PERFORMANCE EVALUATION OF LOGISTICS COMPANIES

USING DATA ENVELOPMENT ANALYSIS

ASST.PROF.DR. WATCHARAVEE CHANDRAPRAKAIKUL

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การประเมินประสิทธิภาพบริษัทผู้ให้บริการโลจิสติกส์ในประเทศไทย

(การใช้เทคนิค Data Envelopment Analysis)

ผศ.ดร. วัชรวี จันทรประกายกุล

รายงานการวิจัยนี้ได้รับทุนส่งเสริมงานวิจัยมหาวิทยาลัยหอการค้าไทย

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ชื่อผู้วิจัย : ผศ.ดร. วัชรวี จันทรประกายกุล

คณะ/สาขา : คณะวิศวกรรมศาสตร์
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คำสำคัญ : การวิเคราะห์ข้อมูลเชิงโอบล้อม, ดัชนี Malmquist, ประสิทธิภาพ, โลจิสติกส์

บทคัดย่อ[1]

การเปิดประชาคมเศรษฐกิจอาเซียนในปี พ.ศ.2558 จะทำให้เกิดความเคลื่อนย้ายทางด้านสินค้า การบริการ การลงทุน แรงงานที่มีทักษะ และการเงินที่เสรี รวมทั้งการลงทุนในอุตสาหกรรมโลจิสติกส์ในกลุ่มประเทศในอาเซียนนั้นทำได้ง่ายมากขึ้น ซึ่งเป็นทั้งโอกาสและอุปสรรคของบริษัทผู้ให้บริการโลจิสติกส์ในประเทศไทยที่ต้องมีความพร้อมในด้านประสิทธิภาพ ดังนั้นวัตถุประสงค์หลักของงานวิจัยนี้คือ การศึกษาประสิทธิภาพและผลการดำเนินงานของบริษัทผู้ให้บริการโลจิสติกส์ในประเทศไทย เพื่อหาบริษัทที่มีประสิทธิภาพ และไม่มีประสิทธิภาพสำหรับการปรับปรุงอุตสาหกรรมต่อไป การวิจัยนี้ได้ประยุกต์เทคนิคการวิเคราะห์ข้อมูลโอบล้อม (Data Envelopment Analysis: DEA) และดัชนี Malmquist (MPI) เพื่อศึกษาการดำเนินงานของบริษัทผู้ให้บริการโลจิสติกส์ของประเทศไทยทั้ง 55 บริษัท ตั้งแต่ปี พ.ศ. 2550 – พ.ศ. 2553

ผลการศึกษาได้นำเสนอบริษัทที่มีประสิทธิภาพและบริษัทที่ดำเนินงานไม่ได้อยู่บนขอบเขตประสิทธิภาพ โดยนำเสนอแนวทางการปรับปรุงประสิทธิภาพของการดำเนินงานของบริษัทเหล่านั้นจากการปรับปรุงระดับปัจจัยนำเข้าละปัจจัยนำออกในระดับที่เหมาะสม วิธีที่ใช้งานวิจัยนี้ผู้ที่อยู่ในอุตสาหกรรมสามารถนำไปใช้ประยุกต์ในการประเมินประสิทธิภาพและปรับปรุงประสิทธิภาพเชิงเทคนิคและเชิงขนาดของตนได้ ส่งผลต่อการพัฒนาอุตสาหกรรมโลจิสติกส์ในโดยรวม

[1] ผลงานวิจัยนี้ได้รับทุนส่งเสริมการวิจัย สาหรับพนักงานประจำมหาวิทยาลัยหอการค้าไทย

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Researcher: Watcharavee Chandraprakaikul

School/Department: Logistics Engineering School of Engineering, University of the Thai chamber of Commerce

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ABSTRACT[2]

As Thailand is a member of ASEAN, the regional economic integration or ASEAN Economic Community will be launched by 2015 to transform ASEAN into a region with free movement of goods, services, investment, skilled labour, and free flow of capital. The structure of logistics companies in the region will be transformed and the countries which have high logistics competence are more likely to gain benefits from this economic integration. The main purpose of this research is to develop appropriate construct to benchmark performances of logistics companies so that deficiencies can be highlighted and possible strategies can be evolved to improve the performances of the industry. The study applies data envelopment analysis (DEA) and Malmquist productivity index (MPI) to explore the operation performances of 55 Thai logistics companies from 2007 to 2010. The results point out the reasons for the inefficient Decision Making Units (DMUs) and provide improving directions for the inefficient companies accordingly.

The study provides a simple but comprehensive methodology for improving logistics competences. By comparing the efficiency of logistics companies, this research contributes to find Thai logistics companies weaknesses in order to take effective measures to improve the their level of input and output so as to improve their logistics efficiency. The method can be adopted by practitioners to assess present performance and find a suitable peer which it should follow to improve own technical and scale efficiency . This will build competence of its performance and as a whole of the industry.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

This chapter gives an introduction to the research (Section 1.1) and presents overview of the research aim and objectives (Section 1.2). The research scope is also explained (Section 1.3), along with the research contribution (Section 1.4).

1.1 Introduction to the research

Logistics Performance Index or LPI by World Bank classification is a benchmarking tool for trade logistics. It is based on a worldwide survey of operators on the ground, providing feedback on the logistics friendliness of the countries in which they operate and those with which they trade (World Bank, 2010). In 2010, Logistics Performance Index of Thailand was ranked 35th from the total 155 countries with the score 3.29 from the full score 5. This country scorecard is the weighted average of the country scores on the six key dimensions: efficiency of the clearance process, quality of trade and transport related infrastructure, ease of arranging competitively priced shipments, competence of logistics services, ability to track and trace consignments, and timeliness of shipments in reaching destination within the scheduled or expected delivery time (World Bank, 2010).

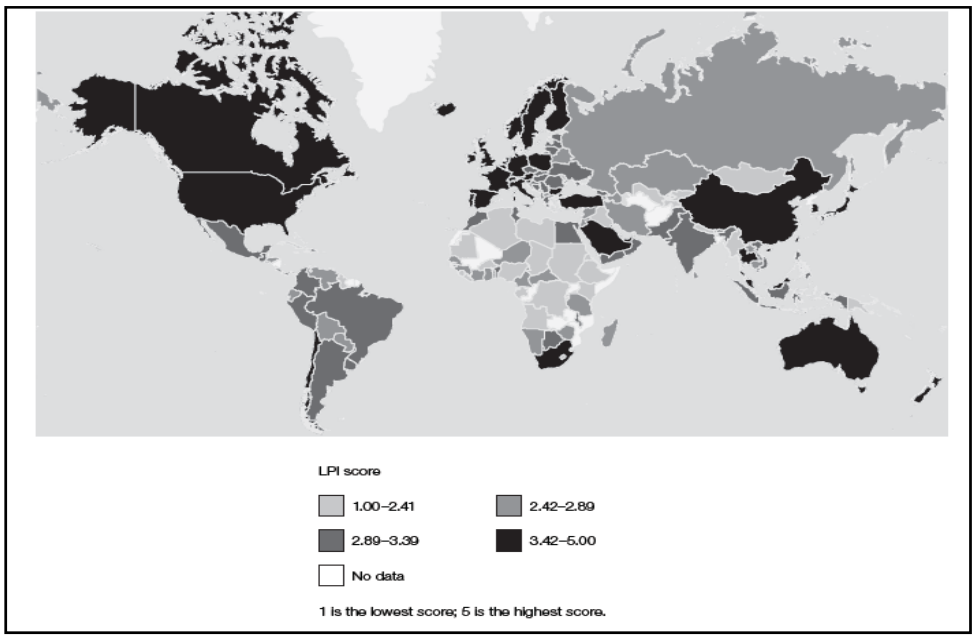

Figure 1.1: Logistics Performance Index Score

On the dimension of competence in the domestics logistics industry, Thailand was ranked 39th with the score 3.16 which is lower than the average total score (see Table 1). The question arises on efficiency of domestic logistics companies in Thailand and possible strategies to improve the performances of the industry. Moreover as Thailand is a member of ASEAN, the regional economic integration or ASEAN Economic Community will be launched by 2015 to transform ASEAN into a region with free movement of goods, services, investment, skilled labour, and free flow of capital. This will allow for foreign (ASEAN) equity participation of not less than 49 percent by 2008, 51 percent by 2010, and 70 percent by 2013. The structure of logistics companies in the region will be transformed and the countries which have high logistics competence are more likely to gain benefits from this economic integration. As a result, it is necessary to understand present performance of Thai logistics companies and define opportunities to improve the industrial performance. Hence, the main purpose of this paper is to develop appropriate construct to benchmark performances of logistics companies so that

deficiencies can be highlighted and possible strategies can be evolved to improve the performances of the industry.

Table 1.1 Thailand Logistics Performance Index Results

Country	LPI Rank	LPI Score	Customs		Infrastructure		International shipments		Logistics quality and competence		Tracking and tracing		timeliness	
			Rank	Score	Rank	score	Rank	score	Rank	score	Rank	score	Rank	score
Thailand	35	3.29	39	3.02	36	3.16	30	3.27	39	3.16	37	3.41	48	3.73

As the research question arises, literature related to performance evaluation is reviewed and therefore data envelopment analysis is chosen in this research. Data envelopment analysis (DEA), being a robust mathematical tool, has been employed to evaluate performance of the logistics industry for technical and scale efficiency. The study applies data envelopment analysis and Malmquist productivity index (MPI) to explore the operation performances of 55 Thai logistics companies from 2007 to 2010. The DEA technique involves the use of mathematical programming to estimate the efficiency of the firms and industry. DEA is a non-parametric, deterministic methodology for determining relatively efficient production frontier, based on the empirical data on chosen inputs and outputs of a number of entities called Decision Making Units (DMUs). From the set of available data, DEA identifies reference (relatively efficient DMUs) that define efficient frontier as the best practice production technology and evaluate the inefficiency of other interior points (relatively inefficient DMUs) that are below the frontier (Manonmni and Ramya, 2011).

The application of DEA in this research is used to compute both efficiency scores under the assumptions of both constant and variable returns to scale (CRS and VRS). In a case of Constant Returns to Scale (CRS), the outputs increase in equal proportion to an increase in inputs. However, if the increase in outputs is not

proportionate with increase in inputs then it is a case of Variable Returns to Scale (VRS). In VRS, the increase in outputs may be either more or less, but not proportionate to the increase in inputs (Garg and Deepti, 2008). To provide more comprehensive results of the study, the Malmquist Productivity Index is used to measure the productivity changes of Thai logistics industry from 2007 to 2010. This index is the prominent index for measuring the productivity change of decision making units (DMUs) in multiple time periods.

The study provides a simple but comprehensive methodology for improving logistics competences. The result can point out the reasons for the inefficient DMUs and provide improving directions for the inefficient companies accordingly. By comparing the efficiency of logistics companies, this research contributes to find Thai logistics companies weaknesses in order to take effective measures to improve the their level of input and output so as to improve their logistics efficiency.

1.2 Research Objectives

The previous section leads to the research objectives in this section. The following research objectives have been defined as follows:

- To evaluate technical and scale efficiency of logistics providers in Thailand by using Data Envelopment Analysis
- To measure the productivity changes of logistics providers in Thailand
- To recommend strategies to improve efficiency of Thai logistics companies.

1.3 Research Scope

This study aims to study the productivity change of the logistics companies from 2007 to 2010 by using data from Corpus database. Corpus database provides business data including financial data for companies in Thailand. This study uses financial data in

the category of logistics providers companies (code 63098 in Corpus database) and arranges the data according to profit.

1.4 Contributions of this research

The main contribution to knowledge of this research is explained as follows:

- The result provides the understanding of technical and scale efficiencies of logistics companies in Thailand.
- The result can point out the reasons for the inefficient companies and provide improving directions for the inefficient companies accordingly.
- The method can be adopted by practitioners to assess present performance and find a suitable peer which it should follow to improve own technical and scale efficiency . This will build competence of its performance and as a whole of the industry.
- By comparing the efficiency of logistics companies, this research contributes to find Thai logistics companies weaknesses in order to take effective measures to improve the their level of input and output so as to improve their logistics efficiency.

CHAPTER 2
LITERATURE REVIEW

This chapter reviews literature for the measurement of efficiency starting with DEA (Data Envelopment Analysis) concept. The concept of Malmquist productivity index is then described and finally followed by a review of previous research work on DEA for performance evaluation in logistics companies.

2.1 Data Envelopment Analysis

Data Envelopment Analysis (DEA), developed by Charnes et al. (1978), is a nonparametric method for measuring the efficiency of a decision-making unit (DMU). Any group of entities that receives the same set of the inputs and produces the same set of outputs could be designated as a DMU. The DEA is designed to measure relative efficiency in such situations where there are one or multiple inputs and one or multiple outputs. The goal of method is to calculate a ratio of total weighted output to total weighted input. This ratio is the relative efficiency of a DMU (Korpela and et al., 2007; Samoilenko and Bryson, 2012). This comparison results in a ranking of the DMUs in terms of their relative efficiency, where the highest-ranking DMUs are considered relatively efficient and assigned a perfect score of 1. The rest of the DMUs in the sample are considered to be relatively inefficient. DEA envelops the data set with the efficiency frontier consisting of the relatively efficient DMUs. The two commonly mentioned orientations of DEA models are the input-oriented and the output oriented.

