Technical efficiency analysis for commercial Black Tiger Prawn (*Penaeus monodon*) aquaculture farms in Nha Trang city, Vietnam

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Cover pictures

Shrimp ponds, Nha Trang, Vietnam. (Photo: L. Lebel, Ambio 31(4): 311-323)

Abstract

This study has used minimizing input-oriented CRS DEA model with two output and five input variables which use theory of technical efficiency. It mainly has used Nha Trang's data (64 samples) to analysis, data from other areas in Khanh Hoa province (33 samples in Ninh Hoa district, 33 samples in Van Ninh district, and 36 samples in Cam Ranh district) only use to compare to Nha Trang to find the worst factors for technical efficiency, improving these factors in section conclusion. All these data was collected from data primary of Ph.D Pham Xuan Thuy when he did Ph.D thesis which he inquired in Khanh Hoa province in 2004

There are 25% performances of Black Tiger Prawn (*Penaeus monodon*) DMUo is efficient and 75% performances of DMUo are inefficient in Nha Trang city. We can put to conduct for each of the inefficient. These are the units that management would focus on to improve input factors or resource reduction.

Camparing among Cam Ranh, Nha Trang city, Van Ninh district, Ninh Hoa district the propotion percent of Black Tiger Prawn (*Penaeus monodon*) *DMUo* technical efficient of Cam Ranh is 42% due to georgapical advandtage. The propotion percent of *DMUo* efficient of Nha Trang and Ninh Hoa is lowest because of nearly populated area and processing factories.

Key words: technical efficiency

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1 CHAPTER 1: INTRODUCTION

Viet Nam map (Source: photo from Ambio 31(4): 311-323)

Vietnam has a great potential for aquaculture development. There are 3,260 km of coastline, 12 lagoons, straits and bays, 112 estuaries, canals and thousands of small and big islands scattered along the coast. In the land, an interlacing network of rivers, canals, irrigation and hydroelectric reservoirs has created a great potential of water surface with an area of about 1,700,000 ha. (Ronald D. Zweig, et al, 2005.)

If we compared with the world, the growth speed of Viet Nam fishery increases rapidly, specially, the growth speed of aquaculture area, the production and value.

According to statistic data, the aquaculture production of Vietnam in 2006 was 1,694.2 tons, increased 1.68 times compared with 1,003.1 tons in 2003, reach the average growth speed with 19%/year, higher than 7 times compared to the average growth speed with 2.7%/year of capture production. As can you seen in table 1-1.

According to statistic data, the aquaculture area of Vietnam in 2006 was 984.4 thousand hectares, reported to increase 1.13 times compared to 2003 (867.6 thousand hectares). In which, shrimp culture is higher than 50 percents of total aquaculture area. As can you seen in table 1-2

Table 1-1: Total fisheries production of Viet Nam from 2003 – 2006

(Unit: 1000 tons)

Norm/Year	**2003**	**2004**	**2005**	**2006**
Capture production	1,856.1	1,940.0	1,987.9	2,001.7
Aquaculture production	1,003.1	1,202.5	1,478.0	1,694.2
- In which: Black Tiger Prawn (Penaeus monodon) production	237.880	281.816	327.194	354.610
Total fisheries production	2,859.2	3,142.5	3,465.9	3,695.9
The proportion of aquaculture production (%)	35.1%	38.3%	42.6%	45.8%

(Hoang Thu Thuy, [2008], Khanh Hoa –Viet Nam)

Table 1-2: Aquaculture area of Vietnam from 2003 to 2006

Norm/ Year	**2003**		**2004**		**2005**		**2006**	
	Area (ha)	**Ratio (%)**	**Area (ha)**	**Ratio (%)**	**Area (ha)**	**Ratio (%)**	**Area (ha)**	**Ratio (%)**
TOTAL	**867.6**	**100.0**	**920.1**	**100.0**	**952.6**	**100.0**	**984.4**	**100.0**
Fish culture	259.0	29.9	278.6	30.3	291.8	30.6	311.4	31.6
Shrimp culture	580.4	66.9	604.4	65.7	533.2	56	536.4	54.5
Culture of other species	25.5	2.9	33.8	3.7	123.8	13	132.9	13.5
Speed producing	2.7	0.3	3.3	0.4	3.9	0.4	3.7	0.4

(Source:Viet Nam General Statistics Office,2007)

According to statistic data, although the proportion of shrimp production from 2003 to 2006 was 22.3 % in comparision with total aquaculture production, but its value was 48.5% as compared to total export value of fishery products. As can you seen in table 1-3.

Table 1-3: The proportion of export value of shrimp products from Viet Nam period 2003 - 2006

(Unit: 1000 USD)

Norm/ Year	**2003**	**2004**	**2005**	**2006**
Export value of fishery products	2,199,577	2,400,781	2,736,865	3,357,959
Export value of shrimp products	1,058,579	1,272,331	1,364,716	1,466,460
The proportion of export value of shrimp products (%)	48.13	53.00	49.86	43.67

(Hoang Thu Thuy, [2008], Khanh Hoa -VietNam)

Khanh Hoa map

(Source: Khanh Hoa department of Culture, Sport and Tourism)

Khanh Hoa province area is 5,197 km² (2007). The provincial coastline spreads 385 km featuring numerous creek mouths, lagoons, river mouths, and hundreds of islands and islets from Đại Lãnh Commune to the end of Cam Ranh Bay. There are notably the four bays Vân Phong Bay, Nha Phu Bay, Nha Trang Bay and Cam Ranh Bay. (en.wikipedia, 2007) [1]. Northern and northeastern border of Khanh Hoa province is contiguous to Phu Yen province, the western borders with Dak Lak province, the southern border with Ninh Thuan Province and the eastern borders with South China Sea. Coastal Khanh Hoa is more than 5000 hectares of land and alluvial

[1] http://en.wikipedia.org/wiki/Khanh_Hoa_Province#Geography_and_climate (11/2007)

ground which gets salty and the natural conditions are suitable for the development of commercial shrimp aquaculture. (Hoang Thu Thuy, [2008], Khanh Hoa -VietNam).

Climate factors, including indicators of temperature, humidity, rainfall are important, have great influence to the development of shrimp, especially temperature. In Khanh Hoa, the highest air temperature in Nha Trang is 37 degrees C, in Cam Ranh is 39.3 degrees C; the lowest air temperature from 23 to 26 degrees C on July to January yearly, and the amplitude of a fluctuation is not great (Hoang Thu Thuy, [2008], Khanh Hoa -VietNam). The Black Tiger Prawn (*Penaeus monodon*) develops well in environmental temperature from 25 to 30 degrees C. If the temperature around 30 degrees C, shrimp grow up quickly, if the temperature is less than 25 degrees C, the shrimp take the bait slowly (Pham Xuan Thuy, [2004], Khanh Hoa -VietNam). So the temperature in Khanh Hoa is in accordance with the shrimp

The pH of Khanh Hoa sea ranges from 7.2 - 8 (pH of the water environment from 7-9 will be suitable for shrimp growing). Every month has 15 days with high tide from 1.5 - 2m and it is appropriate to get the water and drop water of the pond (Hoang Thu Thuy, [2008], Khanh Hoa -VietNam)

In summary, the geographic location in Khanh Hoa is strong advantage for shrimp aquaculture. This is where the climate is fairly, environmental conditions are stable year-round and suitable for aquaculture in general and the Black Tiger Prawn (*Penaeus monodon*) aquaculture in particular. Coastal terrain and hydrographic conditions are in accordance with ecology of shrimp and other seafood species. However, it should also concern about the disadvantageous climate points in the shrimp aquaculture, which is the distribution of rainfall is not steady during the year. Furthermore, reserves of underground water in Khanh Hoa are not large; it only gets the ability to exploit and supply for the living and scale production in coastal areas. This is limited to the ability to expand the area of the shrimp aquaculture. (Hoang Thu Thuy, [2008], Khanh Hoa - VietNam)

Table 1-4: Total production, area and productivity of commercial Black Tiger Prawn in Khanh Hoa period 1999-2002

Norms/year	1999	2000	2001	2002
Shrimp aquaculture area (ha)	4526	4863	4957	5320
Total shrimp production (tons)	3716	7400	7452	6275
The shrimp productivity (tons/ha)	830	1520	1490	1180

(Pham Xuan Thuy, [2004], Khanh Hoa -VietNam)

As can you seen in table 1-4, if in 1999, the area of the shrimp was just the 4526 ha, to 2002, the area of the shrimp was 5,320 ha. Similarly, if the total production of shrimp in 1999 was 3,716 tons, to the 2002, the total production of shrimp was 6,275 tons. However, the productivity has started the decline and it is the necessary attention to rising as well as managers.

