Singapore and Japan's Q4, and all of the Vietnam's four seasons) whose relative efficiencies are attained in relation to the three kinds of efficiency value. They are not only efficient but also exhibited constant return to scale. They had achieved efficiency production levels and did not increase outputs or reduce inputs. As for pure technology efficiency, besides the previous seven DMU, the other three DMU showed relevant efficiency too, such as China's Q4, Singapore and Indonesia's Q1. Their technology efficiency and scale efficiency were not equal to 1; however, the pure technology efficiency was 1.

It is stated that inefficiency in technology efficiency may result from scale efficiency. The allocation of inputs and outputs in every season was not optimized to hinder productivity. In the deep sea region, the three kinds of efficiency for DMU did not meet the total average. The relative efficiency DMU was in Africa.

The New Zealand-Australia's technology efficiency and pure technology efficiency were not 1 at Q3. However, due to the fact that the scale efficiency is 1, the inefficiency of technology efficiency could be attributed to technology. In these DMU, the input and output ratio should be adjusted to improve performance. Africa's technology efficiency and scale efficiency were not equal to 1 at Q1 and Q2.

In the short sea regions, the inefficiency technology resulted from scale. There are two non-optimized scale efficiency season in the African line and may have adversely affected productivity. Among the rest, none of the DMU was relatively efficient in technology efficiency, pure technology efficiency, and scale efficiency. However, the scale efficiency of the deep sea region was greater than the total average. The weak performance of technology efficiency in the rest of the region resulted from lower pure technology efficiency. We can adjust the input-output ratio for those DMU to improve productivity.

The analysis of seasons

In Table 5, there are only two efficiency DMU related to technology efficiency and scale efficiency that is Thailand and Vietnam's Q1. The rest were all relatively inefficient. In addition, the average values of technology efficiency and scale efficiency in Q1 did not exceed the total average. Only five of the DMU were relatively efficient in pure technology efficiency at Q1, such as China, Indonesia, Thailand, Vietnam, and Africa.

If compared on the basis of the three kinds of efficiency values, fewer DMU were efficient in Q2 than Q1. Only the average of scale efficiency exceeded the total average. The technology efficiency and scale efficiency of DMU in Q1 is higher than Q2. However, only the average of scale efficiency exceeded the total average. In the Q4, 25% of all DMU were relatively efficient in technological efficiency and scale efficiency, and 31.25% of all DMU were relatively efficient in pure technology efficiency. The three kinds of efficiency's average value exceeded the total average.

Mostly, the higher technology efficiency's DMU was observed in Q3 and Q4, the higher pure technology efficiency's DMU was in Q1 and Q4, and the high scale efficiency's DMU was in Q1, Q3, and Q4. The lower technological efficiency may be as a result of inefficiency input-output portfolios or lack of optimization in the resource allocation for input and output. Therefore, some of the lines in the seasons could not achieve maximum productivity.

According to the opinion of company's chairman, the peak seasons for ocean freight forwarder are divided into two periods in a year, usually from March to June and September to December. Our research findings with the practice experience are mutually consistent. Generally, if there is an increase demand of goods in the global and shipping load, the ocean freight forwarder will flourish in every period; if the global economy is on the downswing and plagued with financial crises, the decrease in the number of shipments will result in a prolonged low season for the ocean freight forwarder, such as in an economic scenario, it would be rare to find a satisfying result.

The slack variable analysis

To allocate and improve the resources into all of the DMU more efficiently, we used the slack variable analysis to solute the question. In Table 6, we compared the adjustments in input-output variables of sixty-four DMU and the overall results. With regard to the input variables,

Table 3. Descriptive the pure technology efficiency and scale efficiency analysis.