The input–oriented measure can be explained as the optimal combination of inputs to produce a given level of output. A relatively efficient DMU under input-orientation cannot reduce its levels of inputs any further to achieve a given level of output, while the relatively

inefficient DMUs (with the scores of greater than ‘‘0’’ but less than ‘‘1’’) could. On contrary, an output-oriented DEA model defines efficiency as the optimal amount of output that could be produced under the given set of inputs. A relatively efficient DMU under output-orientation cannot increase its levels of outputs any further while relying on a given level of inputs, while the relatively inefficient DMUs (with the scores of greater than ‘‘1’’) could. Thus, while in both cases a relatively efficient DMU is assigned a score of ‘‘1’’, a relatively inefficient DMU will receive a score of greater than ‘‘1’’ under output orientation, and a score in the [0, 1) interval under input orientation. In an input orientation one improves efficiency through proportional reduction of inputs, whereas an output orientation requires proportional augmentation of outputs (Coelli, 2005; Cook and Bala, 2007; Feng and et al., 2007; Samoilenko and Bryson, 2012).

Figure 2.1 presents the case where a firm used 2 inputs (x_1, x_2) to produce 2 outputs (y_1^*, y_2^*). Figure 2(a) shows the way to evaluate the technical efficiency by using the input – oriented measure. Here, the $IQ(y_1^*, y_2^*)$ curve represents the isoquant curve which indicates the minimum levels of inputs used to produce the output (y_1^*, y_2^*). If this firm used the combination of inputs at point A to produce (y_1^*, y_2^*), its production is ineffective, since the same level of outputs can be produced with less inputs (but at the same combination) at point B. Therefore, the level of technical efficiency defined by the input – oriented measure of this firm can be computed as the ratio between the distances 0B and 0A (or 0B/0A).

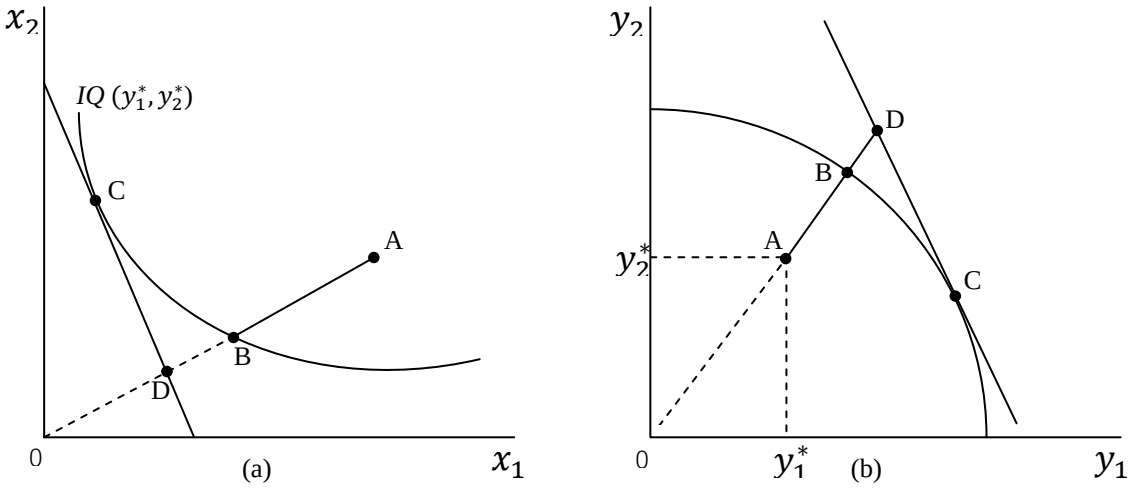

Figure 2.1: Input (a) and output (b) oriented efficiency measures

On the other hand, Figure 2(b) explained the way to compute the technical efficiency by using the output – oriented measure. Point A in figure 1(b) represents the combination of outputs (y_1^*, y_2^*) produced by a particular firm using a given amount of inputs (x_1, x_2). Anyway, if this firm produces at the efficient level, it should produce more of both outputs at point B on the production frontier line by using the same level of inputs as before. Thus, the level of technical efficiency defined by the output – oriented measure in this case can be calculated as the ratio between the distances 0A and 0B (or 0A/0B).

To calculate efficiency scores employing DEA, two different assumptions can be made, i.e. constant return to scale (CRS) and variable returns to scale (VRS). The VRS efficiency score measures pure technical efficiency, i.e. a measure of efficiency without scale efficiency. On the other hand, the CRS efficiency score represents technical efficiency, which measures inefficiencies due to the input/output configuration and the size of operations. Due to the difference in CRS and VRS, a few inefficient DMUs on CRS may turn out to be efficient on VRS. Scale efficiency is the ratio of CRS technical efficiency to VRS technical efficiency. If the ratio is equal to one, the firm exhibits CRS. If scale efficiency is less than one, the respective firm exhibits VRS (increasing/decreasing). Hence, scale efficiency of a DMU

operating in its most productive scale size is one (Cooper et al., 2007; Yu and Ramanathan, 2008). The details of CRS and CRS concepts are described as follows.

2.1.1 Under the assumption of constant returns to Scale (CRS)

In this case, each DMU is assumed to be operated with the appropriate scale of production. Thus, the linear programming problem is to:

$$Max_{u,v}\left(\frac{uy_i}{vx_i}\right) \text{ subject to } \left(\frac{uy_j}{vx_j}\right) \leq 1 \ (j = 1,2,\dots,N) \text{ and } u, v \geq 0 \qquad (1)$$

where, y_i are vectors of outputs from the $M \times N$ output matrix, Y (M outputs from N DMUs), x_i are vectors of inputs from the $K \times N$ output matrix, X (K inputs from N DMUs), $i = 1,2,\dots,N$, and u, v are vectors of $M \times 1$ output weights and $K \times 1$ input weights, consecutively.

Equation (1) can be equivalently transformed into the envelopment form as follows:

$$Min_{\theta,\lambda}\theta \text{ subject to } -y_i + Y\lambda \geq 0, \theta x_i - X\lambda \geq 0, \text{ and } \lambda \geq 0 \qquad (2)$$

where, θ is a scalar$(\theta \leq 1)$, and λ is a $N \times 1$ vector of constants.

In order to include the input and output slacks[1], Ali and Seiford (1993) suggested the following model:

$$Min_{\lambda,OS,IS} - (M_1 OS + K_1 IS) \text{ subject to } -y_i + Y\lambda - OS = 0, \theta x_i - X\lambda - IS = 0, \text{ and } \lambda \geq 0, OS \geq 0, IS \geq 0 \qquad (3)^2$$

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[1] Input slacks refer to the surplus amount of inputs that could be decreased without the reduction of outputs, while the output slacks refer to the deficient amount of outputs that a firm could produce by using the given amount of inputs

[2] Equation (3) is the two – step procedure, since the parameter θ in equation (3) is no longer variable, and is obtained from the results of the calculation from equation (2).

where, M_1 and K_1 are the $M \times 1$ and $K \times 1$ vectors of ones, respectively, OS is a $M \times 1$ vector of output slacks, and IS is a $K \times 1$ vector of input slacks.

2.1.2 Under the assumption of variable returns to Scale (VRS)

Due to the effect of imperfect competition in the market (price rigidity, contracts, law and regulations and etc.), the assumption of CRS is not suitable for the real world, since most of DMUs may not be operated at the optimum scale. Thus, by imposing the assumption of VRS, the linear programming problem in equation (2) can be transformed into (Banker, Charnes, and Coopers, 1984):

$$Min_{\theta,\lambda}\theta \text{ subject to } -y_i + Y\lambda \geq 0, \theta x_i - X\lambda \geq 0, N_1\lambda = 1 \text{ and } \lambda \geq 0 \quad (4)$$

where, N_1 is a $N \times 1$ vector of ones (the convexity constraint).

Equation (4) allows us to decompose the technical efficiency score (under CRS assumption: TE_{CRS}) into 2 components, namely 1) pure technical efficiency score (TE_{VRS}) and 2) scale efficiency score (SE) as follows:

$$TE_{CRS} = TE_{VRS} \times SE \quad (5)$$

Moreover, in order to determine the nature of returns to scale used by each DMU. The linear programming equation (4) can be solved by imposing with the non – increasing returns to scale restriction to produce the NIRS efficiency frontier as follows:

$$Min_{\theta,\lambda}\theta \text{ subject to } -y_i + Y\lambda \geq 0, \theta x_i - X\lambda \geq 0, N_1\lambda \leq 1 \text{ and } \lambda \geq 0 \quad (6)$$

As a result, if the technical efficiency score computed from equation (6), or TE_{NIRS} is not equal to TE_{VRS} from equation (4), the nature of the particular DMU is increasing returns to scale (IRS). However, if they are equal, it means that decreasing returns to scale (DRS) is applied for this DMU.

2.2 Malmquist Productivity Index

The Malmquist productivity index is used to measure and compare the productivity growth of different producing units from one period to another. Measurement is based on constructing best practice frontiers for adjacent years by using data on inputs and outputs of all producing units in the sample and then computing the output growth that is caused by shift of the frontier for each individual producing unit (Krishnasamy and et al., 2004; Muge, 2011). This index allows changes in productivity to be broken down into changes in efficiency (deviations from the best practice frontier) and technology change (TC) (movements of the frontier), and is defined using distance functions (Yu and Ramanathan, 2008). The Malmquist index indicates the change of productivity between period t and $t+1$. In the case, the productivity of a DMU improves, declines, and remains unchanged if Malmquist index is less than 1, greater than 1, and equal to 1, respectively.

This research attempts to capture the over time efficiency change of logistics companies in Thailand by using the Malmquist index based on DEA. Generally, the Malmquist Index measuring the productivity growth can be decomposed into the technical change and the technical efficiency change. In order to understand the basic idea of Malmquist Index, Farrell (1957) suggested the way to measure the technical efficiency as follows:

At time period t, the set of all feasible N input and M output vectors are determined by $x^t = (x_1^t, x_2^t, \dots, x_N^t)$ and $y^t = (y_1^t, y_2^t, \dots, y_M^t)$, consecutively where $x^t \epsilon\, R_+^N$ and $y^t \epsilon\, R_+^M$. Moreover, the technology can be demonstrated by the input requirement set $(L^t(y^t))$:

$$L^t(y^t) = \{x^t : (x^t, y^t) \epsilon\, S^t\}, t = 1,2, \dots, T \quad (7)$$

where, $S^t = \{(x^t, y^t): x^t$can produce $y^t\}$ or the set of technology at period t. In other words, Equation (7) showed all feasible vectors of input (x^t) used to produce the output vector (y^t).

Under Farrell's method, the technical efficiency can be measured in two ways, namely output – oriented and input – oriented measures. For the output – oriented measure, the efficiency score can be measured by holding the level of output constant and decreasing the level of inputs with respect to the technology frontier. On the other hands, under the input – oriented measure which is the main focal points of this study, the technical efficiency score can be obtained by holding the level of input constant and expanding the level of output with respect to the technology frontier..

Figure 2.2 exhibits two piecewise linear isoquants ($L^t(y^t)$ and $L^{t+1}(y^{t+1})$) which represents the technology frontier in two periods (t and $t+1$). In this case, a firm produced at point c in period t and changed the pattern of production to point e in period $t+1$. Under Farrell's measure, the technical efficiency score of this firm in period t can be computed as 0b/0c and the distance function is given by its reciprocal or 0c/0b (Shephard, 1953). Thus, if the production activity is efficient, both efficiency score and the distance function are equal to 1. Moreover, the technical efficiency score ranged between 0 and 1but the distance function is varied from 1 to the value greater than 1.