The Khanh Hoa objective to 2010 for shrimp is 5,456.6 ha area, 15,874 tons production, more than 50 billions USD value. (Khanh Hoa Statistis Office, 2007)

Source: photo from

Khanh Hoa department of Culture, Sport and Tourism

Nha Trang city is the capital of Khanh Hoa province with 251 km² area and 500,000 populations (as of 2007). The north of Nha Trang city borders on Ninh Hoa district, the south borders on Cam Ranh district, and the east borders on East Sea. The city is located on a beautiful bay, the Nha Trang Bay, which is chosen as one of 29 most beautiful bays in the world by Travel and Leisure in two succeeding years. Nha Trang is surrounded on all three sides by mountains and a large island on the fourth side (in the ocean directly in front of the city's main area) that blocks major storms from potentially damaging the city. (en.wikipedia, 2007)[2]

Nha Trang has the many advantages where concentrated in the top offices in the field of technical scientific research of aquaculture, in which Research Institute for Aquacultre No 3, Nha Trang university, Institute of oceanography. Closely relationship between Khanh Hoa Fisheries (now the Khanh Hoa Department of Agriculture and Rural Development) and these offices solved almost problems exist and needs in aquaculture general and the Black Tiger Prawn (*Penaeus monodon*) aquaculture in particular. Some specific topics in this field last time as a primarily research on diseases of the Black Tiger Prawn (*Penaeus monodon*) area by the University of Nha Trang; survey the change of base bottom in shrimp ponds in Phuoc Hai, Nha Trang, proposed methods to improve pond by Institute of Oceanography Nha Trang; techniques and technology research of the seed Black Tiger Prawn (*Penaeus monodon*) production by the Research Institute for Aquaculture 3

Shrimp aquculture in Nha Trang began from 1985. Three research offices in Nha Trang: Fisheries university (Nha Trang University now), Research Institute for Aquacultre No 3, Institute of oceanography helped to produce breed white shrimp. The Black Tiger Prawn (*Penaeus monodon*) aquaculture began from the begin of the 1990s and developed during from 1995 – 2003. Its average productivity is 1.5 tons/ha. However, some households reach 8 – 10 tons/ha. (Baokhanhhoa, 2008)[3]

Table 1-5: The total yield of commercial shrimp in Nha Trang city period 2000-2003

Unit: tons

Norms/year	2000	2001	2002	2003
Total yield (tons)	738	975	994	1,076

(Source: Khanh Hoa Statistics Office, 2003)

[2] http://en.wikipedia.org/wiki/Nha_Trang#Geography

[3] http://www.baokhanhhoa.com.vn/Phongsu/2008/08/289261/)

Natural, economic, social conditions of Khanh Hoa province in general and Nha Trang city in particular show that there are many advantages and opportunities to develop the fishery in general and the commercial Black Tiger Prawn (*Penaeus monodon*) aquaculture. Besides, it also set many difficulties and challenges which need to overcome to improve the economic efficiency of commercial Black Tiger Prawn (*Penaeus monodon*) aquaculture farms in the city of Nha Trang, Khanh Hoa.

Look at table 1-4, we see the output of the commercial shrimp increased. Besides, the rapidly development of the commercial shrimp farms in Khanh Hoa province in general and Nha Trang city in particular will arise the problem should be solved, especially, environmental issues in recent times. Shrimp aquaculture farms have been built in a non-spontaneous, plan out of the locally government, hence, it leads to environmental pollution in local and effect to the quality and productivity of commercial shrimp aquaculture. The shrimp farms have been built incorrectly quality, so waste water from shrimp ponds flows through drains and flows directly to the sea. Issues from environmental pollution have lead to disease in the commercial shrimp ponds.

The effectiveness management of inputs is a cause which effect to shrimp production. From the above, learning to technical efficiency analysis for commercial Black Tiger Prawn (*Penaeus monodon*) aquaculture farms in Nha Trang city, Vietnam is necessary to use of the inputs as well and to develop sustainable shrimp aquaculture.

Multi-input technical factors: Pond area (square meters), Labor (persons), Machines, equipment (things), and pond depth (meters), Activities cost (Vietnam dong million) effect to the commercial Black Tiger Prawn (*Penaeus monodon*) yield (Pham Xuan Thuy, [2004], Khanh Hoa – Viet Nam). Hence, of equal importance is the determination of factors affecting inefficiency of each pond in Nha Trang city. These informations may guide the producers in formulating compatible policies to reach the goal of efficiency for their pond. This issue is needed to study.

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1.1 Statement of the problem

Studying efficiency generally involves two main methodological problems:

- Showing list of the performance of *DMUo is* efficient and inefficient. Since then shows that effective each pond should reduce sources of inputs in how many.

- Establishing a reference norm, or benchmark, consisting of the most efficient production units or processing technologies

- Defining the efficiency measures or some type of distance measure, between the inefficient units and the efficient reference set.

- Comparing technical efficiency between Nha Trang area and other areas in Khanh Hoa provinces (Cam Ranh district, Ninh Hoa district, Van Ninh district) to find the wors factors for the technical efficiency, improving the bad factors

1.2 Restriction and limitation of the thesis

- Method

In this study, i have calculated technical efficiency as the potential reduction of inputs without reducing the pond' outputs, and the calculation of efficiency is therefore input oriented. Only constant returns to scale have been used, variable returns to scale is not allowed. The method is minimizing input – oriented Constant Returns to Scale Data Envelopment Analysis (DEA). Because it is the first time DEA model has applied, my discussion about DEA begins with a description of the input – orientated CRS model

- Data

No consider form of Black Tiger Prawn (*Penaeus monodon*) aquaculture because the econometric data about form of shrimp aquaculture is not complete. Besides, there are not strictly divided among the two most common cultivation methods are semi-intensive and intensive farming

Data is collected from data of Ph.D Pham Xuan Thuy when he did his thesis in 2004 in Nha Trang University, Viet Nam. His Dr. Thesis was"Xây dựng mô hình nuôi tôm thâm canh tại Khánh Hòa (Building a model of intensive shrimp aquaculture in Khanh Hoa province). He shows that multi-input technical factors: Pond area (square meters), Labor (persons), Machines, equipment (things), and pond depth (meters), Activities cost (Vietnam dong million) effect to the commercial Black Tiger Prawn (*Penaeus monodon*) yield and the productivity (Pham Xuan Thuy, [2004], Khanh Hoa – Viet Nam).

Inherit from these results; the authors have researched "Technical efficiency analysis for commercial Black Tiger Prawn (*Penaeus monodon*) aquaculture farms in Nha Trang city, Vietnam". The method between Pham Xuan Thuy and author is completely different because Pham Xuan Thuy used the parameter method; the authors use the non-parameter method. It is the first time, DEA methods is researched Khanh Hoa provience in general and Nha Trang city in particular.

1.3 Structure of thesis

Following the introduction in Chapter 1, Chapter 2 introduces the theory of thecnical efficiency with input- oriented CRS DEA. Data of this research is presented in Chapter 3. The chapter 4 presents the results from data analysis by minimizing input oriented CRS DEA measures. The chapter 5 discusses issues related to the results, conclusion and suggestions for future research.

2 CHAPTER 2: THEORY OF TECHNICAL EFFICIENCY

Methods to estimate frontier functions started with the seminal work of Farrell (1957). The basic theory is indeed based on much earlier distance funtions developed by shaphard (1953, 1970). Extract information from extreme observations in a body of data to determine the best production practice is the common feature of these approaches. They can be generally categorized into parametric and non parametric. The parametric approaches production is treated as a random variable due to the existence of exogenous factors. These factors affect stochastically the relationship between inputs and outputs and lead to the estimation of stochastic frontiers which give the expected value of output conditional upon the level of input use. According to Charnes, Cooper and Rhodes, 1978; Banker, Charnes, and Rhode, 1984, the non parametric approaches (Data Envelopment Analysis) rely on linear programming techniques and lead to piece-wise linear deterministic frontiers. They do not impose functional forms and thus are less prone to misspecification. Technologies with multiple inputs and multiple outputs can be easily handled. They do not take into account stochasticity and hence are not subsequently subject to the problems of assuming an underlying distribution about the error term. *(Panos Fousekis, et al, 2003)*

Depend on the specific problem at hand and the underlying data generating process (DGP) to choice between the methods. The DEA yields are sitable to estimates TE only when the DGP is characterized as a full-frontier deterministic production model. On the other hand, the TE estimates of the DEA are negatively biased. This is due to the envelopment feature of DEA, where the largest random frontier shock in the data determines the production frontier estimate (Sengupta, 1985). Moreover, this bias carries over to the average efficiency estimators which may be obtained by bootstrapping and does not vanish with increased sample size (Lothgren, 2000). The stochastic frontier approach (SFA) appears to be more appropriate for economic sectors where stochasticity is an important element of production (e.g. agriculture and fisheries) [4] *(Panos Fousekis, et al, 2003)*

In this restriction thesis, the writer use DEA method to estimate technical effiency. Hence, the next section will present the constant return to scale DEA model.