Oceanic region	Lines	Q1		Q2		Q3		Q4	
		PTE[a]	SE[b]	PTE	SE	PTE	SE	PTE	SE
Short sea	China	0.479	0.921	0.769	0.886	0.566	0.853	1.000	0.561
	Singapore	1.000	0.907	0.938	0.932	0.918	0.958	1.000	1.000
	Malaysia	0.732	0.646	0.538	0.848	0.534	0.933	0.588	0.967
	Philippines	0.802	0.629	0.567	0.901	0.574	0.951	0.681	0.999
	Indonesia	1.000	0.554	0.476	0.722	0.418	0.734	0.403	0.824
	Thailand	1.000	1.000	0.849	0.981	0.721	0.991	0.848	0.999
	Japan	0.781	0.536	0.655	0.850	0.893	0.967	1.000	1.000
	Korea	0.819	0.732	0.548	0.933	0.694	0.987	0.758	0.954
	Vietnam	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Deep sea	Middle East	0.862	0.480	0.615	0.722	0.520	0.834	0.474	0.915
	Europe	0.742	0.504	0.547	0.738	0.542	0.820	0.497	0.874
	North America	0.692	0.534	0.509	0.722	0.424	0.479	0.403	0.736
	New Zealand-Australia	0.746	0.611	0.540	0.903	0.586	1.000	0.658	0.961
	Africa	1.000	0.782	1.000	0.760	1.000	1.000	1.000	1.000
	Mediterranean Sea	0.757	0.564	0.588	0.962	0.493	0.986	0.512	0.960
The others	Triangular trading	0.387	0.821	0.400	0.949	0.372	0.995	0.522	0.831
Average per season		0.800	0.701	0.659	0.863	0.641	0.906	0.709	0.911

[a]: PTE = pure technology efficiency. [b]: SE = scale efficiency.

Table 4. Descriptive oceanic region analysis.

	Efficiency(+) inefficiency(-)	TE[a]		PTE[b]		SE[c]	
		DMU	Average	DMU	Average	DMU	Average
Short sea	+	7	1.000	10	1.000	7	1.000
	−	29	0.599	26	0.675	29	0.850
	Total	36	0.677	36	0.765	36	0.879
Deep sea	+	2	1.000	4	1.000	3	1.000
	−	22	0.468	20	0.585	21	0.755
	Total	24	0.512	24	0.654	24	0.785
The other	+	0	-	0	-	0	-
	−	4	0.376	4	0.420	4	0.899
	Total	4	0.376	4	0.420	4	0.899

[a]: TE: technology efficiency. [b]: PTE: pure technology efficiency. [c]: SE: scale efficiency.

a surplus was observed in the working hours of salesmen across all the DMU, except the Philippines, Thailand, Vietnam, and Africa lines; also in the working hours of operators across all the DMU, except the Vietnam, New Zealand-Australia, and Africa lines may consider to adjust the input resources. In terms of operating cost, just only the triangular trading (the other regions) in Q4 may be reduced by 7%, and the operating cost of all the other DMUs do not need reduction.

With regard to the output variables, DMU may produce more outputs in total shipping load and revenue. In terms of total shipping load, many DMU may require promotion of the quantity; except China Singapore Malaysia, Thailand, Korea, Vietnam and Africa lines. The three

Table 5. Descriptive season analysis.

Q	Efficiency (+) and Inefficiency (-)	TE		PTE		SE	
		DMU	Average	DMU	Average	DMU	Average
1	+	2	1.000	5	1.000	2	1.000
	−	14	0.503	11	0.709	14	0.659
	Total	16	0.565	16	0.800	16	0.701
2	+	1	1.000	2	1.000	1	1.000
	−	15	0.545	14	0.610	15	0.854
	Total	16	0.574	16	0.659	16	0.863
3	+	2	1.000	2	1.000	3	1.000
	−	14	0.536	14	0.590	13	0.884
	Total	16	0.594	16	0.641	16	0.906
4	+	4	1.000	5	1.000	4	1.000
	−	12	0.536	11	0.577	12	0.882
	Total	16	0.652	16	0.709	16	0.911

weakest DMU with total shipping load were the Middle East, New Zealand-Australia and Europe's Q1.

In the deep sea region, such as the Middle East, Europe, North America, New Zealand-Australia, and Mediterranean Sea lines, it is required so that the output will increase, and also the same with the Triangular trading line.