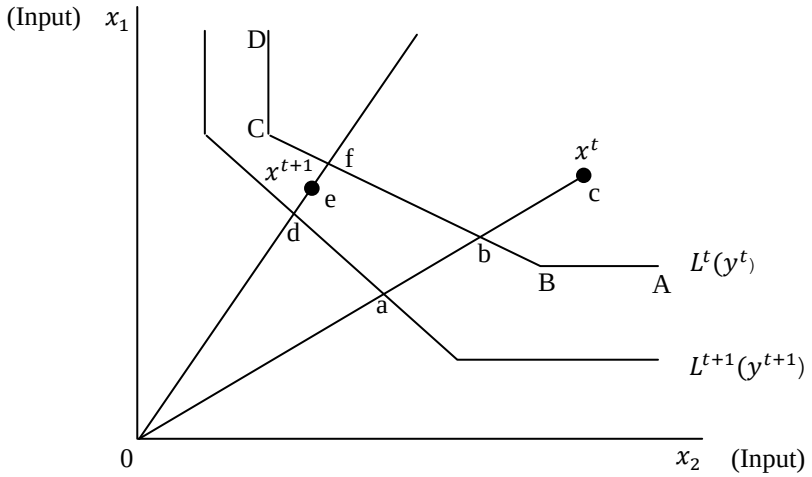

Figure 2.2: The Farrell's input – oriented measure of the technical efficiency

If we let $F_i^t(y_t, x_t)$ be the input – oriented technical efficiency score measured by Farrell's concept and $D_i^t(y_t, x_t)$ be the input – oriented distance function, therefore at any time period t:

$$F_i^t(y^t, x^t) = min_\theta\{\theta: \theta x^t \epsilon\, L^t(y^t)\}$$

$$D_i^t(y^t, x^t) = max_\theta\{\theta \geq 1: (x^t/\theta)\epsilon\, L^t(y^t)\} \quad (8)$$

or,

$$F_i^t(y^t, x^t) = [D_i^t(y^t, x^t)]^{-1} \quad (9)$$

Furthermore, in order to compute the Malmquist index to capture the productivity change between 2 time periods (t and $t+1$), other 3 more distance functions must be calculated as follows:

$$D_i^t(y^{t+1}, x^{t+1}) = max_\theta\{\theta \geq 1: (x^{t+1}/\theta)\epsilon\, L^t(y^{t+1})\} \quad (10)$$

$$D_i^{t+1}(y^t, x^t) = max_\theta\{\theta \geq 1: (x^t/\theta)\epsilon\, L^{t+1}(y^t)\} \quad (11)$$

and

$$D_i^{t+1}(y^{t+1}, x^{t+1}) = max_\theta\{\theta \geq 1: (x^{t+1}/\theta)\epsilon\, L^{t+1}(y^{t+1})\} \quad (12)$$

Equation (10) represented the efficiency measure using the information in period $t+1$ with respect to the technology frontier of period t, while equation (11) referred to the efficiency measure using the information in period t with respect to the technology frontier of period $t+1$. Finally, the distance function in equation (12) represented the efficiency measure using the information in period $t+1$ with respect to the technology frontier of period $t+1$.

These distance functions can be explained by considering figure 2.2 above. In this case, the input requirement set in period $t+1$ is represented by the isoquant line $L^{t+1}(y^{t+1})$. Therefore, $D_i^t(y^{t+1}, x^{t+1})$ is equal to the ratio 0e/0f. By the same token, $D_i^{t+1}(y^t, x^t)$ and $D_i^{t+1}(y^{t+1}, x^{t+1})$ are the ratios 0c/0a and 0e/0d, consecutively. As a result, Caves et al. (1982) showed that the distance functions can be used to construct the Malmquist index in the form of the ratio between 2 distance functions for measuring the change of productivity between period t and $t+1$ as follows:

$$M_i(y^{t+1}, x^{t+1}, y^t, x^t) = \frac{D_i^t(y^{t+1}, x^{t+1})}{D_i^t(y^t, x^t)} \tag{13}$$

Afterwards, Fare et al. (1994) computed the Malmquist index as the geometric mean of index in equation (13) between two time periods, or:

$$M_i(y^{t+1}, x^{t+1}, y^t, x^t) = \left[\frac{D_i^t(y^{t+1}, x^{t+1})}{D_i^t(y^t, x^t)} \frac{D_i^{t+1}(y^{t+1}, x^{t+1})}{D_i^{t+1}(y^t, x^t)}\right]^{1/2} \tag{14}$$

Moreover, Fare et al. (1994) also showed that index in equation (14) can be factored into the technical and the technical efficiency changes as follows:

$$M_i(y^{t+1}, x^{t+1}, y^t, x^t) = \frac{D_i^{t+1}(y^{t+1}, x^{t+1})}{D_i^t(y^t, x^t)} \left[\frac{D_i^t(y^{t+1}, x^{t+1})}{D_i^{t+1}(y^{t+1}, x^{t+1})} \frac{D_i^t(y^t, x^t)}{D_i^{t+1}(y^t, x^t)}\right]^{1/2} \tag{15}$$

The first term on the right – hand side of equation (15) measures the input technical efficiency change (E_i) of a DMU between two time periods. That is if:

$\frac{D_i^{t+1}(y^{t+1},x^{t+1})}{D_i^t(y^t,x^t)} < 1 \rightarrow$ Progress in the input technical efficiency

$\frac{D_i^{t+1}(y^{t+1},x^{t+1})}{D_i^t(y^t,x^t)} > 1 \rightarrow$ Regress in the input technical efficiency, and

$\frac{D_i^{t+1}(y^{t+1},x^{t+1})}{D_i^t(y^t,x^t)} = 1 \rightarrow$ Status Qua

The second geometric – mean term on the right – hand side of equation (15) measures the input technical change (T_i) (or the size of the input frontier shift) of a DMU between two time periods, that is to say if:

$\left[\frac{D_i^t(y^{t+1},x^{t+1})}{D_i^{t+1}(y^{t+1},x^{t+1})}\frac{D_i^t(y^t,x^t)}{D_i^{t+1}(y^t,x^t)}\right]^{1/2} < 1 \rightarrow$ Progress in the frontier technology

$\left[\frac{D_i^t(y^{t+1},x^{t+1})}{D_i^{t+1}(y^{t+1},x^{t+1})}\frac{D_i^t(y^t,x^t)}{D_i^{t+1}(y^t,x^t)}\right]^{1/2} > 1 \rightarrow$ Regress in the frontier technology, and

$\left[\frac{D_i^t(y^{t+1},x^{t+1})}{D_i^{t+1}(y^{t+1},x^{t+1})}\frac{D_i^t(y^t,x^t)}{D_i^{t+1}(y^t,x^t)}\right]^{1/2} = 1 \rightarrow$ Status Qua

Finally, the Malmquist index (M_i) indicates the change of productivity between period t and $t+1$. In this case, the productivity of a DMU improves, declines, and remains unchanged if M_i is less than 1, greater than 1, and equal to 1, respectively.

2.3 DEA Applications in Logistics Sector

Since the advent of DEA in 1978, there has been an impressive growth both in theoretical developments and applications of the ideas to practical situations. It is apparent that the use of DEA is prevalent in several industries such as energy, banking, retail, healthcare service, manufacturing, and etc. The previous research adopting DEA as a tool to evaluate the efficiency in logistics industry is summarised in Table 1.

Table 2.1: Journal Pulications in logistics efficiency using DEA

Authors	Analysis level	Inputs	Outputs
Ross and Droge (2003)	Efficiency in distribution systems	Fleet size Driver experience Delivery route index	Product delivery volumes Vehicle usage
Min and Foo (2006)	3PL providers in USA	Account receivables Salaries and wages Operating expenses Property and equipment	Operating income
Korpela and et al. (2007)	Warehouse operator selection	Direct costs Indirect costs	Reliability Flexibility
Hamdan and Rogers (2008)	3PL logistics operations	Labour Space Technology Material handling equipment	Throughput Order fill Space utilization
Wu and Lin (2008)	Port competitiveness	Labour Land and equipment Number of quayside gantries Number of yard gantries Number of straddle carriers	Actual throughput Service level output
Zhou et al. (2008)	Chinese 3rd party logistics providers	Net fixed asset Salaries and wages Operating expenses Current liabilities	Operating income
Hilmola (2011)	Logistics development for	LPI infrastructure LPI customs	GDP per capita GDP per capita (PPP)

Authors	Analysis level	Inputs	Outputs
	oil exporters	LPI international shipments LPI logistics competence LPI tracking and tracing LPI timeliness	
Wanke (2012a)	Brazilian 3rd party logistics	Number of staff Total warehouse area Total owned warehouses Total client warehouses	Number of clients Gross revenues
Wanke (2012b)	Efficiency of Brazilian airports	Airport area Number of runways Total runway length Number of aircraft parking spaces Terminal area Number of parking places	Number of landlidings and take offs (per year) Number of passengers (per year) Cargo throughput (kg/yr)
Joo et al. (2013)	Longitudinal efficiency of branch operations of a 3PL company	Master airway bill expenses Pickup and delivery expenses Other expenses	Chargeable weight Gross profit

Studies that discuss the application of DEA, specifically in the third party logistics providers, are scarce and relatively recent (Wanke, 2012). However, there are several more papers using DEA for evaluation DMUs (decision-making units) in logistics sector but published as conference papers. For journal publications, Min and Joo (2006) apply DEA technique to a group of six leading US-based logistics companies. They developed a

benchmark as a way to identify the logistics providers developing best practices and to allow other logistics providers to emulate them.

Hamdan and Rogers (2008) used DEA as a tool to evaluate the efficiency of a group of third-party logistics warehouse logistics operations. The data used in this paper were collected for a homogeneous set of 19 warehouses operated by a third party logistics provider for one year data. Therefore, the selection of the inputs and outputs is based on the significance of the resources (inputs) and the company's strategic objectives to increase revenue and raise service levels of the operations. This research aims at efficiency of one logistics provider.

While Zhou et al. (2008) benchmark performance standards for 10 Chinese third-party logistics providers to identify factors that affect the operational efficiency. Based on the DEA results, they categorise Chinese 3PLs into four types: stable 3PL, gradually-rising 3PL, instable 3PL and gradually-declining 3PL and propose areas of improvement to logistics sector in China. According to the authors, the DEA technique is a very useful for identifying the least efficient third party logistics which require the closest attention and provide good results for logistics companies to prove their resource utilization in terms of DEA scores compared to their competitors. Among the main conclusions is the fact that company size does not necessarily impact 3PL efficiency in a positive way. It is also discovered that accumulated sales revenues enabled a better use of 3PL resources, and that investments in staff team training, as well as being good for personnel retention, positively influenced third party logistics provider performance.

Wanke (2012a) focuses on Brazilian 3PL sector with the objective of identifying the chief determinants of scale efficiency. They determine whether a particular third party logistics provider is operating at –or close to- its optimum level, given the set of inputs used

and the level of outputs generated. They analyzed data from the period 2001 to 2009 using a two-stage DEA model. The model involves calculating efficiency scores and then followed by an analysis of unbalanced panel data using a Tobit regression model. The results provide an evidence that coordination mechanisms in the supply chain favour a more rational allocation of third party logistics providers resources (inputs) to client demands (outputs).

Later Wanke (2012b) proposes the work on benchmarking and efficiency analysis of 63 major Brazilian airports, based on cross sectional data for 2009, putting output-increase potentials and input slack. This work does not focus only the physical infrastructure but also the available area for future capacity expansion. The method used in this research adapted the bootstrap methodology to the case of DEA efficiency estimators and used a Gaussian kernel density function for random data generation. The findings corroborate anecdotal and empirical evidence regarding a capacity shortfall within Brazilian airports, where infrastructure slack is virtually inexistent, regardless of the airport type and location.

Joo et al. (2013) analyze the longitudinal efficiency of branch operations of a third party logistics company for comparative performance measurement and internal benchmarking. DEA is used for measuring the performance of a branch of a 3PL company for 36 months using internal data. The contribution of this work is to provide a functional framework for measuring the operational performance of 3PL companies using pertinent internal data regarding the pickup, delivery, and movement of freight. 3PL companies concentrated in freight forwarding will be able to alter the input and output variables to better demonstrate their individual operational efficiency and performance. This study provides the focal company with an insight regarding the performance of one station specializing in freight management, which can then be applied to similarly structured stations.

CHAPTER 3

RESEARCH METHODOLOGY

Reviews of the industrial context in Chapter 1 and literature in Chapter 2 have established the area in which to direct research. Therefore the intention of this research is to evaluate efficiency of logistics companies in Thailand. In the following sections, the development of the research program is presented. Subsequently, the input and output variables and details of these variables are described.

3.1 Research Methodology

This research evaluates the efficiency of logistics companies in Thailand by using the DEA-based efficiency evaluation method. The objective of the study is to propose a way to enhance the competitive of logistics industry. In this research, two methodologies, namely DEA and MPI are used to study the efficiencies of logistics sector in Thailand. The conceptual framework is proposed in Figure 3.1. In the first-stage analysis, DEA is used to calculate technical and scale efficiencies of logistics companies, which includes the conventional inputs and outputs. In general, DEA study considers performance analysis at a given point time. However, extensions to the standard DEA procedures such as MPI approach have been reported to provide performance assessment over a period (Yu and Ramnathan, 2008). Therefore, MPI is used to examine the patterns of efficiency change over the period 2007-2010.