The constant Return to scale DEA model[5]

This section introduce the basic DEA model, which assumed a constant returns to scale (CRS) technology

The use of linear programming methods is involved by DEA to construct a non parametric piece – wise surface (or frontier) over the data. Fare, Grosskopf and Lovell (1985, 1994), Charnes et al (1995), Seiford (1996), Cooper, Seiford and Tone (2000) and Thanassoulis (2001) calculated efficiency measures. (Tomothy J.Coelli, et al, 2005)

Farrell (1957) proposed the piece – wise – linear convex hull approach to frontier estimation which was considered by only a few authorsin the two decades following his paper. Mathematical programming methods that could achieve the task are suggested by Boles (1996), Shephard (1970) and Afriat (1972). It did not receive wide attention until the paper by Charnes, Cooper and Rhodes (1978) that it is the first time it has used data envelopment analysis (DEA). Since then DEA methodology has been appeared by a large number of papers which which have extended and applied it. (Tomothy J.Coelli, et al, 2005)

A model that had an input orientation and assumed constant return to scale (CRS) is proposed by Charnes, Cooper and Rhodes (1978). Subsequent papers have considered

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[4] This theoretically reference is from “Technical efficiency in the inshore fishery of Greece” of Panos Fousekis and Stathis Klonaris, 2003

[5] This theoretically reference is from "An introduction to efficiency and productivity analysis, second edition" of Tomothy J. Coelli, DS Christopher J. Prasada Rao O'Donnell and George E. Battese, 2005

alternative sets of assumption in variable returns to scale (VRS) models, which Fare, Grosskopf and Logan (1983) and Banker, Charnes and Cooper (1984) proposed. Our discussion of DEA begins with a description of the input – orientated CRS model (Tomothy J.Coelli, et al, 2005)

Each of I firms has the data on on N inputs and M outputs. The column vectors x_i and q_i respectively represented these for the *i-th* firm. The data for all I firms is represented with the NxI input matrix, X, and the MxI output matrix, Q (Tomothy J.Coelli, et al, 2005)

The ratio form is an intuitive way to introduce DEA. We would get a measure of the ratio of all outputs over all input such as $u'q_i/v'x_i$ where **v** is an Nx1 vector of input weight and u is an Mx1 vector of output weight. Solving the mathematical programming problem obtained the optimal weights.

$$\begin{aligned} &\max_{u,v}(u'q_i / v'x_i) \\ &st \quad u'q_j / v'x_j \le 1, \qquad j = 1,2,...,I \quad (2.1) \\ &\quad u,v \ge 0 \end{aligned}$$

This involves finding valuves for u and v subjected to the constraints that all effciency measures must be less than or equal to one. That the eficiency measure for the i – th firm is maximised. This particular ratio formulation has one problem is that has an infinite number of solutions. To avoid this, we can impose the constraint $v'x_i = 1$, which provides:

$$\begin{aligned} &\max_{\mu,v} \ (\mu' q_i), \\ &st \qquad v'x_i = 1, \\ &\mu' q_j - v'x_j \le 0, \qquad j = 1,2,....,I, \qquad (2.2) \\ &\mu, v \ge 0 \end{aligned}$$

where the change of notation form u and v to μ and **v** is used to stress that is a different linear programming problem. The multiplier form is the form of the DEA model in linear programming (LP) problem 2.2 (Tomothy J.Coelli, et al, 2005)

One can derive an equivalent envelopment form of this problem by using the duality in programming

$$\begin{aligned} &\min_{\theta,\lambda} \quad \theta, \\ &st \quad -q_i + Q\lambda \geq 0 \qquad (2.3) \\ &\theta x_i - X\lambda \geq 0 \\ &\lambda \geq 0, \end{aligned}$$

where θ is a scalar and λ is a Ix1 vector of constants. The multiplier form (N + M < I +1) involves more constraints than the envelopment and hence is generally the preferred form to solve. According to the Farrell (1957) definition, the value of θ obtained is the efficiency score for the i – th firm. It satisfies: $\theta \leq 1$ with a value of 1 indicating a point on the frontier and hence a technically efficient firm. Once for each firm in the sample will must be solved 1 time, hence, the the linear programming problem must be solved I times (Tomothy J.Coelli, et al, 2005)

It is a nice intuitive interpretation in the DEA problem in LP 2.3. While still remaining within the feasible input set, the problem takes the i – th firm and then seeks to radially contract the input vector, x_i, as much as possible. The inner–boundary of this set determined by the observed data points (i.e., all the firm in the sample) is a piece – wise linear isoquant (refer to Figure 2.3). A projected point, ($X\lambda$, $Q\lambda$), is produced by the radial contraction of the input vector, x_i, on the surface of this technology. A linear combination of these observed data points is this projected point. The contraints in LP 2.3 ensure that the feasible set contain this projected point. (Tomothy J.Coelli, et al, 2005)

The production technology associated with LP 2.3 can be defined as $T = \{(x,q): q \leq Q\lambda, x \geq X\lambda\}$ was described in Fare et al. (1994) that show that this technology defines a production set. That is closed and convex, and exhibits constrant returns to scale and strong disposability

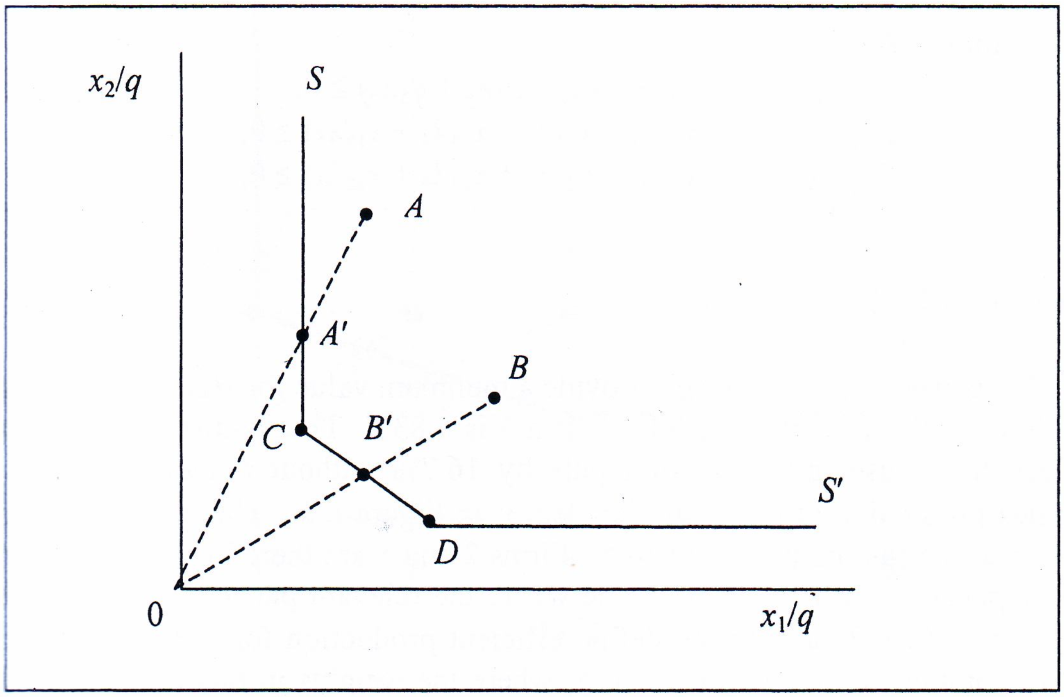

Figure 2-1: Efficiency Measurement and input Slacks
(Source: Tomothy J.Coelli, et al, 2005)

To illustrate the problem, in Figure 2-3, the two efficient firms that define the frontier and firms A and B are inefficicient firms, use input combinations C and D. According to Farrell (1957), OA'/OA and OB'/OB, respectively is measured of technical efficiency gives the efficiency of firms A and B. (Tomothy J.Coelli, et al, 2005)

In the summary, we can find DEA efficient and DEA inefficient.

> ***"Definition Full DEA Efficient:*** *The performance of DMUo is fully (100%) efficient if and only if both (i) an efficiency rating of $\theta^* = 1$ and (ii) all slacks* $s_i^{-*} = s_r^{+*} = 0$

Definition Weakly DEA Efficient: *The performance of DMUo is weakly efficient if and only if both (i) an efficiency rating of θ* =1 and (ii)* s_i^{-*} *# 0 and/or* s_r^{+*} *# 0 for some i and r.*

Where θ is the DEA efficiency score obtained from model and s_i^{-} *and* s_r^{+} *are input and out put slacks*

Definition DEA Inefficient: *The performance of DMUo is inefficient if an efficiency rating of θ* < 1"*

(Sherman and Zhu, 2006)

3 CHAPTER 3: PROCEDURE AND DATA

3.1 Primary and secondary data

Primary data

All data which is used in this thesis was collected from data primary of Ph.D Pham Xuan Thuy for Black Tiger Prawn (*Penaeus monodon*) aquaculture when he did Ph.D thesis which he inquired in Khanh Hoa province in 2004. There are 64 samples in Nha Trang city, 33 samples in Ninh Hoa district[6], 33 samples in Van Ninh district[7], and 36 samples in Cam Ranh district[8]. This thesis mainly uses Nha Trang‘s data to analysis, data from other areas only is used to compare to Nha Trang city to find the worst factors for technical efficiency, improving these bad factors.

Secondary data

Some data was collected from secondary data of Khanh Hoa Agriculture and Rural Development Department, Khanh Hoa Statistic Office and some newpapers.

3.2 Input and output

Total production and size of commercial Black Tiger Prawn (*Penaeus monodon*), generally, depend on multi-input technical factors: Pond area (square meters), Labor (persons), Machines, equipment (things), and Pond depth (meters), Activities cost (Vietnam dong million). (Pham Xuan Thuy, [2004], Khanh Hoa – Viet Nam).

[6] The survey initially consists of 64 farms in Ninh Hoa, however, due to missing information in some questionnaires, the results of 33 farms which are used in this paper

[7] Similarly, the survey initially consists of 64 farms in Van Ninh district, however, due to missing information in some questionnaires, the results of 33 farms which are used in this paper

[8] Similarly, the survey initially consists of 64 farms in Cam Ranh district, however, due to missing information in some questionnaires, the results of 36 farms which respectively, are used in this paper

This thesis will concentrate on above five input technical factors. The DEA-analyzes is a minimizing input oriented CRS DEA model and is planned to be carried out with two output and five input variables. The different variables are presented and discussed below

Table 3-1: Output – and input variables technical for Black Tiger Prawn (Penaeus monodon) aquaculture

Outputs	Inputs
1. Size (gram/shrimp) 2. Total production (kilogram)	1. Pond area (square meters) 2. Labor (persons/crop) 3. Machines (things) 4. Pond depth (meters) 5. Activities cost (Vietnam dong million/crop)

3.2.1 Output

Output variable were available for both harvest and value of harvest were available. When deciding between using output in form of quantities or in form of values, a pragmatic balance must be found. When quantity is used as output, lesser-valued Black Tiger Prawn (*Penaeus monodon*) would play an equal role with high-priced species. Using value of harvest as output, market prices have been introduced as implicit weights.