In terms of revenue, such as the Malaysia, Japan and Mediterranean Sea's Q1; China's Q2; Korea, Europe and New Zealand-Australia's Q1 and Q2; Indonesia's Q3; Singapore's Q2 and Q3; Thailand's Q2 and Q4; North America's Q1 and Q3; Philippines's Q1, Q2 and Q4; Middle East from Q1 to Q3, all may increase outputs.

The sensitivity analysis

In the sensitivity analysis, input or output variables are reduced to examine the efficiency value with one by one approach. In other words, if eliminating a variable induces a greater change in the efficiency value that is compared to the original TE, then the variable has a larger contribution. The results can be served a reference for decision-making.

Table 7 shows how to eliminate revenue variable that introduces no changes in the efficiency values of some DMU, such as the China and Thailand's Q2, Africa's Q4, Vietnam's Q1 and Q2, Singapore's in all seasons. A decrease in the efficiency values of the rest of the DMU were Indonesia, Japan, Middle East, Europe, North America, and triangular trading lines in all seasons, and New Zealand-Australia and Africa's Q1 and Q2.

Furthermore, the Thailand's Q1, Vietnam and Africa's Q3 all changed from efficient to inefficient. The overall was a 32.2% decrease in efficiency that shows that revenue was an important item. After eliminating the variable of total shipping load, there were no changes in the Philippines, Thailand and New Zealand-Australia's Q1, and triangular trading and Mediterranean's Q1 and Q2, Africa's Q3 and Q4, Japan and Vietnam's Q2, Q3 and Q4, and Middle East, North America and Europe's in all seasons. The rest of the other DMUs witnessed a decrease in efficiency, though the decrease was only observed in few of them (5.54%).

In the operational process, salesmen may not find it easy to win a successful agreement from customers at the first time. From meeting customers to obtaining specific shipping loads, salesmen have to put huge effort to satisfy customers by constantly communicating with them and providing them with good price and optimal information.

It is necessary to spend more time to obtain more shipping loads for various lines. In the freight forwarding operation, salesmen and operators can be teamed on the basis of either freight lines or oceanic regions, or both to coordinate and complement with each other in a team. Without the contribution of operators, freight forwarding operation cannot be completed by salesmen alone. Under the structure of division it may encourage an overlap in department responsibilities and low in substitutability for each other. They may be in charge of several lines at the same time, which may cause confusion in responsibilities and weaken operational performance. Thus, the ocean freight forwarding industry often adopts a combination of both.

The results showed that inputs in the working hours by salesmen and operators are oftentimes redundant. This can affect salesmen and operators working together, as

Table 6. Descriptive slack variable analysis.

(Unit :%)	Input variables												Output variables							
	WHS				WHO				OC				TSL				R			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
China	-34	-12	-24	0	-39	-41	-30	0	0	0	0	0	0	0	0	0	0	30	0	0
Singapore	0	-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	0
Malaysia	0	-15	0	0	-8	-17	-9	-12	0	0	0	0	0	0	0	0	21	0	0	0
Philippines	0	0	0	0	-32	-13	-14	-26	0	0	0	0	88	5	0	0	51	8	0	1
Indonesia	0	-5	-5	-24	0	-1	0	-16	0	0	0	0	0	89	35	0	0	0	2	0
Thailand	0	0	0	0	0	-21	-17	-39	0	0	0	0	0	0	0	0	0	21	0	1
Japan	-29	-46	-16	0	0	-27	-11	0	0	0	0	0	121	229	33	0	37	0	0	0
Korea	-6	0	-4	0	0	0	0	-2	0	0	0	0	0	0	0	0	41	9	0	0
Vietnam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Middle East	0	0	0	-14	-52	-33	-27	-27	0	0	0	0	783	318	197	109	73	21	6	0
Europe	0	0	-5	-31	-46	-31	-32	-37	0	0	0	0	438	116	181	116	53	10	0	0
North America	-20	-20	-13	-14	0	-4	0	-2	0	0	0	0	219	293	260	276	24	0	52	0
New Zealand-Australia	-65	-48	-49	-50	0	0	0	0	0	0	0	0	532	121	6	0	49	10	0	0
Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mediterranean Sea	0	-19	0	0	-44	-36	-25	-27	0	0	0	0	221	214	0	0	58	0	0	0
Triangular trading	-31	-9	0	0	-30	-24	-20	-36	0	0	0	-7	296	120	0	0	0	0	0	0