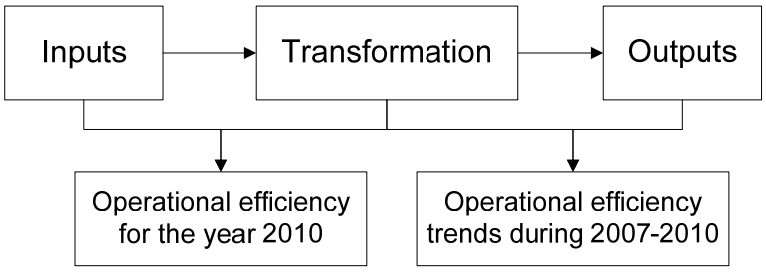

Figure 3.1. Conceptual framework

There are many ways in which this research could be carried out, but it should be structured according to the need and purpose of the research (Field and Morse, 1991). The research objectives have suggested four phases to achieve the delivery of the purpose of this research. The focus on phase 1 is to select input and output variables which reflect to the efficiency of logistics companies in Thailand. The second phase is to compute the efficiency of the companies by using DEA method and MPI. The next phase is to analyse and discuss the results not only in the big picture but also pinpoint down to input and output in each company. The last phase is to propose a way to improve efficiency to the logistics industry in Thailand.

3.2 Input and Output Variables

In order to fulfil the aim of the research, the input–oriented measure for evaluating the efficiency score was employed in this study to measure the efficiency of logistics companies how they use their inputs to generate their profits. The input and output data used in this study were collected from the income statements of logistics companies in Thailand available at www.bol.co.th/corpus. The 55 logistics companies were chosen from available data of 2007-2010 with respect to the ranking of the logistics companies making the highest profits in 2010 (the last year the data are available at the time of study). The nature of their returns to scale was computed only for the year of 2010. The panel data of these companies during the period of 2007-2010 were used to calculate the Malmquist index. The list of these DMUs is shown table 3.1 as follows:

Table 3.1: The top highest profits logistics companies of Thailand in 2010 regarding to available data for 2007-2010

Rank	Name	Capital	Profits in 20120 (Baht)	Company Symbol
1	CEVA Logistics (Thailand) Co., Ltd.	30,000,000.00	447089636.00	No. 1
2	DHL Supply Chain (Thailand) Co., Ltd.	50,000,000.00	342758991.00	No. 2
3	DHL Distribution (Thailand) Co., Ltd.	709,800,000.00	341484314.00	No. 3

Rank	Name	Capital	Profits in 20120 (Baht)	Company Symbol
4	Thai Beverage Logistics Co., Ltd.	1,012,000,000.00	322101097.00	No. 4
5	Linfox M Logistics (Thailand) Co., Ltd.	10,000,000.00	313885806.00	No. 5
6	United Thai Logistics Co., Ltd.	280,000,000.00	292887067.00	No. 6
7	Via Logistics Co., Ltd.	142,262,000.00	262780641.00	No. 7
8	Bangpakong Equipment Co., Ltd.	21,000,000.00	257126375.66	No. 8
9	Logist Plus Co., Ltd.	5,000,000.00	256469395.62	No. 9
10	YCH (Thailand) Co., Ltd.	41,500,000.00	255790995.00	No. 10
11	Lucky Dragon Logistics Co., Ltd.	1,000,000.00	255330616.40	No. 11
12	Universal Transport and Logistics Co., Ltd.	2,000,000.00	254732879.42	No. 12
13	RCL Logistics Co., Ltd.	5,000,000.00	254592394.00	No. 13
14	Venus Logistics Co., Ltd.	5,000,000.00	253190342.46	No. 14
15	Siam Nippon Steel Logistics Co., Ltd.	12,000,000.00	253177734.90	No. 15
16	Kawasaki Heavy Industry Ltd (Thailand)		252814657.00	No. 16
17	Lucky Dragon Co., Ltd.	1,000,000.00	252737912.78	No. 17
18	Golden World Intertrans Co., Ltd.	2,000,000.00	252326141.12	No. 18
19	Trans Logistics Co., Ltd.	5,000,000.00	252266734.19	No. 19
20	TBSC Logistics Co., Ltd.	10,000,000.00	252107609.00	No. 20
21	TVS Logistics Siam Co., Ltd.	10,000,000.00	250516320.25	No. 21
22	Trans Distributor Co., Ltd.	5,000,000.00	251866642.00	No. 22
23	Seiwa Pioneer Logistics Co., Ltd.	60,000,000.00	251659086.86	No. 23
24	Logistics One Co., Ltd.	5,000,000.00	251659086.86	No. 24
25	Thai Logistics Expertise Co., Ltd.	1,000,000.00	251545298.63	No. 25
26	Cheetah Supply Chain Co., Ltd.	50,000,000.00	251370177.08	No. 26
27	S.P. Logistics Management Co., Ltd.	1,250,000.00	251070831.51	No. 27
28	Kong Supply Part., Ltd.	1,000,000.00	251067614.92	No. 28
29	Triple I Logistics Management Co., Ltd.	15,000,000.00	250994759.99	No. 29
30	Quality Logistics Co., Ltd.	15,000,000.00	250963034.95	No. 30
31	FPS Logistics (Thailand) Co., Ltd.	5,000,000.00	250869859.66	No. 31
32	General Merchandise Marketing Co., Ltd.	2,000,000.00	250399998.86	No. 32

Rank	Name	Capital	Profits in 20120 (Baht)	Company Symbol
33	Siam Logistics Management Co., Ltd.	2,000,000.00	250312775.24	No. 33
34	United Relocation (Thailand) Co., Ltd.	4,000,000.00	250183302.84	No. 34
35	Alawee Engineering Co., Ltd.	1,000,000.00	250098070.45	No. 35
36	Progressive Trading Co., Ltd.	1,000,000.00	250015294.80	No. 36
37	South Siam Trading Co., Ltd.	1,000,000.00	250003143.51	No. 37
38	South Land Inter Logistics Co., Ltd.	1,000,000.00	249985332.92	No. 38
39	Trailer Trans Service Co., Ltd.	1,000,000.00	249960974.35	No. 39
40	Saeng Prakai Service Co., Ltd.	1,000,000.00	249954569.95	No. 40
41	M. P. Inter Progress Co., Ltd.	1,000,000.00	249836245.81	No. 41
42	Welcome Logistics Service Co., Ltd.	1,000,000.00	249794137.26	No. 42
43	Rungaroon Air and Sea Logistics Co., Ltd.	1,000,000.00	249747097.40	No. 43
44	Kawaliar Global Logistics Co., Ltd.	2,000,000.00	249665489.65	No. 44
45	Repower Asia Co., Ltd.	1,000,000.00	249517969.91	No. 45
46	P and O Management Services (Thailand) Ltd.	2,000,000.00	249506858.00	No. 46
47	Well Growth International Co., Ltd.	5,000,000.00	249359648.32	No. 47
48	RBO Logistics Co., Ltd.	5,000,000.00	249205705.46	No. 48
49	The Billenium Corporation Co., Ltd.	4,995,500.00	248925062.12	No. 49
50	Logistics Mart Co., Ltd.	3,000,000.00	248140550.03	No. 50
51	AQ Transport Co., Ltd.	5,000,000.00	247859650.31	No. 51
52	Thai Somdej Logistics Co., Ltd.	11,000,000.00	246851251.75	No. 52
53	Toll Warehouse (Thailand) Co., Ltd.	36,000,000.00	243301026.00	No. 53
54	All Logistics Center Co., Ltd.	10,000,000.00	240145630.02	No. 54
55	Wyncoast Logistics Co. Ltd.	80,000,000.00	132184659.00	No. 55

The selection of appropriate input and output measures can be aggregated into a composite index of overall performance standards (see Table 3.2). The inputs in this study include the net value of lands, buildings and equipments (X_1), shareholder fund (X_2), operating

cost (X_3), cost of sales and/or cost of service (X_4), and current liabilities (X_5), while profit (Y_1) and revenue $(Y_2)$are treated as outputs (two outputs).

Table 3.2: Input and output variables

Input	Description
x_1	Net value of lands, buildings and equipments
x_2	Shareholder fund
x_3	Operating cost
x_4	Cost of sales and/or cost of service
x_5	Current liabilities
Output	Description
y_1	Profit
y_2	Revenue

Fixed assets such as lands, buildings, and equipments reflect an efficiency of asset management as logistics companies often sell their services by lending their assets to the clients and therefore these can be a key resource for increasing sales and subsequent revenue (Zhou et al., 2008). Operating expenses and cost of sales include numerous variable costs which comprise of key resources for logistics service operations providing services to their clients. Furthermore, logistics companies use shareholder funds and current liabilities as major sources of financing their current assets which need to use to serve clients and consequently considered as inputs (Zhou et al., 2008; Yu and Ramanathan, 2008).

In regards to the output side, measures that would represent financial and operational aspects were selected. As such, since the logistics companies' gross revenues portray the product of service-provided sales, gross revenues were selected as an output (Yu and Ramanatha, 2008; Wanke, 2012). Apart from that, logistics companies pay attention to results as they guarantee the viability of the company. Therefore, the second output used is the profit volume of the company. The data on inputs and outputs for 55 logistics companies used in this

study are shown in Appendix and the descriptive statistics for input and output variables are shown in Table 3.3.

Table 3.3: Descriptive statistics for input and output variables of DEA model

Variables	y_1	y_2	x_1	x_2	x_3	x_4	x_5
2007							
Mean	257,603,374	432,108,826	294,378,972	291,546,531	273,567,482	400,410,800	353,815,465
Max	427,121,203	2,394,729,409	850,784,030	941,418,137	465,672,416	2,084,683,241	2,431,961,628
Min	164,923,655	250,000,000	250,000,000	132,703,189	250,012,083	250,000,000	250,010,830
S.D.	31,577,903	427,484,505	113,772,424	127,643,462	47,541,666	372,485,105	357,010,374
2008							
Mean	253,724,879	443,053,403	301,428,097	301,322,221	274,737,821	379,284,662	352,697,486
Max	359,280,174	2,631,131,711	977,181,979	1,042,415,125	480,996,203	2,306,800,028	2,409,746,453
Min	141,925,598	250,000,000	250,000,000	184,994,392	250,087,906	250,000,000	250,006,094
S.D.	28,726,221	472,974,245	127,697,096	143,638,652	49,924,957	324,513,451	359,693,328
2009							
Mean	257,304,180	422,122,299	257,304,180	313,280,348	320,983,418	269,356,746	395,490,762
Max	337,081,440	2,573,208,588	337,081,440	1,224,704,531	1,381,051,954	471,176,698	2,218,702,336

Variables	y_1	y_2	x_1	x_2	x_3	x_4	x_5
Min	218,812,514	250,000,000	218,812,514	250,000,000	156,173,896	250,000,000	250,000,000
S.D.	21,394,541	421,393,061	21,394,541	178,160,755	208,718,530	38,747,613	355,934,234
2010							
Mean	258,985,245	457,114,317	309,566,248	329,790,762	269,567,312	430,724,599	322,788,473
Max	447,089,636	2,846,875,573	1,674,535,233	1,453,153,051	523,607,240	2,450,616,763	1,602,310,041
Min	132,184,659	250,000,000	250,000,000	38,358,555	250,000,000	250,000,000	250,007,000
S.D.	37,754,323	542,277,204	214,934,980	227,233,146	44,448,898	463,919,095	222,551,667

CHAPTER 4

RESULTS AND DISCUSSION

The preceding chapter has formed the research methodology. This chapter will present the results of the research with discussion. This chapter is structured as follows. The calculation of the technical and scale efficiency is first discussed (Section 4.1). The result of input and output slacks is then explained (Section 4.2). Subsequently, the analysis of productivity change is described (Section 4.3) and the conclusion is then made (Section 4.4).

4.1 The Calculation of the Technical and Scale Efficiency

In this study, the tradition DEA technique is applied to the input and output data only for the year 2010 so as to measure the technical and scale efficiency and the nature of the returns to scale of the logistics companies in Thailand ranked by their profits in this year. The results are shown in Table 4.1.

Table 4.1: The Technical Efficiency, Scale Efficiency and Returns to Scale of Thai logistics companies in 2010

Company	TE_{CRS}	TE_{VRS}	SE	Returns to Scale
1	1.000	1.000	1.000	-
2	1.000	1.000	1.000	-
3	1.000	1.000	1.000	-
4	0.997	1.00	0.997	IRS
5	1.000	1.000	1.000	-
6	1.000	1.000	1.000	-
7	0.976	0.987	0.989	IRS
8	0.965	0.966	0.999	DRS
9	1.000	1.000	1.000	-

Company	TE_{CRS}	TE_{VRS}	SE	Returns to Scale
10	0.951	0.972	0.979	IRS
11	1.000	1.000	1.000	-
12	1.000	1.000	1.000	-
13	0.967	1.000	0.967	IRS
14	1.000	1.000	1.000	-
15	0.998	1.000	0.998	IRS
16	1.000	1.000	1.000	-
17	1.000	1.000	1.000	-
18	1.000	1.000	1.000	-
19	1.000	1.000	1.000	-
20	0.984	0.989	0.995	IRS
21	0.988	0.999	0.989	IRS
22	0.966	0.980	0.986	IRS
23	1.000	1.000	1.000	-
24	1.000	1.000	1.000	-
25	1.000	1.000	1.000	-
26	1.000	1.000	1.000	-
27	1.000	1.000	1.000	-
28	1.000	1.000	1.000	-
29	1.000	1.000	1.000	-
30	1.000	1.000	1.000	-
31	0.980	1.000	0.980	IRS
32	0.998	1.000	0.998	IRS
33	1.000	1.000	1.000	-
34	0.999	1.000	0.999	IRS
35	1.000	1.000	1.000	-
36	1.000	1.000	1.000	-
37	1.000	1.000	1.000	-
38	1.000	1.000	1.000	-
39	1.000	1.000	1.000	-
40	1.000	1.000	1.000	-
41	0.997	1.000	0.997	IRS

Company	TE_{CRS}	TE_{VRS}	SE	Returns to Scale
42	0.999	1.000	0.999	IRS
43	1.000	1.000	1.000	-
44	1.000	1.000	1.000	-
45	0.999	1.000	0.999	IRS
46	0.998	1.000	0.998	IRS
47	0.996	1.000	0.996	IRS
48	0.997	1.000	0.997	IRS
49	0.988	0.999	0.989	IRS
50	0.989	1.000	0.989	IRS
51	1.000	1.000	1.000	-
52	0.993	0.996	0.997	IRS
53	0.941	0.963	0.976	IRS
54	1.000	1.000	1.000	-
55	1.000	1.000	1.000	-

Note: TE_{CRS}, TE_{VRS} and SE represented the technical efficiency scores under the assumption of the constant returns to scale, variable returns to scale and the scale efficiency, respectively.