In this thesis, I research technical efficiency; hence, i use the quantity for two outputs as total yeild (kilogram) for output1 and size (gram/shrimp) for output2. Table 3-2 presents data of two outputs of ponds following

Table 3-2: Data size and total yield for Black Tiger Prawn (Penaeus monodon) Farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Farm unit	Size (gram/shrimp) Output 1	Total yeild (kilogram) Output 2
P1	50	600
P2	35	1700
P3	40	550
P4	30	400
P5	40	300
P6	40	1000
P7	60	700
P8	40	2100
P9	40	2000
P10	40	900
P11	60	500
P12	30	300
P13	30	500
P14	32	530
P15	50	1000
P16	40	600
P17	50	1000
P18	42	1000
P19	40	2100
P20	40	2200
P21	40	1250
P22	40	200
P23	45	2000
P24	40	620
P25	45	300
P26	50	600
P27	42	570
P28	40	3000
P29	40	700
P30	60	100
P31	40	8000
P32	60	4000

Farm unit	Size (gram/shrimp) Output 1	Total yeild (kilogram) Output 2
P33	60	400
P34	40	500
P35	40	1000
P36	40	300
P37	40	500
P38	50	650
P39	37	1500
P40	60	650
P41	60	500
P42	40	460
P43	40	3100
P44	65	650
P45	50	550
P46	40	500
P47	40	3400
P48	35	700
P49	40	300
P50	40	800
P51	40	600
P52	40	1000
P53	30	700
P54	40	800
P55	45	2000
P56	50	500
P57	45	800
P58	40	3000
P59	40	3000
P60	50	1000
P61	50	4000
P62	40	4500
P63	40	4300
P64	50	650

Table 3-3: Summary of Statistics of the output Variables for for Black Tiger Prawn (Penaeus monodon) Farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Variables	Maximum	Minimum	Mean	Standard deviation
Size (gram) Output 1	65.00	30.00	43.56	8.21
Total yeild (kilogram) Output 2	8,000.00	100.00	1,322.34	1,394.77

(Calculating by author)

3.2.2 Inputs

Pond area (square meters)

Most ponds are rectangular shape to handy for feeding, taking care and management of pond. Little ponds are square or quadrangular shape because of the history or the terrain. In the central of Viet Nam, only 27.8% households have got the process farm to clean the water because average farm area is 1.27ha/household here. Most of households want to use the process farm to clean the water in aquaculture to increase total yield, little households see the role of these ponds. See Pham Xuan Thuy, [2004], Nha Trang – Viet Nam.

The ponds area from 0.5 ha to 1.0 ha gets many advandtages to manage farm environment and care of the Black Tiger Prawn (*Penaeus monodon*). The ponds area are less than 0.3 ha often get many disadvantages during the aquaculture process. Because the change suddenly of the factors in envireoment of the farm when the weather change such as rainly, sunlight do shock shrimp. On the contrary, farm area is more than 1.0 ha is often difficult to care of and manage regular. (Pham Xuan Thuy, [2004], Nha Trang – Viet Nam).

Labor (persons/crop)

It is disputed for Black Tiger Prawn (*Penaeus monodon*) production processes by the relevance of labour as input. Crew size can be regarded more a consequence, rather than a cause of production (Pascoe *et al.* 2001). A minimum number of crew is required to operate the pond, and adding more men is not likely to increase production. The amount labour used per farm per crop is available and was used as labour input in this study.

Machines (things)

Machines such as water fans apply oxyzen, create water flow to stimulus shrimp activing for feeding, collect waste to create clean yard for shrimp, help shrimp to use more foods to avoid farm pollution, help seaweed to develop for more nutrition restriction because of unnecessary food.

The first month, demand of oxyzen is not much, a mount of hours which water fan should be run few to reduce the cost. Beginning the third, fourth month, because size and weight of shrimp increase quickly, waste from shrimp aquaculture also increase, the demand of oxyzen increase, we need increase amount of running hours of water fan. Specially, the last month, we should use full capacity of machine to avoid shrimp head drift

(Pham Xuan Thuy, [2004], Nha Trang – Viet Nam)

Pond depth (meters)

To increasing pond depth, we should not lower pond's bottom because it will cause alum for pond's bottom and it is difficult for pond improving and bottom drying. Hence, to keeping the level of water in pond, need increase the edge of pond is efficiency (Pham Xuan Thuy, [2004], Nha Trang – Viet Nam).

Depending on type of difference aquaculture forms, pond depth also is difference. Semi-intensive, intensive aquaculture ponds get average depth from 1.2 to 1.4 metre, improve extensive aquaculture ponds gets average depth about 1.1 metre. (Pham Xuan Thuy, [2004], Nha Trang – Viet Nam)

In semi-intensive, intensive, improve extensive aquaculture ponds, during young shrimp time, the producers often keep the low level of water in pond from 0.8 to 1.2 metre, after that they increase the little by little level of water by change the water. When shrimp from 1.5 to 2 age months, the level of water in pond is kept with maximum level as possible. In general, intensive aquaculture ponds often get higher depth than 1.2 metre, helping to develop seaweed, to keep stable water environment and water temperature. (Pham Xuan Thuy, [2004], Nha Trang – Viet Nam)

However, if pond depth is very large, it is waste the cost and pond depth depend on the aquaculture result with the low level of water for young shrimp, the high level of water for mature shimp.

An Activity cost (Vietnam dong million/crop) as input

Acivities cost here include amout breed cost, amout of food cost, amout of medicine for treat diseases. Breed shimps in Khanh Hoa often are bought by the locality producers, nearly the aquaculture area; hence, there is no large difference between breed farm environment and environment of commercial the Black Tiger Prawn (*Penaeus monodon*) aquaculture pond, the propotion of shrimp alive reach nearly 100%. However, almost of breed shimp in local has ever kept in quarantine, shrimp farming has boomed as an industry and not included in government planning cause the low quality of breed shrimp. This also cause much diseases, and need much amout of medicine for treat diseases, hence, the higher cost for treat diseases. (Pham Xuan Thuy, [2004], Nha Trang – Viet Nam)

To feeding enough quantity and quality of food for shrimp help strong shimp, fast grow up, not cause enviromental pollution, high efficiency. Lack of food, shrimp gets slow grow up, undersized, unsize, easy disease. Unnecessary food cause pond pollution, seaweed and microorganism will effect to pond enviroment, cause flower phenomenon, cause lack of oxyzen at night. (Pham Xuan Thuy, [2004], Nha Trang – Viet Nam)

Table 3-4: Inputs data for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Farm unit	Pond area (square meters) Input 1	Labor (persons/crop) Input 2	Machines (things) Input 3	Depth (meters) Input 4	Activities cost (Vietnam dong million/crop) Input 5
P1	0.2	2	2	0.8	42
P2	4.7	3	4	1.6	51.8
P3	0.8	3	3	0.7	35.5
P4	2	4	2	1	22.5
P5	0.4	2	3	0.7	14.3
P6	1	2	2	1	33
P7	0.3	2	2	1.2	37.2
P8	1.3	6	3	0.7	73
P9	1.1	3	3	1.1	59
P10	0.47	3	3	1	24
P11	0.3	4	2	1.4	12
P12	0.15	2	2	1	7
P13	0.2	4	2	1.4	19
P14	0.3	2	3	0.8	13
P15	0.35	3	3	1	24.6
P16	0.6	2	2	1	34.5
P17	0.8	2	2	1	24.6
P18	1	2	2	1.2	65
P19	1.2	2	3	1	61
P20	1.6	5	3	0.7	62
P21	0.33	6	2	1.7	61
P22	2.9	2	4	0.8	9
P23	1.2	4	2	0.8	63
P24	1.3	2	2	1	27
P25	1	2	2	1.5	24
P26	0.6	2	3	1.5	27
P27	0.2	2	3	1.1	18
P28	1	5	3	0.8	76
P29	0.65	1	2	1.5	22
P30	0.08	2	2	2	4.5
P31	2	3	2	1.2	250
P32	2.5	2	2	1	270

Table 3-5: (continued) Inputs data for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Farm unit	Pond area (square meters) Input 1	Labor (persons/crop) Input 2	Machines (things) Input 3	Depth (meters) Input 4	Activities cost (Vietnam dong million/crop) Input 5
P33	0.17	2	2	1.2	7
P34	0.8	5	2	1.4	17
P35	0.5	2	2	1.2	65
P36	0.5	3	3	1.2	26
P37	0.2	2	2	1.2	21
P38	0.6	2	2	1	22.5
P39	2.4	6	3	1.2	44
P40	0.4	2	2	1	6.5
P41	0.2	2	3	0.8	20
P42	0.22	2	2	1.1	14.4
P43	1	2	3	0.8	79
P44	0.4	2	2	1.2	6.3
P45	0.2	5	3	1.1	39
P46	0.23	3	2	1.8	13
P47	0.5	2	2	1	123
P48	0.8	4	2	1.4	38
P49	0.12	2	2	1	6
P50	1.4	2	2	0.8	32
P51	0.5	3	2	1.2	27
P52	1	4	2	0.8	26
P53	0.8	5	2	1.5	23
P54	0.8	2	2	1.2	29
P55	1.2	4	2	0.9	63
P56	0.28	6	3	1.5	17
P57	0.4	2	3	1	20
P58	0.5	2	2	1	120
P59	1	4	3	1.2	94
P60	1	6	3	1.2	6.4
P61	1	2	2	1.2	126.3
P62	1.5	2	2	1.3	212
P63	0.7	3	3	1.2	122.8
P64	1.3	2	2	1.4	28

Table 3-6: Summary of Statistics of the input Variables for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Variables	Maximum	Minimum	Mean	Standard deviation
Pond area (square meters) Input 1	4.70	0.08	0.86	0.78
Labor (persons/crop) Input 2	6.00	1.00	2.94	1.33
Machines, equipment (things) Input 3	4.00	2.00	2.41	0.56
Depth (meters) Input 4	0.70	2.00	1.13	0.28
Activities cost (Vietnam dong million/crop) Input 5	270.00	4.50	47.82	53.52

4 CHAPTER 4: RESULTS OF DEA EFFICIENCY ANALYSIS

4.1 The reasons for applying methods of the minimizing input - oriented CRS DEA

The DEA-analyzes is a minimizing input oriented CRS DEA model and is planned to carry out with two output and five input variables. The producers in Nha Trang do not want to get maximizing output because of some reasons following:

- Much outputs often cause price reducing. Actual, some recently years, price reducing caused the losing for the producers. Hence, the producers do not want to get maximizing output.