Negative values of input variables show underutilization of resources and zero indicates full utilization. Absolute values of output variables show the extent of potential improvement in output and zero indicated no longer for potential improvement.

they are teamed up by combinations of freight lines and oceanic regions. It is the key point that human resource is an important asset in the ocean freight forwarding industry, providing the value-added logistics services for customers by the salesmen and operators corporation together.

Identification of factors impacting ocean freight forwarder performances

In an effort to understand the causal relationship among the aforementioned factors and the performances, we conducted a multiple regression analysis that is the relationship among the dependent variable (y) and multiple independent variables $(x_1, x_2, x_3, ..., x_n)$. It reflects the changes in the value of the dependent variable if any one of the independent variables is varied. In other words, it determines the relationship, direction, and level of impact among the dependent variable and independent variables. The regression model is as follows:

$$y = f(x_1, x_2, ..., x_n) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \mu$$

Where y stands for the predicted score for the dependent variable, the profitability, β_0 stands for the constant, β_1, β_2 are regression coefficients, x_1, x_2 represent independent variables (technology efficiency, pure technology efficiency, scale efficiency, capital cost), and μ are errors under the assumption that the estimated coefficients are asymptotically normally distributed and the errors are normally distributed. By using the regression models to analysis the relationship of relative efficiency, and the capital cost among profitability. In Table 8, Pearson correlation analysis was used to test the relationship between variables.

The model studies the relationship between the production efficiency, the capital cost, and

Table 7. Descriptive sensitivity analysis.

Country/region	DMU	Original	Eliminated TSL	Eliminated R	Eliminated WHS	Eliminated WHO	Eliminated OC
China	Q1	0.441	0.415	0.223	0.441	0.441	0.008
	Q2	0.682	0.447	0.682	0.682	0.682	0.035
	Q3	0.483	0.448	0.287	0.483	0.483	0.016
	Q4	0.561	0.527	0.287	0.561	0.561	0.017
Singapore	Q1	0.907	0.763	0.907	0.907	0.907	0.088
	Q2	0.875	0.738	0.875	0.875	0.875	0.114
	Q3	0.879	0.753	0.879	0.879	0.879	0.129
	Q4	1.000	0.862	1.000	1.000	1.000	0.156
Malaysia	Q1	0.473	0.435	0.306	0.473	0.473	0.040
	Q2	0.457	0.425	0.303	0.453	0.457	0.042
	Q3	0.498	0.445	0.378	0.476	0.498	0.054
	Q4	0.569	0.506	0.433	0.542	0.569	0.061
Philippines	Q1	0.505	0.505	0.334	0.434	0.505	0.106
	Q2	0.511	0.506	0.437	0.478	0.511	0.115
	Q3	0.546	0.532	0.519	0.527	0.546	0.139
	Q4	0.680	0.548	0.666	0.577	0.680	0.147
Indonesia	Q1	0.554	0.553	0.078	0.554	0.554	0.026
	Q2	0.343	0.342	0.076	0.343	0.343	0.035
	Q3	0.307	0.301	0.108	0.306	0.307	0.035
	Q4	0.332	0.317	0.148	0.325	0.332	0.038
Thailand	Q1	1.000	1.000	0.942	1.000	1.000	0.354
	Q2	0.833	0.637	0.833	0.717	0.833	0.392
	Q3	0.715	0.685	0.670	0.686	0.715	0.432
	Q4	0.848	0.709	0.847	0.770	0.848	0.483
Japan	Q1	0.419	0.415	0.101	0.419	0.419	0.043
	Q2	0.557	0.557	0.079	0.557	0.557	0.077
	Q3	0.863	0.863	0.177	0.863	0.863	0.132
	Q4	1.000	1.000	0.229	1.000	1.000	0.161
Korea	Q1	0.600	0.501	0.588	0.582	0.600	0.104
	Q2	0.511	0.444	0.465	0.511	0.478	0.108
	Q3	0.685	0.613	0.591	0.685	0.625	0.137
	Q4	0.723	0.650	0.628	0.723	0.659	0.148
Vietnam	Q1	1.000	0.970	1.000	1.000	0.538	0.729
	Q2	1.000	1.000	1.000	1.000	0.565	1.000
	Q3	1.000	1.000	0.990	0.980	0.624	1.000
	Q4	1.000	1.000	1.000	1.000	0.695	1.000
Middle East	Q1	0.414	0.414	0.050	0.381	0.414	0.045
	Q2	0.444	0.444	0.087	0.395	0.444	0.058
	Q3	0.434	0.434	0.109	0.382	0.434	0.061
	Q4	0.433	0.433	0.156	0.379	0.433	0.066