The results show that under the assumption of constant returns to scale (CRS), the logistics companies operating on the efficient frontier line in 2010 encompass 33 companies, and the rest 22 companies are inefficient with the technical efficiency score (TE_{CRS}) ranging from 0.941to 0.999. These technical efficiency scores are computed under the input-oriented measure and therefore they can be interpreted as the percentage of overall inputs that inefficient DMU can be reduced in order to reach the efficient level. The 22 companies could reduce their overall inputs so as to reach the efficient level.

The technical efficiency scores under the assumption of variable returns to scale (TE_{VRS}) presents that 46 logistics companies operated on the efficient frontier line in

2010. The rest inefficient DMUs are only 9 companies with the results of technical efficiency ranging from 0.963-0.999.

Finally, the results of scale efficiency show that there is only one DMU among 22 companies operating under the decreasing returns to scale (DRS) or another word; they have relatively large level of production comparing with the optimal scale level. While the rest of 21 companies operated with increasing returns to scale (IRS) which means these companies have relatively small level of production comparing with the optimal scale level.

4.2 The Input and Output Slacks

The results for the input and output slacks are given in Table 4.2. The numbers in the table indicated the size of inputs that can be reduced by maintaining the current output level of the particular company (input slacks) and the size of outputs that can be raised by using the current level of inputs (output slacks).

The results show that company 7, 10, 21, 39, 41, 42, 46, 47, 48, 49 and 53 could increase their profits according to the numbers of $\mathbf{y_1}$ as shown in Table 4.2 in million baht unit. This increment of profit is on the assumption of using the current level of inputs. On the contrary, there is no output slack for revenue output ($\mathbf{y_2}$). Considering input slack results, company 7, 8, 20, 22, 35, 42, 47 and 53 could reduce their net value of lands buildings, and equipments ($\mathbf{x_1}$) with the amount as shown in Table 4.2, while companies 7, 8, 10, 20, 21, 39, 42, 46 and 53 could reduce their shareholder fund without giving impact to their level of output. Furthermore, companies 21, 39, 41, 42, 46, 47, 48, 49 would decrease their operating cost and companies 21, 22 and 53 are likely to be able to cut their cost of sales/services by maintain the same level of output. Finally,

companies 7, 10, 21, 22, 39, 41, 46 and 53 should decrease their current liabilities without affecting to the level of outputs.

Table 4.2: The input and output slacks for Thai logistics companies in 2010 (million baht)

Company	Output Slacks		Input Slacks				
	y_1	y_2	x_1	x_2	x_3	x_4	x_5
7	7.950	-	138.018	87.542	-	-	33.889
8	-	-	44.305	72.758	-	-	-
10	16.036	-	-	84.394	-	-	48.643
20	-	-	11.968	0.093	-	-	-
21	1.167	-	-	0.002	0.825	0.003	14.949
22	-	-	0.168	-	-	3.180	7.908
35	-	-	0.456	-	-	-	-
39	0.040	-	-	0.170	0.030	-	0.050
41	0.347	-	-	-	0.124	-	0.417
42	0.160	-	0.360	0.430	0.170	-	-
46	0.440	-	-	0.320	0.450	-	0.180
47	0.463	-	0.098	-	0.383	-	-
48	0.732	-	-	-	0.664	-	-
49	3.431	-	-	-	3.432	-	-
53	5.445	-	30.692	4.172	-	21.760	1.729

4.3 The Productivity Change

The panel data of the inputs and outs of logistics companies were collected from the period of 2007-2010. In this section, the results of productivity change in Thai logistics companies are reported into three subsections: the input technical efficiency scores, the input technical change and the malmquist index.

4.3.1 The Input Technical Efficiency Scores ($\mathbf{E_i}$) from 2007 – 2010

Technical efficiency refers to the ability to use a minimal amount of input to make a given level of output. To the extent an organisation fails to achieve an output combination on its production possibility frontier, and falls beneath this frontier, it can be said to be technically inefficient. The results of input technical efficiency change present that there are 8 companies (1, 3, 11, 12, 14, 19, 36, and 39) having no evidence of changes in the input technical efficiency level during the period of 2007-2010. By considering in each pair of period, in the first period (2007/2008), 14 companies exhibited a progress in the input technical efficiency (E_i < 1), whereas the E_i scores of the rest 23 companies in the same period indicated a regress in the input technical efficiency level (E_i >1). The results of input technical efficiency scores show in Table 4.3 and 4.4.

In the latter year 2008/2009, 10 companies had the evidence of improvement in the input technical efficiency level, while 27 companies exhibited the regression of their input efficiency level. The remaining 18 companies still maintained its technical efficiency at the level as the previous year. The results support the evidence of Thailand economics giving the impact to Thai logistics industries. The recession during the year 2008 to 2009 by GDP growth dropped down from 2.5% to -2.3% which reflects the regression of input technical efficiency level during the year 2008 to 2009.

During the period of 2009-2010, the results show that the evidence of the steady level in the level of input technical efficiency of most companies (23 companies) and the level of input technical efficiency of 18 companies were worsened than the previous year. Finally, the rest 14 logistics companies showed the evidence of an improvement on the technical efficiency level. During this period, the input technical efficiency seems

to be more efficient than the previous year which would be the result of economic recovery on GDP growth from -2.3% to 7.8% in 2010.

Table 4.3: The Malmquist Indices and their Decomposition for Thai logistics companies from 2007 to 2009

Company	2007/2008			2008/2009		
	E_i	T_i	M_i	E_i	T_i	M_i
1	1.000	1.813	1.813	1.000	0.463	0.463
2	1.048	1.070	1.121	1.003	0.982	0.985
3	1.000	1.133	1.133	1.000	0.833	0.833
4	1.000	0.954	0.954	1.000	0.938	0.938
5	0.985	1.025	1.010	1.015	1.054	1.070
6	0.695	1.077	0.749	1.457	0.843	1.228
7	1.058	0.979	1.036	1.064	0.882	0.939
8	1.000	1.109	1.109	1.000	0.914	0.914
9	0.994	0.997	0.991	1.009	0.996	1.005
10	1.000	1.052	1.052	1.000	0.787	0.787
11	1.000	1.001	1.001	1.000	0.998	0.998
12	1.000	1.004	1.004	1.000	0.996	0.996
13	1.000	0.971	0.971	1.000	0.986	0.986
14	1.000	0.980	0.980	1.000	0.998	0.998
15	1.033	0.975	1.008	1.027	0.988	1.015
16	1.000	0.721	0.721	0.983	0.988	0.971
17	0.983	0.997	0.980	1.015	0.998	1.013
18	1.001	1.000	1.000	1.001	1.000	1.001
19	1.000	0.982	0.982	1.000	1.024	1.024
20	1.007	0.996	1.002	1.006	0.995	1.001
21	0.993	0.992	0.985	1.010	0.991	1.001
22	1.008	0.998	1.006	0.999	0.994	0.992

Company	2007/2008			2008/2009		
	E_i	T_i	M_i	E_i	T_i	M_i
23	1.020	0.996	1.016	1.027	0.992	1.019
24	1.005	0.997	1.002	0.997	1.000	0.997
25	1.000	0.997	1.002	1.003	1.002	1.004
26	1.000	0.998	0.998	1.001	1.000	1.001
27	1.006	0.997	1.003	1.000	1.000	1.000
28	1.004	1.000	1.004	0.997	1.000	0.997
29	1.004	0.987	0.991	1.025	0.974	0.999
30	0.978	1.000	0.978	1.035	0.992	1.027
31	1.055	0.957	1.010	0.996	0.985	0.981
32	0.986	0.997	0.982	1.013	0.999	1.012
33	0.998	0.999	0.998	1.002	1.000	1.002
34	1.013	0.998	1.011	1.001	1.000	1.001
35	1.001	0.999	1.000	1.001	1.000	1.000
36	1.000	1.000	1.000	1.000	1.000	1.000
37	1.001	1.000	1.000	1.000	1.000	1.000
38	1.001	1.000	1.000	1.000	0.998	0.997
39	1.000	0.998	0.998	1.000	1.000	1.000
40	1.000	1.000	1.000	1.002	1.000	1.002
41	1.002	0.999	1.001	0.995	1.000	0.995
42	0.999	0.999	0.998	1.003	1.000	1.003
43	1.000	1.000	1.000	1.000	1.000	1.000
44	0.998	0.999	0.998	0.998	1.000	0.998
45	0.997	0.999	0.996	1.003	1.000	1.002
46	0.997	0.991	0.989	1.001	1.000	1.000
47	1.001	0.999	1.000	1.001	0.999	1.000
48	1.000	1.000	1.000	1.000	1.000	1.000
49	0.997	0.997	0.994	1.007	1.000	1.007
50	1.015	0.999	1.013	0.994	0.986	0.980

Company	2007/2008			2008/2009		
	E_i	T_i	M_i	E_i	T_i	M_i
51	1.037	0.990	1.026	1.000	1.007	1.007
52	1.001	1.004	1.005	0.985	0.989	0.975
53	1.014	1.023	1.038	0.957	0.987	0.945
54	0.658	1.024	0.673	1.556	0.854	1.329
55	1.363	1.025	1.398	1.081	1.058	1.145

Table 4.4: The Malmquist Indices and their Decomposition for Thai logistics companies from 2009 to 2010

Company	2009/2010		
	E_i	T_i	M_i
1	1.000	1.198	1.198
2	1.000	1.024	1.024
3	1.000	1.171	1.171
4	0.997	1.039	1.035
5	1.000	1.051	1.051
6	1.049	1.032	1.083
7	1.032	0.992	1.024
8	0.965	1.000	0.965
9	1.000	0.992	0.992
10	0.951	0.998	0.949
11	1.000	1.000	1.000
12	1.000	1.002	1.002
13	0.967	1.031	0.996
14	1.000	0.997	0.997
15	1.007	0.993	1.000
16	1.018	1.002	1.020

Company	2009/2010		
	E_i	T_i	M_i
17	1.002	1.001	1.003
18	1.000	1.000	1.000
19	1.000	0.992	0.992
20	0.990	1.001	0.990
21	0.997	1.005	1.002
22	0.987	1.023	1.010
23	1.000	1.000	1.000
24	1.005	0.997	1.002
25	1.000	1.000	1.000
26	1.000	0.991	0.991
27	1.000	0.999	0.999
28	1.005	0.999	1.004
29	1.011	0.986	0.997
30	1.012	0.998	1.010
31	0.994	1.008	1.002
32	1.001	1.000	1.001
33	1.000	0.997	0.997
34	1.001	0.999	1.000
35	1.001	0.999	1.000
36	1.000	1.000	1.000
37	1.000	1.000	1.000
38	1.002	1.001	1.003
39	1.000	1.000	1.000
40	1.000	1.000	1.000
41	1.002	0.998	1.000
42	1.000	1.000	1.000
43	1.002	0.999	1.000
44	1.006	0.998	1.004

Company	2009/2010		
	E_i	T_i	M_i
45	0.999	0.999	0.998
46	1.000	1.000	1.000
47	0.997	1.000	0.997
48	0.997	0.997	0.994
49	0.988	0.989	0.977
50	0.995	0.999	0.994
51	1.000	1.001	1.001
52	1.017	0.996	1.013
53	0.983	1.004	0.987
54	1.005	1.014	1.019
55	1.000	1.514	1.514

4.3.2 The Technical Change ($\mathbf{T_i}$) from 2007 – 2010

The computed technical change ($\mathrm{T_i}$) is defined as any shift in the production frontier. Technical change is a change in technology index which affects the relationship between inputs and outputs. The results show that during the period of 2007/2008, there were 33 logistics companies that had the input technical improvement ($T_i < 1$), and among these 17 companies still improved their level of input technical change during the period of 2008/2009. In contrast, 13 companies had the deterioration of the input technical change during 2007/2008 and 11 companies from these 13 companies turned out to be the technical change improvement in the latter year (2008/2009). During the year 2008/2009, 30 logistics companies of the total 55 logistics companies improved their input technical change, while there were only 5 companies decreasing their technical change, and the rest of 20 companies remained their steady of input technical change. The results of the last period (2009/2010) present that 23 companies had the

evidence of improvement in the technical change but 19 companies exhibited the worsening of technical change. The remaining 13 companies retained their input technical change as same as the previous year.