- Most producers are poor and they conduct farming activities in the incentives loan capital from the government. So the producers want to cut inputs as much as possible, they do not have enough financial resources to put to the increased output

- Nha Trang is one of most 29 beautiful bays in the world. Therefore the policy of local authorities is to reduce the minimizing input factors to develop ecological tourism and residential area and they limited maximizing output[9]

- There is environmental pollution. Maximizing output will lead to much aquaculture and aquaculture farming's have been developed outside government's programming. Thus it will lead to environmental pollution, reduction of farms efficiency.

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[9] People's Committee of Khanh Hoa province, the sea economic of Khanh Hoa province to 2010

For the above reasons, in this study, we have calculated technical efficiency as the potential reduction of inputs without increasing the pond' outputs. Only constant returns to scale have been used, variable returns to scale is not allowed.

4.2 Empirical results

4.2.1 Technical eficicency in Nha Trang

• According to **"**Definition DEA Efficient**:** The performance of *DMUo is* fully (100%) efficient if and only if both (i) $\theta^* = 1$ and (ii) all slacks $s_i^{-*} = s_r^{+*} = 0$. Weakly DEA Efficient**:** The performance of *DMUo is* weakly efficient if and only if both (i) $\theta^* = 1$ and (ii) s_i^{-*} # 0 and/or s_r^{+*} # 0 for some i and *r.*

Where θ *is the DEA efficiency score obtained from model and* s_i^- and s_r^+ are input and out put slacks" (Sherman and Zhu, 2006).

The efficiency ratings are generated by an efficient rating of $\theta^* = 1$ as in Appendix 1-1. All slacks in appendix 1-2 get $s_i^{-*} = s_r^{+*} = 0$, hence, the list of the performance of DMUo is full efficient. These units (table 4-1) are relatively, and not strictly, efficient. That is, no other unit is clearly operating more efficiently than these units, but it is possible that all units, including these relatively efficient units, can be operated more efficiently. Therefore, the efficient DMUo (table 4-1) represent the best existing (but not necessarily the best possible) management practice with respect to efficiency.

• Inefficient units are identified by an efficiency rating of $\theta^* < 1$ as in Appendix 1-1. These units (table 4-1) are strictly inefficient compared to all other units and are candidates for remedial action by management. In fact, the inefficiency identified with DEA will tend to understate, rather than overstate, the inefficiency present because of the nature of linear programming which seeks to maximize the efficiency rating.

Table 4-1: The table of the performance of DMUo is efficient and inefficient for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Order	Norms	DMU name	Amount
1	List of the performance of *DMUo is* efficient	P1, P20, P28, P29, P30, P31, P32, P33, P40, P41, P43, P44, P47, P60, P61, P63	16
2	List of the performance of *DMUo is* inefficient	P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P19, P21, P22, P23, P24, P25, P26, P27, P34, P35, P36, P37, P38, P39, P42, P45, P46, P48, P49, P50, P51, P52, P53, P54, P55, P56, P57, P58, P59, P62, P64	48
Total the the performance of *DMUo*			64

(Calculating by author)

- The estimated means of the technical scores for farming in Nha Trang city are given in Table 4-2

Table 4-2: Input oriented CRS efficiency (efficiency rating) for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Mean	*Range*	Standard deviation
0.826	0.500 – 1.000	0.149

(Calculating by author)

Average efficiency rating (θ*) in Nha Trang is 0.826. The lowest efficiency rating of is 0.500

• The efficiency reference set (ERS) indicates the relatively efficient units against which the inefficient units were most clearly determined to be inefficient. The presentation in Appendix 1-1 summarizes the magnitude of the identified inefficiencies by comparing the inefficient unit with its efficiency reference set (Benchmarks). For example, P4 was found to have operating inefficiencies in direct comparison to P32 and P40. The value in parentheses represents the relative weight assigned to each efficiency reference set (ERS) member to calculate the efficiency rating *(θ*)*. If a service unit's efficiency rating is 100%, then this unit is its own ERS and we generally do not report it as an ERS

• The target value = (actual input) x (efficiency rating)-slack.The difference between the target and the actual input levels indicates the potential resource reductions (and cost savings) for each input based on the actual performance of other best practice units. All of the input reductions together would increase that unit's productivity to the best practice level. This information and the efficiency rating provide the unique insights that make DEA so valuable for service performance management. From appendix 1-3, we have from table 4-4 to 4-8 to describe resource reduction.

Table 4-3: Resource reduction for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Order	Norms		P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
1	Actual inputs and outputs	Input1	4.7	0.8	2	0.4	1	0.3	1.3	1.1	0.47	0.3
		Input2	3	3	4	2	2	2	6	3	3	4
		Input3	4	3	2	3	2	2	3	3	3	2
		Input4	1.6	0.7	1	0.7	1	1.2	0.7	1.1	1	1.4
		Input5	51.8	35.5	22.5	14.3	33	37.2	73	59	24	12
		Output1	35	40	30	40	40	60	40	40	40	60
		Output2	1700	550	400	300	1000	700	2100	2000	900	500
2	Input oriented target	Input1	0.67	0.28	0.26	0.16	0.39	0.29	1.27	0.78	0.35	0.29
		Input2	2	1	1	1	1	2	4	2	2	2
		Input3	3	2	1	2	1	2	3	2	2	2
		Input4	1.1	0.5	0.5	0.6	0.7	1.2	0.7	0.8	0.7	1.2
		Input5	36.7	27.7	11.3	11.5	23.5	13.9	71.2	47.0	17.9	6.1
		Output1	59	40	30	40	40	60	40	40	42	60
		Output2	1,700	550	427	354	1,000	700	2,100	2,000	900	500
3	Resource reductions [(3) =(1)-(2)]	Input1	4.03	0.52	1.74	0.24	0.61	0.01	0.03	0.32	0.12	0.01
		Input2	1	2	3	1	1	0	2	1	1	2
		Input3	1	1	1	1	1	0	0	1	1	0
		Input4	0.5	0.2	0.5	0.1	0.3	0.0	0.0	0.3	0.3	0.2
		Input5	15.1	7.8	11.3	2.8	9.5	23.3	1.8	12.0	6.1	5.9
		Output1	-24	0	0	0	0	0	0	0	-2	0
		Output2	0	0	-27	-54	0	0	0	0	0	0

(Calculating by author)

Table 4-4: (continued): resource reduction for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Order	Norms		P12	P13	P14	P15	P16	P17	P18	P19	P21	P22
1	Actual inputs and outputs	Input1	0.15	0.2	0.3	0.35	0.6	0.8	1	1.2	0.33	2.9
		Input2	2	4	2	3	2	2	2	2	6	2
		Input3	2	2	3	3	2	2	2	3	2	4
		Input4	1	1.4	0.8	1	1	1	1.2	1	1.7	0.8
		Input5	7	19	13	24.6	34.5	24.6	65	61	61	9
		Output1	30	30	32	50	40	50	42	40	40	40
		Output2	300	500	530	1000	600	1000	1000	2100	1250	200
2	Input oriented target	Input1	0.12	0.13	0.22	0.33	0.40	0.43	0.56	0.74	0.25	0.23
		Input2	1	1	1	2	1	2	1	2	2	1
		Input3	1	1	1	2	1	2	1	2	2	2
		Input4	0.8	0.6	0.6	0.9	0.7	0.9	0.8	0.8	0.9	0.6
		Input5	5.6	12.3	9.6	22.9	21.1	21.4	43.2	51.7	41.0	7.0
		Output1	40	30	32	50	40	50	42	40	40	40
		Output2	300	500	530	1,000	646	1,000	1,000	2,100	1,250	403
3	Resource reductions [(3) =(1)-(2)]	Input1	0.03	0.07	0.08	0.02	0.20	0.37	0.44	0.46	0.08	2.67
		Input2	1	3	1	1	1	0	1	0	4	1
		Input3	1	1	2	1	1	0	1	1	0	2
		Input4	0.2	0.8	0.2	0.1	0.3	0.1	0.4	0.2	0.8	0.2
		Input5	1.4	6.7	3.4	1.7	13.4	3.2	21.8	9.3	20.0	2.0
		Output1	-10	0	0	0	0	0	0	0	0	0
		Output2	0	0	0	0	-46	0	0	0	0	-203