Table 7. Continued.

Europe	Q1	0.374	0.374	0.058	0.361	0.374	0.033
	Q2	0.403	0.403	0.123	0.378	0.403	0.041
	Q3	0.445	0.445	0.096	0.414	0.445	0.046
	Q4	0.435	0.435	0.135	0.401	0.435	0.048
North America	Q1	0.369	0.369	0.037	0.369	0.369	0.025
	Q2	0.367	0.367	0.033	0.367	0.367	0.033
	Q3	0.203	0.203	0.033	0.203	0.203	0.021
	Q4	0.297	0.297	0.032	0.297	0.297	0.032
New Zealand-Australia	Q1	0.456	0.456	0.066	0.456	0.400	0.058
	Q2	0.487	0.487	0.160	0.487	0.391	0.076
	Q3	0.585	0.585	0.328	0.585	0.463	0.099
	Q4	0.632	0.632	0.418	0.632	0.501	0.110
Africa	Q1	0.782	0.704	0.767	0.782	0.774	0.543
	Q2	0.760	0.726	0.747	0.760	0.757	0.706
	Q3	1.000	1.000	0.838	1.000	1.000	0.946
	Q4	1.000	1.000	1.000	1.000	1.000	1.000
Mediterranean Sea	Q1	0.427	0.427	0.151	0.376	0.427	0.062
	Q2	0.566	0.566	0.124	0.491	0.566	0.088
	Q3	0.486	0.476	0.385	0.422	0.486	0.084
	Q4	0.492	0.474	0.449	0.422	0.492	0.087
Triangular trading	Q1	0.318	0.318	0.041	0.318	0.318	0.022
	Q2	0.380	0.380	0.059	0.372	0.380	0.033
	Q3	0.370	0.368	0.130	0.353	0.370	0.035
	Q4	0.434	0.426	0.193	0.408	0.434	0.042
Increased/decreased (%)		-	5.54	32.21	3.02	5.70	67.95

Table 8. Contemporaneous Pearson correlations[b].

Variables[a]	P	TE	PTE	SE	CC
P	1	0.659***	0.583***	0.381***	0.123**
TE		1	0.836***	0.594***	-0.209*
PTE			1	0.076*	-0.161*
SE				1	-0.123
CC					1

a: P: profitability. TE: technology efficiency. PTE: pure technology efficiency. SE: scale efficiency. CC: capital cost. b. The test is significant at the 10 %(*), 5 %(**), and 1 %(***).

profitability. Charles et al. (2009) pointed out that it is will of goodness of fit test when the R^2 (coefficient of determination) passes 0.3. The result showed that the R^2 of regression model were 0.489 ($p < 0.01$), 0.368 ($p < 0.01$). In the Table 9, column (1) and (2) present the technology efficiency, pure technological efficiency, scale efficiency, and the capital cost were positively correlated with profitability, and the results were statistically significant; but column 3 presents the capital cost and profitability presented positive but no statistical significance.