The results aligned with the evidence of GDP growth as 5.0%, 2.5%, -2.3% and 7.8 from year 2007 to 2010 consecutively. During the economic recession, Thai logistics companies tried to improve their level of input technical change in order to confront with the world financial crisis. After the recession period, the companies seem to be more relax on their input technical change with the higher number of regress in the frontier technology.

4.3.3 The Malmquist Index of Logistics Companies from 2007-2010

The Malmquist index (M_i) indicates the change of productivity between period t and $t+1$. In this case, the productivity of a DMU improves, declines, and remains unchanged if M_i is less than 1, greater than 1, and equal to 1, respectively. The results of Malmquist index during 2007/2008 showed that there was an improvement on the productivity level of the 21 logistics companies. On the contrary, the productivity levels of 25 companies in the same period were declined and those of 11 companies were retained. The worse productivity in this period came from the deterioration of input technical efficiency in most cases.

During the period of 2008/2009, the Malmquist indices exhibited that 23 companies improved their productivity level and the productivity level of the same amount at 23 companies was declined. The rest of 9 companies had the same productivity level as the previous year. The reduction of the productivity level in this period was mostly from the regression of the input technical efficiency.

The Malmquist in the last period (2009/2010) presented that 23 logistics companies provided the regression productivity level and 17 logistics companies improved their productivity level. The main source of improvement came from the development of technical efficiency and technical change. Similarly, the main cause of regression were from the contribution of both input technical efficiency regression and the worsen input frontier technology. Finally, there were 15 companies which can maintain the productivity level as same as the previous year.

4.4 Conclusion

The evaluation of Thailand logistics companies in this study used the technique called Data Envelopment Analysis and Malmquist productivity index to estimate the efficiency scores of the logistics companies in Thailand. The financial data used as main inputs for the analysis comprised of the net value of lands, buildings and equipments, shareholder fund, operating cost, cost of sales and/or cost of service, and current liabilities, while profit and revenue were used as the input variables. The results from DEA model showed that even though the GDP growth in 2010 was 7.8%, the 22 logistics companies still operated below the efficient frontier line and there were 33 companies operating on the efficient frontier line. Among the inefficient companies, there was only one DMU operating under the decreasing returns to scale (DRS) and the rest of 21 companies operated with increasing returns to scale (IRS). The results for the input and output slacks suggested that some logistics companies could increase their profits with using the current level of inputs and some logistics companies could decrease reduce their inputs and still maintaining the level of their outputs.

The results of Malmquist index analysis showed the productivity change of the logistics companies during 2007 to 2010. This index can be decomposed into the ratio

of the input technical change and the input technical efficiency. The study of the input technical efficiency presented that the companies tended to put their effort to gain their efficiency during the hard time of economic recession while they were more relax during the economic growth. The productivity change can be improved by increasing collaboration between logistics company providers and their customers. Alliance among logistics company providers is also a way to improve efficiency of the industry as a whole.

This research contributions can be adopted by practitioners to assess present performance and find a suitable peer which it should follow to improve own technical and scale efficiency. This will build competence of its performance and as a whole of the industry. The limitation of the research is the inputs and outputs considered in the study which are based on financial results. The further study should include other factors covering several dimensions in the logistics business such as internal factors, investment, customer service, profitability and etc. Another limitation is the time duration of data which using four-year data. The results can be improved with longer period of the data.

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APPENDIX

		2010						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
1	CEVA Logistics (Thailand) Co., Ltd.	447089636.00	2828407585.00	361063084.00	442736953.00	426533324.00	2450616763.00	731892300.00
2	DHL Supply Chain (Thailand) Co., Ltd.	342758991.00	2846875573.00	630943770.00	628437099.00	523607240.00	2441655479.00	1602310041.00
3	DHL Distribution (Thailand) Co., Ltd.	341484314.00	1907888732.00	909507528.00	1204414507.00	323535826.00	1699818821.00	623498286.00
4	Thai Beverage Logistics Co., Ltd.	322101097.00	1464127114.00	1674535233.00	1453153051.00	303661195.00	1322557335.00	1063280126.00
5	Linfox M Logistics (Thailand) Co., Ltd.	313885806.00	638129566.00	287516216.00	530776795.00	318985678.00	587206738.00	298171797.00
6	United Thai Logistics Co., Ltd.	292887067.00	413154814.00	378519748.00	424740268.00	268172774.00	403772943.00	417807727.00
7	Via Logistics Co., Ltd.	262780641.00	525007730.00	406796210.00	378770145.00	281956065.00	478078501.00	336061704.00
8	Bangpakong Equipment Co., Ltd.	257126375.66	304642485.74	313633746.89	362966823.53	264792951.02	302299370.29	272298574.84
9	Logist Plus Co., Ltd.	256469395.62	318521557.13	251084600.70	261869807.15	260127826.68	300094947.82	258515473.22
10	YCH (Thailand) Co., Ltd.	255790995.00	536933803.00	271195463.00	384023167.00	289619213.00	494285934.00	357819078.00
11	Lucky Dragon Logistics Co., Ltd.	255330616.40	303389758.17	250118592.98	268726460.68	254848988.42	291990346.01	254302311.62

		2010						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
12	Universal Transport and Logistics Co., Ltd.	254732879.42	324362205.90	256571477.42	292918430.00	283961763.73	284204510.67	255121170.02
13	RCL Logistics Co., Ltd.	254592394.00	474174523.00	250840141.00	334384518.00	266550241.00	451767291.00	269375608.00
14	Venus Logistics Co., Ltd.	253190342.46	273640000.00	250000554.66	258339077.67	252295271.23	423955285.23	253306702.90
15	Siam Nippon Steel Logistics Co., Ltd.	253177734.90	332720690.41	252169285.74	265824572.77	272984982.67	307201279.25	267243881.18
16	Kawasaki Heavy Industry Ltd (Thailand)	252814657.00	262000000.00	250000000.00	867181408.00	254517510.00	255672001.00	250130617.00
17	Lucky Dragon Co., Ltd.	252737912.78	278491711.90	257014694.43	278162903.47	252759162.27	272971221.90	251505840.63
18	Golden World Intertrans Co., Ltd.	252326141.12	261187790.67	250405994.23	253750741.66	251802616.43	256982829.20	252890915.77
19	Trans Logistics Co., Ltd.	252266734.19	447331017.00	273221318.20	255875817.00	265151558.00	438966533.00	253721314.95
20	TBSC Logistics Co., Ltd.	252107609.00	354718359.00	267837732.00	275568834.00	263220022.00	338718687.00	258276288.00
21	TVS Logistics Siam Co., Ltd.	250516320.25	277797377.35	250252048.05	261370845.94	252764980.13	274243681.33	266517187.63
22	Trans Distributor Co., Ltd.	251866642.00	447331017.00	261155235.00	255875817.00	265151558.00	438966533.00	300612013.00
23	Seiwa Pioneer Logistics Co., Ltd.	251659086.86	342647828.88	267074254.36	251218608.03	260076011.23	329410317.92	256912828.65
24	Logistics One Co., Ltd.	251659086.86	266598585.45	251664269.98	258672185.63	255468988.82	259014933.98	251097435.49
25	Thai Logistics Expertise	251545298.63	268632440.31	251305163.66	255980070.60	250000000.00	260734570.28	252232817.16

		2010						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
	Co., Ltd.							
26	Cheetah Supply Chain Co., Ltd.	251370177.08	272261318.40	383193882.82	305818878.79	254178641.54	260753532.73	269588533.99
27	S.P. Logistics Management Co., Ltd.	251070831.51	265973522.95	250483906.89	256113144.79	254710194.90	260029262.73	250616604.20
28	Kong Supply Part., Ltd.	251067614.92	264599934.58	251253081.55	251952709.64	255116793.74	258399157.49	251187238.36
29	Triple I Logistics Management Co., Ltd.	250994759.99	360987439.73	255813274.17	255468266.87	276419513.94	333099376.13	276102142.27
30	Quality Logistics Co., Ltd.	250963034.95	265924203.93	253305712.16	249590233.34	252867669.43	262348989.50	262019584.32
31	FPS Logistics (Thailand) Co., Ltd.	250869859.66	401597275.93	251334937.17	270459988.26	280301301.77	370812551.54	275519723.86
32	General Merchandise Marketing Co., Ltd.	250399998.86	254050101.38	250046599.87	255379120.02	250916345.87	252584465.84	251006192.76
33	Siam Logistics Management Co., Ltd.	250312775.24	252227390.44	250142191.78	252315538.47	251864289.47	250000000.00	252892251.85
34	United Relocation (Thailand) Co., Ltd.	250183302.84	263079589.56	250168183.58	253454022.09	253392668.41	259468816.95	250090701.55
35	Alawee Engineering Co., Ltd.	250098070.45	261413923.59	250633248.50	251441405.48	251514837.68	259793896.46	250198779.15
36	Progressive Trading Co., Ltd.	250015294.80	250286700.00	250009474.99	250983251.91	250271424.20	250000000.00	250025663.04

		2010						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
37	South Siam Trading Co., Ltd.	250003143.51	250000000.00	250000916.77	250790061.64	250011350.12	250000000.00	250017000.00
38	South Land Inter Logistics Co., Ltd.	249985332.92	301314896.99	250093114.43	250777720.29	250691565.58	300637998.49	250031922.63
39	Trailer Trans Service Co., Ltd.	249960974.35	250000000.00	250000000.00	250958394.96	250043520.00	250000000.00	250067780.00
40	Saeng Prakai Service Co., Ltd.	249954569.95	250000000.00	250000000.00	250494944.05	250045453.50	250000000.00	250014630.00
41	M. P. Inter Progress Co., Ltd.	249836245.81	257978648.68	250102432.34	251401923.17	252598728.66	255332673.26	250947645.42
42	Welcome Logistics Service Co., Ltd.	249794137.26	250000000.00	250361755.72	250917915.10	250215286.20	250000000.00	250007000.00
43	Rungaroon Air and Sea Logistics Co., Ltd.	249747097.40	250000000.00	250447431.08	249325119.55	250252902.60	250000000.00	250905448.58
44	Kawaliar Global Logistics Co., Ltd.	249665489.65	253535457.97	250029484.95	249191914.73	252176045.16	251693946.86	250047958.07
45	Repower Asia Co., Ltd.	249517969.91	250229000.00	250091434.57	250095470.60	250506929.62	250204600.00	250171496.47
46	P and O Management Services (Thailand) Ltd.	249506858.00	250000000.00	250000004.00	250810468.00	250498380.00	250000000.00	250192102.00
47	Well Growth International Co., Ltd.	249359648.32	257589071.52	250156582.46	253585940.51	251696326.14	256526030.78	250073218.29

		2010						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
48	RBO Logistics Co., Ltd.	249205705.46	250600000.00	250036142.22	251330853.36	250859367.86	250539926.68	250045000.00
49	The Billenium Corporation Co., Ltd.	248925062.12	284483845.10	251729680.52	261273790.71	263498179.34	272053320.32	253319894.43
50	Logistics Mart Co., Ltd.	248140550.03	293952613.33	250233083.96	251101307.62	261378090.14	284784391.04	267205411.22
51	AQ Transport Co., Ltd.	247859650.31	459836490.55	252021649.40	268061747.75	250000000.00	445468671.88	256776084.40
52	Thai Somdej Logistics Co., Ltd.	246851251.75	283057735.23	251725774.69	247418945.19	258725890.92	274303243.86	266889182.33
53	Toll Warehouse (Thailand) Co., Ltd.	243301026.00	413971391.00	293286131.00	279580200.00	259509762.00	439002821.00	267205411.22
54	All Logistics Center Co., Ltd.	240145630.02	273486112.28	255010053.78	224301191.75	262533946.72	269715218.54	279362581.73
55	Wyncoast Logistics Co. Ltd.	132184659.00	250138521.00	250007104.00	38358555.00	266860985.00	257113185.00	465936805.00