Table 4-5: (continued): resource reduction for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Order	Norms		P23	P24	P25	P26	P27	P34	P35	P36	P37	P38
1	Actual inputs and outputs	Input1	1.2	1.3	1	0.6	0.2	0.8	0.5	0.5	0.2	0.6
		Input2	4	2	2	2	2	5	2	3	2	2
		Input3	2	2	2	3	3	2	2	3	2	2
		Input4	0.8	1	1.5	1.5	1.1	1.4	1.2	1.2	1.2	1
		Input5	63	27	24	27	18	17	65	26	21	22.5
		Output1	45	40	45	50	42	40	40	40	40	50
		Output2	2000	620	300	600	570	500	1000	300	500	650
2	Input oriented target	Input1	0.61	0.37	0.28	0.42	0.16	0.30	0.34	0.26	0.14	0.44
		Input2	2	1	1	1	2	1	1	1	1	2
		Input3	2	1	1	2	2	1	1	2	1	2
		Input4	0.8	0.7	0.8	1.1	0.9	0.7	0.8	0.6	0.8	0.8
		Input5	62.2	18.0	4.4	11.3	14.3	10.5	26.0	12.0	14.0	18.8
		Output1	45	40	45	50	42	40	40	40	40	50
		Output2	2,000	620	450	600	570	500	1,000	459	500	711
3	Resource reductions [(3) =(1)-(2)]	Input1	0.59	0.93	0.72	0.18	0.04	0.50	0.16	0.24	0.06	0.16
		Input2	2	1	1	1	0	4	1	2	1	0
		Input3	0	1	1	1	1	1	1	1	1	0
		Input4	0.0	0.3	0.7	0.4	0.2	0.7	0.4	0.6	0.4	0.2
		Input5	0.8	9.0	19.6	15.7	3.7	6.5	39.0	14.0	7.0	3.8
		Output1	0	0	0	0	0	0	0	0	0	0
		Output2	0	0	-150	0	0	0	0	-159	0	-61

(Calculating by author)

Table 4-6: (continued) resource reduction for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Order	Norms		P39	P42	P45	P46	P48	P49	P50	P51	P52	P53
1	Actual inputs and outputs	Input1	2.4	0.22	0.2	0.23	0.8	0.12	1.4	0.5	1	0.8
		Input2	6	2	5	3	4	2	2	3	4	5
		Input3	3	2	3	2	2	2	2	2	2	2
		Input4	1.2	1.1	1.1	1.8	1.4	1	0.8	1.2	0.8	1.5
		Input5	44	14.4	39	13	38	6	32	27	26	23
		Output1	37	40	50	40	35	40	40	40	40	30
		Output2	1500	460	550	500	700	300	800	600	1000	700
2	Input oriented target	Input1	0.79	0.16	0.17	0.18	0.35	0.12	0.35	0.31	0.40	0.37
		Input2	4	1	2	2	1	1	1	1	1	2
		Input3	2	1	2	2	1	1	2	1	2	1
		Input4	0.9	0.8	0.9	0.9	0.7	0.8	0.6	0.7	0.7	0.6
		Input5	31.4	10.3	21.2	10.2	21.0	5.8	25.6	12.6	22.2	13.6
		Output1	37	40	50	45	35	40	40	40	40	30
		Output2	1,500	460	550	500	700	300	800	600	1,000	700
3	Resource reductions [(3) =(1)-(2)]	Input1	1.61	0.06	0.03	0.05	0.45	0.00	1.05	0.19	0.60	0.43
		Input2	2	1	3	1	3	1	1	2	3	3
		Input3	1	1	1	0	1	1	0	1	0	1
		Input4	0.3	0.3	0.2	0.9	0.7	0.2	0.2	0.5	0.1	0.9
		Input5	12.6	4.1	17.8	2.8	17.0	0.2	6.4	14.4	3.8	9.4
		Output1	0	0	0	-5	0	0	0	0	0	0
		Output2	0	0	0	0	0	0	0	0	0	0

Table 4-7: (continued): resource reduction for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang city, Khanh Hoa Province, Vietnam

Order	Norms		P54	P55	P56	P57	P58	P59	P62	P64	Average
1	Actual inputs and outputs	Input1	0.8	1.2	0.28	0.4	0.5	1	1.5	1.3	0.87
		Input2	2	4	6	2	2	4	2	2	3.02
		Input3	2	2	3	3	2	3	2	2	2.42
		Input4	1.2	0.9	1.5	1	1	1.2	1.3	1.4	1.14
		Input5	29	63	17	20	120	94	212	28	38.27
		Output1	40	45	50	45	40	40	40	50	41.52
		Output2	800	2000	500	800	3000	3000	4500	650	1,000.63
2	Input oriented target	Input1	0.33	0.62	0.18	0.32	0.48	0.85	1.46	0.40	0.40
		Input2	1	2	2	2	2	2	2	2	1.63
		Input3	1	2	2	2	2	3	2	2	1.66
		Input4	0.8	0.8	1.0	0.8	1.0	0.9	0.9	0.9	0.80
		Input5	18.6	57.5	11.0	16.0	106.7	80.0	173.1	16.5	28.06
		Output1	40	45	50	45	40	40	40	50	42.37
		Output2	800	2,000	500	800	3,000	3,000	4,500	650	1,015.21
3	Resource reductions [(3) =(1)-(2)]	Input1	0.47	0.58	0.10	0.08	0.02	0.15	0.04	0.90	0.47
		Input2	1	2	4	0	0	2	0	0	1.39
		Input3	1	0	1	1	0	0	0	0	0.76
		Input4	0.4	0.1	0.5	0.2	0.0	0.3	0.4	0.5	0.34
		Input5	10.4	5.5	6.0	4.0	13.3	14.0	38.9	11.5	10.21
		Output1	0	0	0	0	0	0	0	0	-0.85
		Output2	0	0	0	0	0	0	0	0	-14.59

(Calculating by author)

To illustrate the contrasting message of the input-oriented, consider the unit P4, which had the lowest efficiency rating with the input-oriented model of 0.5 or 50% (see Appendix 1-1).

The key difference from a managerial perspective is the slack values and the excess resources or additional services that the models suggest would make P4 as efficient as its ERS. These are most directly reported in the table that describes the target inputs for each unit, and suggest what the input levels could be if the unit was performing as well as its ERS. The input-oriented model suggests that P4 has the potential to reduce Input 1 by 1.74 units, Input 2 by 3.0 units, Input 3 by 1.0 units, Input 4 by 0.5 units, Input 5 by 11.3 units to become as efficient as the best practice ERS units.

- Inputs of the efficiency ponds in Nha Trang city

Table 4-8: Inputs Data of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture farmers in Nha Trang

Norms	Input 1	Input 2	Input 3	Input 4	Input 5
Maximum	2.5	6	3	2	270
Minimum	0.08	1	2	0.7	4.5
Mean	0.8375	2.6875	2.375	1.1	76.4875
Standard Deviation	0.6921	1.4009	0.5	0.3246	84.3233

(Calculating by author)

The area of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture in Nha Trang is range 0.08 - 2.5 ha. The data from table 4.4 to table 4.8 shows that the area of pond's P2 and P22 is too large with 4.7 and 2.9 ha, respectively. These ponds area should be reduced by divide into the aquaculture pond and water pond.

The number of labors of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture in Nha Trang is range 1 - 6 persons. The data from table 4.4 to table 4.8 shows that the number of labors of pond's P8, P21, P39, and P56 is a lot. The labor for these ponds should be reduced by labor curb to costs saving. On the other hand, the number labors for ponds which are smaller than range of the number labors of efficiency pond should be increased by labor hiring.

The number of machines of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture in Nha Trang is range 2 to 3 things. The table 4.4 to table 4.8 data shows that the number of machines of pond's P2, P22 is more than necessary. These number machines for ponds should be reduced by machines curb to save costs. On the other hand, the number machines for ponds which are smaller than range of the number machines of efficiency pond should be conducted bought or bought.

The pond depth of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture in Nha Trang is range 0.7 – 2 metres. The pond depth which is larger than range of the depth in effective ponds should be reduced by water level curb to save costs. On the other hand, the pond depth which is smaller than range of the pond depth of efficiency ponds should be increased by conducting to pump water into ponds.

The activities cost of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture in Nha Trang is range from 4.5 to 270 million VNDs dong/crop. The activities cost for pond which is larger than range of the activities cost in effective ponds should be reduced by cost curb to get cost saving. On the other hand, the activities cost which is smaller than range of the activities cost of efficiency ponds should be increased by loan or property money.

4.2.2 Compare to technical efficiency in Nha Trang city and other districts in Khanh Hoa province

The propotion percent of *DMUo* efficient

The propotion percent of *DMUo* efficient in Cam Ranh district is highest with 42%. Van Ninh district is ranked the second with 0.911.

The propotion percent of *DMUo* efficient in Nha Trang city and Ninh Hoa district is lowest with 25% and 24%, respectively.