The results showed that the higher the technological efficiency, the more the capital cost, the better profitability; the higher the pure technology efficiency and the more the capital cost, the better profitability; the

Table 9. Test for the relationship of the relative efficiency, the capital cost and profitability.

Dependent variable: profitability (operating income = revenue - operating cost)						
Independent variable	Column (1)		Column (2)		Column (3)	
	Parameter	t-value	Parameter	t-value	Parameter	t-value
Intercept	-2004833.3	-5.11***	-2244874.5	-4.25***	-2263461.0	-2.47**
TE	4499052.6	7.77***				
PE			4225564.2	6.10***		
SE					3584707.5	3.42***
CC	8.12	2.95***	6.62	2.19**	5.14	1.47
Adjusted R^2	0.489		0.368		0.147	

higher the scale efficiency, the better profitability; the more the capital cost, the better profitability but no statistical significance.

Conclusions

There are curious parallels between economics and trade. Due to rapid economic development, the demand for ocean freight forwarding logistic services has skyrocketed in international trade. This paper proposes DEA to evaluate the operational efficiency of ocean freight forwarders. In the technological efficiency of all DMU distributed in the Q1 and Q4, the resources were not yet up to optimal under the operation; the pure technology efficiency was still better in Q1 and Q4, and the scale efficiency was better in Q1, Q3 and Q4.

Overall, the Vietnam line exhibited excellent operational efficiency, and followed by the African line. The illustrated example was the Vietnam line operated in 2006; this line was the core niche of the short sea regions and it is the best performance line of all. In the other lines, the lower efficiency score in every season could be from either inefficiency pure technology efficiency or inefficiency scale efficiency, or can be both. It is on record that they did not effectively utilize the input resources and implement output management that resulted in the waste and restriction of many resources, thus, the optimal outcome does not reach the operational purpose.

As the ocean freight forwarding industry began to blossom, the ocean freight forwarding world was proliferated rapidly with intensified levels of competition. Ocean freight forwarders must learn to deal properly with all kinds of complicated situations to manage their resources efficiently, increase market shares, and enhance operational efficiencies, and then they will survive after the competitive market.

In an effort to assist the ocean freight forwarder in planning the strategies, this paper proposed a DEA that was designed to analyze the operational efficiency of ocean freight forwarder, identify potential sources of inefficiency, and provide useful information for the future improvement of operational efficiency.

This paper also defines several major input and output variables of this benchmarking study and develops practical guidelines for improving the operational efficiency of the ocean freight forwarding industry. Otherwise, in the ocean freight forwarding services, capital costs refer to the uncollected service fees and prepayments in the course of operations.

Since the daily cash flow is very high, besides owned capital, the company always needs internal or external financing for daily cash flows. With additional available capital, the company faces higher capital costs risk. On the other hand, if there is good financial leverage, the company can use its sufficient capital to expand the business running and create opportunity. Also it can increase freight loading volume and operating income, and lead to higher profitability. This will help to provide more professional and high-quality service for customers and co-corporate company; that will increase more cash flow and create profitability.

In conclusion, this paper differentiates between lines, oceanic regions and seasonal grouping of the ocean freight forwarder as example on the basis of DEA efficiency scores. If the DEA efficiency score gives management a warning signal; the lower score of DEA, the greater DMU will fail. Thus, DEA is very useful for identifying the least efficiency DMU which require the closest attention.

The ocean freight forwarders should enhance their existing and potential customers so that their resource utilization of DEA scores would be comparatively higher than their competitors. The proposed DEA model can be extended to include multiple outputs and a greater number of the ocean freight forwarder; thus DEA becomes an important tool for selecting the right line and oceanic region for the ocean freight forwarder. In addition, in finding causal relationships between a set of variables and the ocean freight forwarder operational efficiency, a regression model was used in this study given that DEA efficiency scores derived some management implication.

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