		2009						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
1	CEVA Logistics (Thailand) Co., Ltd.	310652925.00	1973345793.00	378045949.00	245647317.00	404290165.00	1710538571.00	924861722.00
2	DHL Supply Chain (Thailand) Co., Ltd.	335307265.00	2573208588.00	672351671.00	535678108.00	471176698.00	2218702336.00	1666436561.00
3	DHL Distribution (Thailand) Co., Ltd.	337081440.00	1575817428.00	1029019622.00	1121213379.00	352924373.00	1337923694.00	721023017.00
4	Thai Beverage Logistics Co., Ltd.	303381719.00	706134022.00	1224704531.00	1381051954.00	310461133.00	605505783.00	432705825.00
5	Linfox M Logistics (Thailand) Co., Ltd.	302535935.00	673321289.00	322024385.00	466890989.00	328571163.00	617624478.00	300240558.00
6	United Thai Logistics Co., Ltd.	257139769.00	323086386.00	493826472.00	381853201.00	271678835.00	314924225.00	381077635.00
7	Via Logistics Co., Ltd.	246874898.00	399495110.00	418205837.00	365989504.00	275486848.00	373372365.00	300493114.00
8	Bangpakong Equipment Co., Ltd.	288574616.67	784716834.84	481897327.34	372778109.72	276154712.47	705446894.50	403659884.07
9	Logist Plus Co., Ltd.	255132549.67	310275824.92	250403204.57	258200411.53	269629455.25	283754578.10	257873509.17
10	YCH (Thailand) Co., Ltd.	273446330.00	473653407.00	262295107.00	378232172.00	276760019.00	425555677.00	294613956.00
11	Lucky Dragon Logistics Co., Ltd.	254634751.65	293788114.91	250220079.89	264554444.28	254095945.47	284163435.68	253395067.73
12	Universal Transport and Logistics Co., Ltd.	257041815.68	334524234.36	257952752.22	288185550.78	278794735.64	294644670.47	255699779.90

		2009						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
13	RCL Logistics Co., Ltd.	259343000.00	441140554.00	251792879.00	329792124.00	265253706.00	442973525.00	269727865.00
14	Venus Logistics Co., Ltd.	253797730.13	274360000.00	250205355.54	255148735.21	252297919.93	268297861.10	253332468.33
15	Siam Nippon Steel Logistics Co., Ltd.	250251348.26	290077640.86	253198673.67	262646837.87	270538297.73	289323821.35	251150754.37
16	Kawasaki Heavy Industry Ltd (Thailand)	247176592.00	261753646.00	250459111.00	864366751.00	258889720.00	255636321.00	253217824.00
17	Lucky Dragon Co., Ltd.	252479522.83	279312360.54	257456505.15	276044790.69	253927045.43	272808459.20	252037012.24
18	Golden World Intertrans Co., Ltd.	249961987.30	250000000.00	250000443.41	249424600.54	250038156.61	250000000.00	250003000.00
19	Trans Logistics Co., Ltd.	251443911.97	529732847.26	275184583.65	255162519.49	273047540.90	510916600.79	257324838.10
20	TBSC Logistics Co., Ltd.	254126570.00	345945100.00	265069538.00	273461225.00	261457238.00	328831420.00	257021061.00
21	TVS Logistics Siam Co., Ltd.	251937079.15	359856794.08	252016719.69	260854525.69	261286150.95	345676492.95	265357474.87
22	Trans Distributor Co., Ltd.	250484205.56	529732847.26	269323076.94	255162519.49	273047540.90	510916600.79	311618476.20
23	Seiwa Pioneer Logistics Co., Ltd.	251168538.92	312292456.40	274793118.33	249388321.44	259845288.26	316422572.74	255756503.04
24	Logistics One Co., Ltd.	251168538.92	265708739.34	252373998.43	257013098.77	257176811.69	257025429.26	253503641.05
25	Thai Logistics Expertise Co., Ltd.	250890357.85	261663851.98	251547895.02	254434771.97	250000000.00	255454958.70	251498232.88

		2009						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
26	Cheetah Supply Chain Co., Ltd.	252679721.02	268443976.00	385869222.66	289848701.71	253368129.68	256425482.37	264671738.09
27	S.P. Logistics Management Co., Ltd.	250944973.10	266431769.41	251693313.77	255042313.28	255140431.97	260276017.55	250219612.57
28	Kong Supply Part., Ltd.	248987426.12	250793695.33	251232897.29	250885094.72	251424297.20	250381972.01	250539167.51
29	Triple I Logistics Management Co., Ltd.	251083563.13	347932637.34	258171312.91	254473506.88	274787422.22	321733121.47	272133568.96
30	Quality Logistics Co., Ltd.	248027028.42	264646858.49	254042019.36	248627198.39	254010003.90	262640478.51	261992631.52
31	FPS Logistics (Thailand) Co., Ltd.	250870534.76	375752106.29	251331039.79	269590128.60	277688161.11	347779634.93	277131604.70
32	General Merchandise Marketing Co., Ltd.	250173998.72	254571645.67	250064586.41	254979121.16	251681156.07	252682835.06	251574624.49
33	Siam Logistics Management Co., Ltd.	250859173.62	254685969.71	250342191.78	252002763.23	253770735.42	250000000.00	251883945.71
34	United Relocation (Thailand) Co., Ltd.	250020986.00	258908351.22	250199478.48	251270719.25	252145889.68	256744094.93	250117008.05
35	Alawee Engineering Co., Ltd.	250068089.47	257872517.29	250084831.03	251343335.03	251158961.89	256633450.14	250102544.76
36	Progressive Trading Co., Ltd.	249972643.33	250222900.00	250003014.15	251012177.11	250250256.67	250000000.00	250024025.96

		2009						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
37	South Siam Trading Co., Ltd.	249901279.09	250209480.00	250006266.77	250786918.13	250056167.26	250254905.41	250017000.00
38	South Land Inter Logistics Co., Ltd.	249822956.09	262039063.23	250059003.60	250792387.37	250686454.88	261529652.26	250076373.04
39	Trailer Trans Service Co., Ltd.	249900309.77	250000000.00	250000000.00	250997420.61	250101146.08	250000000.00	250024260.00
40	Saeng Prakai Service Co., Ltd.	249934577.75	250000000.00	250000000.00	250540374.10	250066463.26	250000000.00	250014630.00
41	M. P. Inter Progress Co., Ltd.	249509470.47	255520989.37	250112054.35	251565677.36	252589225.66	253307934.84	250854674.40
42	Welcome Logistics Service Co., Ltd.	249794182.57	250000000.00	250570041.92	251123777.84	250215286.20	250000000.00	250007000.00
43	Rungaroon Air and Sea Logistics Co., Ltd.	249699743.74	250304153.51	250695833.68	249583522.15	250530438.57	250050777.07	250401344.94
44	Kawaliar Global Logistics Co., Ltd.	248645351.30	251382889.35	250034816.20	249526425.08	251710542.20	251026995.85	250056779.39
45	Repower Asia Co., Ltd.	249893933.34	250227500.00	250154296.65	250577500.69	250336389.62	250000000.00	250025639.33
46	P and O Management Services (Thailand) Ltd.	249604750.00	250000000.00	250000004.00	251303610.00	250401309.00	250000000.00	250171886.00
47	Well Growth International Co., Ltd.	250164454.79	257850267.49	250195857.94	254226292.19	250783587.61	256877289.87	250087254.20

		2009						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
48	RBO Logistics Co., Ltd.	249985966.63	250000000.00	250046119.99	248125147.90	250014033.37	250000000.00	250024910.00
49	The Billenium Corporation Co., Ltd.	253878027.56	286247315.13	251971292.09	262348728.59	265554623.75	265497829.56	252410845.98
50	Logistics Mart Co., Ltd.	250882786.88	294315681.22	250455248.67	252960757.59	254941423.24	289134327.14	257706824.64
51	AQ Transport Co., Ltd.	251720797.19	437593505.73	252068417.86	270202097.44	250000000.00	418474466.27	262003655.98
52	Thai Somdej Logistics Co., Ltd.	245847054.71	274086128.01	252519042.75	250567693.44	257088009.74	270664694.05	260552199.84
53	Toll Warehouse (Thailand) Co., Ltd.	244187703.00	446175360.00	309288956.00	286279174.00	269092154.00	456450226.00	257706824.64
54	All Logistics Center Co., Ltd.	239822481.81	269221885.40	257199446.00	234155561.73	261825848.72	267067498.24	265832303.00
55	Wyncoast Logistics Co. Ltd.	218812514.00	308345920.00	357639711.00	156173896.00	266372988.00	319917435.00	462876925.00

		2008						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
1	CEVA Logistics (Thailand) Co., Ltd.	302291203.00	2545665127.00	412018478.00	184994392.00	463860530.00	447247935.00	1021777188.00
2	DHL Supply Chain (Thailand) Co., Ltd.	310381996.00	2631131711.00	732170668.00	450370843.00	480996203.00	2306800028.00	1706559471.00
3	DHL Distribution (Thailand) Co., Ltd.	359280174.00	1542985650.00	977181979.00	1042415125.00	319719593.00	1350390869.00	537609462.00
4	Thai Beverage Logistics Co., Ltd.	288130105.00	710942340.00	458821678.00	577670235.00	295929149.00	652208129.00	291970990.00
5	Linfox M Logistics (Thailand) Co., Ltd.	264846621.00	668989414.00	349687065.00	414355054.00	360052490.00	623511260.00	308582188.00
6	United Thai Logistics Co., Ltd.	169332224.00	410715682.00	498771680.00	374713432.00	270150937.00	387846825.00	378459925.00
7	Via Logistics Co., Ltd.	247514889.00	447057598.00	432512388.00	369114606.00	340252085.00	358173742.00	300675367.00
8	Bangpakong Equipment Co., Ltd.	300720093.10	1078946141.38	481678254.82	339033493.05	279753204.33	977443069.01	425105625.31
9	Logist Plus Co., Ltd.	251825326.88	277924510.47	250398599.30	254967861.86	258325288.20	267241333.31	254544161.35
10	YCH (Thailand) Co., Ltd.	292683658.00	472912979.00	268230752.00	354785842.00	434709898.00	250000000.00	317099643.00
11	Lucky Dragon Logistics Co., Ltd.	254274531.18	289147320.17	250453264.71	260988292.63	252285474.58	281735321.18	252274850.66

		2008						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
12	Universal Transport and Logistics Co., Ltd.	255570467.41	330698419.02	257427789.49	281143735.10	283559568.38	289036716.01	253395532.89
13	RCL Logistics Co., Ltd.	263764558.00	464549650.00	252972897.00	320449124.00	274596444.00	420302231.00	265178726.00
14	Venus Logistics Co., Ltd.	253951824.90	274116014.58	252049935.17	251351005.08	252945251.22	266858424.36	253994310.89
15	Siam Nippon Steel Logistics Co., Ltd.	250177639.75	350460532.83	253053856.98	262395489.61	279331526.18	320000019.97	270772756.73
16	Kawasaki Heavy Industry Ltd (Thailand)	263444538.00	362770418.00	250851861.00	867190159.00	264598465.00	342040228.00	2409746453.00
17	Lucky Dragon Co., Ltd.	251454939.89	291520249.74	257599663.33	273928967.86	254683012.61	286014408.61	254246479.80
18	Golden World Intertrans Co., Ltd.	249681870.71	250000000.00	250009315.93	249462613.24	250318465.89	250000000.00	250006875.00
19	Trans Logistics Co., Ltd.	251979050.98	443181119.75	276927849.33	250678313.96	265851658.26	433889767.06	254165899.42
20	TBSC Logistics Co., Ltd.	253504194.00	345607353.00	266578869.00	269334655.00	260451066.00	330436793.00	257223347.00
21	TVS Logistics Siam Co., Ltd.	251245408.98	337772999.18	250426542.36	258917446.54	260836173.49	324885356.08	263018791.84
22	Trans Distributor Co., Ltd.	250303498.45	443181119.75	265304995.41	250678313.96	265851658.26	433889767.06	289843655.50
23	Seiwa Pioneer Logistics Co., Ltd.	251219677.47	330262165.47	285184544.56	264436776.54	263006768.61	330260537.25	257140205.57
24	Logistics One Co., Ltd.	251219677.47	263146526.56	252825265.02	255844559.85	255225561.28	256314682.15	251939877.95

		2008						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
25	Thai Logistics Expertise Co., Ltd.	250881668.72	262345094.26	250246929.96	253544414.12	254851795.43	256334400.73	251723328.80
26	Cheetah Supply Chain Co., Ltd.	251347442.49	259429976.00	357598906.14	271768980.69	251775855.73	254092617.61	267068625.41
27	S.P. Logistics Management Co., Ltd.	250986063.21	267467474.79	251091423.06	257847340.18	254602098.88	261793248.19	250183947.04
28	Kong Supply Part., Ltd.	250303382.82	256361229.44	251657441.90	251897668.60	252500397.37	253527786.63	250800031.41
29	Triple I Logistics Management Co., Ltd.	250625480.15	343201259.12	258076803.55	253389943.75	276778355.97	315793048.33	270693266.06
30	Quality Logistics Co., Ltd.	242578790.38	262683206.48	256137238.39	250600169.97	254801098.53	265307378.58	262193733.41
31	FPS Logistics (Thailand) Co., Ltd.	251926495.64	425400324.01	250422081.90	268719593.84	280077624.56	393375214.89	272340753.61
32	General Merchandise Marketing Co., Ltd.	247174861.32	253659122.12	250028398.82	254805122.44	255636264.42	250704000.00	251888757.45
33	Siam Logistics Management Co., Ltd.	249640654.06	250840000.00	250542191.78	251143589.61	251199400.63	250000000.00	250320626.18
34	United Relocation (Thailand) Co., Ltd.	250367056.72	257511315.55	250223289.32	251249733.25	253033253.42	254930312.40	251133067.29
35	Alawee Engineering Co., Ltd.	250068600.79	259822405.95	250153624.71	251275245.56	251374406.71	258367292.43	250153579.21