Table 4-9: Campare technical efficiency for Black Tiger Prawn (Penaeus monodon) aquaculture farmers between Nha Trang city and Ninh Hoa, Cam Ranh and Van Ninh district in Khanh Hoa province

Norms/district	Nha Trang	Ninh Hoa	Cam Ranh	Van Ninh
1. Sample	64	33	36	33
2. The propotion percent of *DMUo* efficient (%)	25	24	42	36
3. Efficiency rating (θ*)				
Mean	0.826	0.878	0.911	0.921
Range	0.500 – 1.000	0.717 -1.000	0.641 - 1.000	0.696 - 1.000
Standard deviation	0.149	0.098	0.116	0.090
4. Average Resource reductions				
Input 1	0.47	0.58	0.13	0.88
Input 2	1.39	0.62	1.07	1.12
Input 3	0.76	0.70	0.47	0.32
Input 4	0.34	0.32	0.24	0.39
Input 5	10.21	7.77	22.90	1.83

(Calculating by author)

Average efficiency rating

Van Ninh district got average efficiency rating which is highest with 0,921; Cam Ranh district is ranked the second with 0.911. Nha Trang got average efficiency rating which is lowest with 0.826

Cam Ranh district which the efficiency rating is 0.911 closed to the efficiency rating of Van Ninh district (0.921) but the propotion percent of *DMUo* efficient in Cam Ranh is highest with 42% compare to Van Ninh district with 36%. Hence, Cam Ranh generally still is better. Cam Ranh gets pond area (input 1) and depth (input 4) relatively suitable with 0.13 for average pond area resource reductions, 0.24 for average pond depth resource reductions. Besides, other inputs such as labor (input 2) and machines (input 3) are average.

Average Resource reductions

- Pond area (input 1): we can see in table 4-9, Van Ninh used the most pond area scarces with 0.88 for average resource reductions.

- Labor (input 2): we can see in table 4-9, Nha Trang city used the most labour scarces with 1.39 for average resource reductions.

- Activities cost (input 5): we can see in table 4-9, Cam Ranh district get the most activities cost scarces with 22.90 for average resource reductions

Campare to input of technical efficiency ponds in Nha Trang city and Cam Ranh district

In Cam Ranh district, the area of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture ponds is range 0.28 - 3 ha, while in Nha Trang, this area is range 0.8 - 2.5 ha.

Table 4-10: Data inputs of the technical efficiency farms for Black Tiger Prawn (Penaeus monodon) aquaculture between Cam Ranh and Nha Trang

Norms	Input 1		Input 2		Input 3		Input 4		Input 5	
	Nha Trang	Cam Ranh	Nha Trang	Cam Ranh	Nha Trang	Cam Ranh	Nha Trang	Cam Ranh	Nha Trang	Cam Ranh
Maximum	2.5	3	6	7	3	3	2	2	270	310
Minimum	0.08	0.28	1	2	2	2	0.7	0.8	4.5	19
Mean	0.8375	0.7647	2.6875	3.0667	2.375	2.2	1.1	1.3	76.4875	105.1818
Standard Deviation	0.6921	0.7048	1.4009	1.6242	0.5	0.4140	0.3246	0.35051	84.3233	95.7317

(Calculating by author)

In Cam Ranh district, the number of labors of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture ponds is range 2 - 7, while in Nha Trang, this number of labors is range 1 – 6 persons/crop.

In Cam Ranh, number of machines of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture ponds is ranges 2 - 3, while in Nha Trang, this number of machines is the same.

In Cam Ranh, the depth of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture is range 0.8 – 2 metres, while in Nha Trang, the depth of this pond is range 0.7 – 2 metres.

In Cam Ranh, activities costs of the technical efficiency ponds for Black Tiger Prawn (Penaeus monodon) aquaculture is range 19 - 310 million dong, while in Nha Trang, this costs is range 4.5 - 270 million VNDs/crop

5 CHAPTER 5: SUMMARY AND CONCLUSIONS

This study has used minimizing input-oriented CRS DEA model with two output and five input variables which use theory of technical efficiency. It mainly has used Nha Trang‘s data (64 samples) to analysis, data from other areas in Khanh Hoa province (33 samples in Ninh Hoa district, 33 samples in Van Ninh district, and 36 samples in Cam Ranh district) only use to compare to Nha Trang to find the worst factors for technical efficiency, improving these factors in section conclusion. All these data was collected from data primary of Ph.D Pham Xuan Thuy when he did Ph.D thesis which he inquired in Khanh Hoa province in 2004.

- As can you seen in the table 4-1, there are 16 performance of DMUo is efficient (25%) and 48 performance of DMUo is inefficient (75%) in Nha Trang city. We can put to conduct for each of the inefficient. These are the units that management would focus on to improve input factors or resource reduction.

The list of the performance of *DMUo* efficient is P1, P20, P28, P29, P30, P31, P32, P33, P40, P41, P43, P44, P47, P60, P61, and P63. On the contrary, list of the performance of *DMUo* inefficient is P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P19, P21, P22, P23, P24, P25, P26, P27, P34, P35, P36, P37, P38, P39, P42, P45, P46, P48, P49, P50, P51, P52, P53, P54, P55, P56, P57, P58, P59, P62, P64

- According to calculating by author, as can you seen in the table 4-8, the average resource reductions of the list of the performance of *DMUo* inefficient in Nha Trang with input 1 is 0.47, input 2 is 1.39, input 3 is 0.76, input 4 is 0.34, input 5 is 10.21. Like this, input 5 (Activities cost), input 2 (labour), input 3 is 0.76 (machines) is most inefficiency, respectively.

As can you seen in the table 5-1, the propotion percent of *DMUo* efficient of Cam Ranh which relate to geographical advantages is highest with 42%. Nha Trang and Ninh Hoa which close for residential areas, processing factories and tourism areas are lowest with 25 and 24%, respectively. In Nha Trang city, Black Tiger Prawn (Penaeus monodon) aquaculture farmer's area is polluted by wastewater from the processing factories, as water from residential areas, tourism development. Hence, inefficiency ponds in Nha Trang should be reduced inputs or run or remove switch to other aquaculture forms.

Results of this study are in accordance with the plans of local government. According to the programming of Khanh Hoa province, commercial Black Tiger Prawn aquculture area in the city of Nha Trang will be reduced from 520 ha in 2005 to 357 ha in 2010[10].

- Average resource reductions

Pond area (input 1): areas away from big cities are cheap land price, hence, the producer's often scarce pond area. To prove this in a scientific fashion, we can see in table 5-1, Van Ninh used the most pond area scarces with 0.88 average resource reductions.

Labor (input 2): according to aquaculture characteristic, aquaculture farms which are farly populated area are labour scarces and a lot labours for nearly populated area. To prove this in a scientific fashion, we can see in table 5-1, Nha Trang city used the most labour scarces with 1.39 average resource reductions.

Activities cost (input 5): Cam Ranh approach rich source for shrimp aquaculture service about breed, food, and medicine for treat diseases by georgapical. Hence, the producer's in here often chose good breed, food, and medicine for treat diseases. These cause higher price and higher cost than other areas in Khanh Hoa. To prove this in a scientific fashion, we can see in table 5-1, Cam Ranh district get the most activities cost scarces with 22.90 average resource reductions

[10] Data from Khanh Hoa department of Agriculture and Rural Development, 2005

- In Nha Trang city, commercial Black Tiger Prawn area is should range 0.08 -2.5 ha, labor is range 1-6 people/crop, the number of machines is range 2-3, ponds depth is range 0.7-2m, activities cost is range 4.5 to 270 million VND/crop. In the limit, the increased area will increase stability in the ponds and the ecological factors of each other the shrimp ponds

- The area of ponds which is larger than range of efficiency pond area should be reduced the pond area by divide the aquaculture pond and water pond. This will contribute to greater environmental protection and bring to long-term aquaculture efficiency. On the contrary, the ponds area which is smaller than range of efficiency pond area should be increased or run or remove switch to other aquaculture forms.

The number labors for ponds which are larger than range of the number labors in effective ponds should be reduced by labor curb to save costs. On the other hand, the number labors for ponds which are smaller than range of the number labors of efficiency pond should be increased by labor hiring.

The number machines for ponds which are larger than range of the number machines in effective ponds should be reduced by machines curb to save costs. On the other hand, the number machines for ponds which are smaller than range of the number machines of efficiency pond should be increased by machines hiring or buying.

The pond depth which is larger than range of the depth in effective ponds should be reduced by water level curb to save costs. On the other hand, the pond depth which is smaller than range of the pond depth of efficiency ponds should be increased by conducting to pump water into ponds

The activities cost for pond which is larger than range of the activities cost in effective ponds should be reduced by cost curb to get cost saving. On the other hand, the activities cost which is smaller than range of the activities cost of efficiency ponds should be increased by loan or property money

- The tools for fisheries management in Viet Nam includes input control and output control. Close and temporary closed areas, division aquaculture areas have been applied. But, in reality, the efficiency of this tool application and management is limited and low. Aquaculture farming's have been developed outside government's programming [11]. Similarly, also in Khanh Hoa, now, according to unprompted trend, many households changed from Black Tiger Prawn (Penaeus monodon) aquaculture to White Leg Shrimp (Liptopenaeus vannamei or Pennaeus vannamei) aquaculture. Khanh Hoa fishery department got "the inshore aquaculture project in Khanh Hoa from 2001-2010" and it is accepted by Khanh Hoa province committee. According to this project, to 2005, Black Tiger Prawn (*Penaeus monodon*) aquaculture area in Khanh Hoa province would reduce to 4.500 ha [12] (baokhanhhoa, 2003). But now, a nearly half of Black Tiger Prawn (Penaeus monodon) aquaculture area change to commercial White Leg Shrimp (Liptopenaeus vannamei or Pennaeus vannamei) aquaculture because the producer's think that White Leg Shrimp (Liptopenaeus vannamei or Pennaeus vannamei) aquaculture get more quickly growth, uniform size, and short aquaculture time than commercial Black Tiger Prawn (*Penaeus monodon*) aquaculture. For example, in 2009, Ninh Hoa district is droped 1,600 ha for shrimp, in which: 1,000 ha for commercial Black Tiger Prawn (*Penaeus monodon*) aquaculture and 600 ha for commercial White Leg Shrimp aquaculture (Liptopenaeus vannamei or Pennaeus vannamei)[13] (thvm, 2009). This cause my next research way of that wills compare between cost efficiency of White Leg Shrimp (Liptopenaeus vannamei or Pennaeus vannamei) aquaculture and Black Tiger Prawn (*Penaeus monodon*) aquaculture.