		2008						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
36	Progressive Trading Co., Ltd.	250100770.81	250381500.00	250002196.78	250995313.78	250280729.19	250000000.00	250025047.51
37	South Siam Trading Co., Ltd.	249881361.59	250000000.00	250025229.75	250885639.04	250119862.45	250000000.00	250064074.08
38	South Land Inter Logistics Co., Ltd.	250209732.34	251239965.37	250040422.97	250955698.20	250511890.26	250510239.05	250066509.59
39	Trailer Trans Service Co., Ltd.	250193560.17	252810542.68	250000000.00	251259100.73	250560699.85	252027475.91	250010000.00
40	Saeng Prakai Service Co., Ltd.	249489698.25	250000000.00	250000000.00	250605796.35	250520628.84	250000000.00	250006094.00
41	M. P. Inter Progress Co., Ltd.	250734967.56	256660684.37	250116499.67	252056206.89	251649673.65	254159122.46	250592625.34
42	Welcome Logistics Service Co., Ltd.	249188164.33	250000000.00	250778328.12	251329595.27	250815826.09	250000000.00	250127110.00
43	Rungaroon Air and Sea Logistics Co., Ltd.	249720918.93	250244854.48	250934156.04	249883778.41	250422355.93	250094913.48	250145620.63
44	Kawaliar Global Logistics Co., Ltd.	249192516.76	250000000.00	250000000.00	249881073.78	250807483.24	250000000.00	250121000.00
45	Repower Asia Co., Ltd.	249382849.39	250707959.06	250223733.45	250683567.35	251000140.25	250322658.43	250012221.28
46	P and O Management Services (Thailand) Ltd.	249498848.00	250000000.00	250000004.00	251698860.00	250574611.00	250000000.00	250115827.00

		2008						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
47	Well Growth International Co., Ltd.	250167362.01	255871358.06	250215904.63	254061837.40	250642136.09	255871358.06	250060321.30
48	RBO Logistics Co., Ltd.	249913855.80	250013000.00	250056167.69	248139181.27	250087905.83	250011241.42	250021910.00
49	The Billenium Corporation Co., Ltd.	253557541.79	296455650.29	252479966.81	258470701.03	262204451.94	279517643.92	255061218.11
50	Logistics Mart Co., Ltd.	257211118.69	307592421.76	250759203.66	252077970.71	260700421.73	288976936.35	258085189.69
51	AQ Transport Co., Ltd.	252164250.57	440113316.30	251135660.92	268481300.25	260416951.31	427029520.44	258947248.13
52	Thai Somdej Logistics Co., Ltd.	253872328.46	285970749.65	253273713.93	254720638.73	256337626.65	274383886.71	259805377.82
53	Toll Warehouse (Thailand) Co., Ltd.	258923262.00	486717251.00	332435759.00	349379321.00	260428976.00	485328633.00	258085189.69
54	All Logistics Center Co., Ltd.	141925597.73	266126452.16	255981840.57	244333079.92	262556977.61	264092825.43	257426757.81
55	Wyncoast Logistics Co. Ltd.	204840960.00	354625009.00	370770012.00	187361382.00	266019784.00	377577210.00	445750870.00

		2007						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
1	CEVA Logistics (Thailand) Co., Ltd.	286358484.00	2394729409.00	456987710.00	132703189.00	465672416.00	2084683241.00	1150611077.00
2	DHL Supply Chain (Thailand) Co., Ltd.	238464615.00	2245436969.00	725879135.00	389988847.00	462900300.00	2043065189.00	1571972429.00
3	DHL Distribution (Thailand) Co., Ltd.	342144171.00	1245850492.00	850784030.00	941418137.00	332570392.00	1120679808.00	513573190.00
4	Thai Beverage Logistics Co., Ltd.	322436810.00	788243963.00	251575165.00	289540130.00	353021705.00	676936261.00	374172997.00
5	Linfox M Logistics (Thailand) Co., Ltd.	277127099.00	611471223.00	360518845.00	399508433.00	334198506.00	564572236.00	300737521.00
6	United Thai Logistics Co., Ltd.	253199548.00	434198014.00	530504811.00	458302817.00	267614124.00	402890226.00	305388955.00
7	Via Logistics Co., Ltd.	239382575.00	331052330.00	351067942.00	328768097.00	309710883.00	279674748.00	294995595.00
8	Bangpakong Equipment Co., Ltd.	265659828.12	502414079.16	459677599.35	288313399.95	263684995.03	466925036.21	350037008.78
9	Logist Plus Co., Ltd.	250793088.41	254979583.00	250005621.20	251142534.98	251674038.70	252541151.00	251298979.18
10	YCH (Thailand) Co., Ltd.	289157772.00	438524051.00	273657193.00	340777184.00	409512603.00	250000000.00	347226135.00
11	Lucky Dragon Logistics Co., Ltd.	253625020.42	284652247.37	250636576.14	258526261.45	251854088.08	278326594.74	251913452.03
12	Universal Transport and Logistics Co., Ltd.	256276827.12	329750486.85	257398105.07	275573267.69	280558222.19	290883923.25	255700910.26

		2007						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
13	RCL Logistics Co., Ltd.	262344260.00	414935701.00	254170522.00	306684566.00	270734973.00	262768986.00	272284986.00
14	Venus Logistics Co., Ltd.	263589366.45	291092639.29	254523248.24	247399180.18	271487810.99	254539792.30	267723182.61
15	Siam Nippon Steel Logistics Co., Ltd.	250191285.59	382509118.77	254094126.52	262217849.86	288099089.89	336638740.71	282067342.94
16	Kawasaki Heavy Industry Ltd (Thailand)	427121203.00	1381518435.00	251223935.00	853745621.00	263004578.00	1163281714.00	2431961628.00
17	Lucky Dragon Co., Ltd.	256600280.68	312794141.23	259140090.50	275774027.97	256157899.10	298712084.16	253451913.62
18	Golden World Intertrans Co., Ltd.	249676992.21	250467728.97	250011568.59	249780742.53	250370452.79	250000000.00	250011634.73
19	Trans Logistics Co., Ltd.	253677089.71	440637001.60	257254149.49	250374815.51	264233621.22	432408948.45	253418352.31
20	TBSC Logistics Co., Ltd.	251643782.00	344226772.00	260791262.00	265830461.00	259447004.00	332499955.00	255543374.00
21	TVS Logistics Siam Co., Ltd.	252392811.00	387110345.00	250638019.58	257672037.56	260610004.39	374416036.89	265939898.41
22	Trans Distributor Co., Ltd.	248434336.51	440637001.60	266866264.87	250374815.51	264233621.11	432408948.45	298761996.25
23	Seiwa Pioneer Logistics Co., Ltd.	249624882.38	314383499.51	292034747.34	278567499.59	262678576.28	322177033.75	258690239.12
24	Logistics One Co., Ltd.	249624882.38	253322681.93	251696881.01	254624882.38	251527803.50	252170996.89	251254072.69
25	Thai Logistics Expertise Co., Ltd.	251272344.73	267033406.06	250228835.95	252662745.40	253936112.08	261496662.71	254340234.11

		2007						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
26	Cheetah Supply Chain Co., Ltd.	250421538.20	252339994.00	314215950.50	255421538.20	250316423.83	251381558.11	308961816.64
27	S.P. Logistics Management Co., Ltd.	250921826.40	267839338.04	254431927.13	256861276.97	254283199.33	262369709.67	251057946.76
28	Kong Supply Part., Ltd.	250436994.26	259220390.03	252081987.36	251594285.78	252245509.83	256455206.85	254742363.78
29	Triple I Logistics Management Co., Ltd.	250500242.30	323980907.62	257420637.62	252764463.60	275479521.56	296983919.54	264309501.30
30	Quality Logistics Co., Ltd.	248517066.37	270294752.96	256709727.80	258021379.59	254580838.11	267289195.03	253507559.76
31	FPS Logistics (Thailand) Co., Ltd.	252715702.95	446891974.57	250635874.69	269508801.15	280240209.40	412200830.07	289673033.84
32	General Merchandise Marketing Co., Ltd.	250956731.13	255824167.28	250118304.80	256630261.12	251273044.88	253400000.00	251770099.58
33	Siam Logistics Management Co., Ltd.	249747117.28	250000000.00	250742191.78	250502935.55	250012082.72	250000000.00	250020000.00
34	United Relocation (Thailand) Co., Ltd.	246167899.97	250083307.45	250111727.48	251616789.97	250414919.48	250052150.00	250031165.25
35	Alawee Engineering Co., Ltd.	250065725.84	258193099.20	250268628.32	251206644.77	251152837.06	256962937.62	250166506.86
36	Progressive Trading Co., Ltd.	250169874.99	250443400.00	250000248.32	250894542.97	250242983.03	250000000.00	250040711.26

		2007						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
37	South Siam Trading Co., Ltd.	249862232.02	250000000.00	250084392.20	251004277.45	250139233.80	250000000.00	250064074.08
38	South Land Inter Logistics Co., Ltd.	250028544.10	250469914.13	250058991.19	250737864.90	250433269.07	250000000.00	250063531.87
39	Trailer Trans Service Co., Ltd.	252565540.56	277450204.26	250001994.52	253065540.56	253950403.89	270195985.48	251013505.29
40	Saeng Prakai Service Co., Ltd.	249995662.04	264737462.96	250000000.00	251316098.10	250329713.81	261435803.08	250015000.00
41	M. P. Inter Progress Co., Ltd.	250391959.31	256497310.56	250112460.99	251321239.33	251374765.98	254658263.76	250568441.48
42	Welcome Logistics Service Co., Ltd.	249641430.94	250000000.00	250986614.32	252141430.94	250358569.06	250000000.00	250121893.98
43	Rungaroon Air and Sea Logistics Co., Ltd.	249713513.43	250307936.90	250406420.51	250162859.48	250354400.28	250240038.94	250111588.60
44	Kawaliar Global Logistics Co., Ltd.	249688557.02	250000000.00	250000000.00	250188557.02	250311442.98	250000000.00	250010830.00
45	Repower Asia Co., Ltd.	250379098.03	252179298.76	250293170.23	251300717.96	251370300.79	250430705.06	250049676.49
46	P and O Management Services (Thailand) Ltd.	255450429.00	264033471.00	250000004.00	266344000.00	256941313.00	250000000.00	253986889.00
47	Well Growth International Co., Ltd.	250456872.91	261206626.87	250039558.78	253894475.39	250773953.31	259872457.78	250071779.90

		2007						
		Profit	Revenue	Net value of lands, buildings and equipment	Shareholder fund	Operating cost	Selling and administrative expenditures	Current liabilities
48	RBO Logistics Co., Ltd.	249957236.90	250462940.00	250066217.39	248225325.47	250101330.27	250403268.57	250017029.26
49	The Billenium Corporation Co., Ltd.	253913159.24	277954554.12	250849228.97	254913159.24	257563247.32	265140593.04	254077430.60
50	Logistics Mart Co., Ltd.	249733966.29	298657173.31	251030221.92	244866852.02	258394917.11	289990172.61	276603476.47
51	AQ Transport Co., Ltd.	250580838.33	457322342.27	253343456.06	266317049.68	271599502.79	434785776.74	270288966.55
52	Thai Somdej Logistics Co., Ltd.	249539110.83	265931236.79	252139268.04	250848310.27	252455583.41	264828323.94	257874137.97
53	Toll Warehouse (Thailand) Co., Ltd.	254783181.00	375665262.00	338346095.00	340456059.00	255784008.00	368614905.00	276603476.47
54	All Logistics Center Co., Ltd.	245140482.19	253347759.78	254958953.86	250140482.19	252678145.57	255526480.05	252487044.19
55	Wyncoast Logistics Co. Ltd.	164923654.66	332679287.57	380022846.04	232520421.60	261561995.20	404677382.49	428463997.86

BIBIOGRAPHY

Name	Watcharavee Chandraprakaikul
Education	Eng.D. (Manufacturing Global Supply Chains), Cranfield University, UK
	M.Sc. (Engineering Business Management), Warwick University, UK
	M.Eng. (Engineering Management), Chulalongkorn University
	B.Eng. (Civil Engineering), Kasetsart University
Contact	Department of Logistics Engineering, School of Engineering
	University of the Thai Chamber of Commerce
Telephone	02-697-6726