Input factors are fairly suitable to actual local. This result and this approach can be used by Khanh Hoa Agriculture and Rural Development Department to refer to bring out

[11] Source: Vietnam's Fisheries Sector Country Profile
[12] http://baokhanhhoa.com.vn/Kinhte-Dulich/2004/01/2215/
[13] http://thvm.vn/News/Thoi-su/Dia-phuong/Nam-2009-Ninh-Hoa-Khanh-Hoa-Tha-nuoi-khoang-1600-ha-tom-su-va-tom-the-chan-trang/Show-6873/

aquaculture sector management policy. Hopefully, the producers also can use this result to improve input factors, to help reach technical efficiency.

6 Reference

CEMARE, University of Portsmouth, UK: Single output measures of technical efficiency in EU fisheries

Hoang Thu Thuy, [2008], Đánh giá hiệu quả kinh tế, xã hội nghề nuôi tôm sú giống tại tỉnh Khánh Hòa (economic, social efficiency evaluation for breed Black Tiger Prawn -Penaeus monodon aquaculture- in Khanh Hoa province). Master thesis, Nha Trang University, Viet Nam.

Khanh Hoa department of Agriculture and Rural Development, 2005

Khanh Hoa Newpaper, 2004, http://baokhanhhoa.com.vn/Kinhte-Dulich/2004/01/2215/ http://www.baokhanhhoa.com.vn/Phongsu/2008/08/289261/

Khanh Hoa Statistis 2007, 2007 statistics report.

People's Committee of Khanh Hoa province, 2005, the sea economic of Khanh Hoa province to 2010

Pham Xuan Thuy, [2004], Xây dựng mô hình nuôi tôm thâm canh tại Khánh Hòa (Building a model of intensive shrimp aquaculture in Khanh Hoa province). Dr. Thesis, Nha Trang University, Viet Nam.

Ronald D. Zweig, Ha Xuan Thong, Le Thanh Luu, Jonathan R. Cook and Michael Phillips 2005. Vietnam: Fisheries and Aquaculture Sector Study EASRD

Sherman and Zhu, 2006. Service Productivity Management Improving Service Performance using DATA ENVELOPMENT ANALYSIS (DEA). Springer Science-i-Business Media, LLC: 1-127

Thvm, 2009, http://thvm.vn/News/Thoi-su/Dia-phuong/Nam-2009-Ninh-Hoa-Khanh-Hoa-Tha-nuoi-khoang-1600-ha-tom-su-va-tom-the-chan-trang/Show-6873/

Tomothy J.Coelli, D.S. Prasada Rao Christopher J. O'Donnell and George E.Battese, 2005. An introduction to efficiency and Productivity Analysis. Springer Science-i-Business Media, Lnc: 1-181

Viet Nam General Statistics Office 2007. 2007 statistics report.

Vietnam's Fisheries Sector Country Profile 2007. TERM-PAPER SVF-3552: INTRODUCTION TO FISHERIES DEVELOPMENT MASTER IN NTERNATIONAL FISHERIES MANAGEMENT. UNIVERSITY OF TROMS□ THE NORWEGIAN COLLEGE OF FISHERY SCIENCE

Wikipedia, 2007,

http://en.wikipedia.org/wiki/Khanh_Hoa_Province#Geography_and_climate (11/2007)

http://en.wikipedia.org/wiki/Nha_Trang#Geography

7 List of appendix

7.1 Nha Trang

Appendix 1-1: Efficiency sheet (Envelopment model) in Nha Trang city

Inputs	Outputs
Input 1	Output 1
Input 2	Output 2
Input 3	
Input 4	
Input 5	

		Input-Oriented												
		CRS												
DMU No.	DMU Name	Efficiency	Σλ	RTS	Benchmarks									
1	P1	1.00000	1.000	Constant	1.000	P1								
2	P2	0.70768	1.062	Decreasing	0.412	P43	0.649	P44						
3	P3	0.78070	0.671	Increasing	0.013	P20	0.055	P32	0.603	P41				
4	P4	0.50000	0.500	Increasing	0.030	P32	0.470	P40						
5	P5	0.80152	0.667	Increasing	0.139	P40	0.528	P41						
6	P6	0.71266	0.696	Increasing	0.032	P31	0.551	P40	0.016	P41	0.017	P43	0.081	P61
7	P7	0.98255	0.983	Increasing	0.455	P33	0.464	P44	0.064	P47				
8	P8	0.97589	0.887	Increasing	0.608	P20	0.054	P31	0.062	P32	0.163	P41		
9	P9	0.79645	0.857	Increasing	0.018	P31	0.511	P43	0.163	P44	0.164	P60		
10	P10	0.74539	0.739	Increasing	0.608	P40	0.051	P43	0.081	P63				
11	P11	0.95261	0.953	Increasing	0.077	P30	0.306	P33	0.569	P44				
12	P12	0.79758	0.665	Increasing	0.646	P33	0.010	P44	0.008	P63				
13	P13	0.64560	0.529	Increasing	0.455	P33	0.074	P63						
14	P14	0.73652	0.537	Increasing	0.041	P33	0.275	P40	0.169	P44	0.052	P63		
15	P15	0.92916	0.879	Increasing	0.210	P33	0.440	P40	0.093	P41	0.136	P63		
16	P16	0.66667	0.667	Increasing	0.063	P32	0.603	P40						
17	P17	0.86917	0.855	Increasing	0.028	P31	0.728	P40	0.027	P41	0.001	P43	0.071	P61
18	P18	0.66522	0.665	Increasing	0.130	P32	0.496	P44	0.039	P61				
19	P19	0.84832	0.878	Increasing	0.058	P29	0.623	P43	0.196	P44				
20	P20	1.00000	1.000	Constant	1.000	P20								
21	P21	0.76186	0.762	Increasing	0.366	P33	0.088	P44	0.308	P47				
22	P22	0.78307	0.667	Increasing	0.466	P40	0.201	P41						
23	P23	0.98669	0.817	Increasing	0.201	P31	0.013	P32	0.264	P40	0.339	P41		
24	P24	0.66839	0.668	Increasing	0.001	P31	0.049	P32	0.612	P40	0.001	P41	0.003	P61
25	P25	0.69231	0.692	Increasing	0.692	P44								
26	P26	0.74111	0.865	Increasing	0.249	P29	0.007	P32	0.609	P44				
27	P27	0.79314	0.727	Increasing	0.009	P30	0.638	P33	0.031	P47	0.048	P63		
28	P28	1.00000	1.000	Constant	1.000	P28								
29	P29	1.00000	1.000	Constant	1.000	P29								
30	P30	1.00000	1.000	Constant	1.000	P30								
31	P31	1.00000	1.000	Constant	1.000	P31								

32	P32	1.00000	1.000	Constant	1.000	P32								
33	P33	1.00000	1.000	Constant	1.000	P33								
34	P34	0.61835	0.618	Increasing	0.003	P31	0.022	P32	0.593	P44				
35	P35	0.67107	0.671	Increasing	0.487	P44	0.086	P47	0.097	P61				
36	P36	0.51852	0.667	Increasing	0.018	P32	0.427	P40	0.222	P41				
37	P37	0.70128	0.693	Increasing	0.041	P30	0.556	P33	0.017	P41	0.078	P47		
38	P38	0.83333	0.833	Increasing	0.051	P32	0.783	P40						
39	P39	0.71325	0.763	Increasing	0.075	P31	0.073	P40	0.112	P43	0.502	P60		
40	P40	1.00000	1.000	Constant	1.000	P40								
41	P41	1.00000	1.000	Constant	1.000	P41								
42	P42	0.71464	0.681	Increasing	0.522	P33	0.083	P40	0.033	P41	0.011	P47	0.034	P63
43	P43	1.00000	1.000	Constant	1.000	P43								
44	P44	1.00000	1.000	Constant	1.000	P44								
45	P45	0.84395	0.856	Increasing	0.191	P30	0.596	P41	0.068	P47				
46	P46	0.78103	0.760	Increasing	0.596	P33	0.122	P44	0.042	P63				
47	P47	1.00000	1.000	Constant	1.000	P47								
48	P48	0.55231	0.552	Increasing	0.028	P31	0.041	P32	0.484	P44				
49	P49	0.97290	0.670	Increasing	0.031	P30	0.629	P33	0.011	P63				
50	P50	0.79948	0.680	Increasing	0.039	P31	0.032	P32	0.369	P40	0.240	P41		
51	P51	0.62411	0.624	Increasing	0.020	P31	0.015	P32	0.590	P44				
52	P52	0.85291	0.729	Increasing	0.017	P31	0.463	P40	0.079	P41	0.169	P43		
53	P53	0.59105	0.514	Increasing	0.042	P31	0.316	P44	0.155	P60				
54	P54	0.64092	0.641	Increasing	0.006	P32	0.526	P44	0.109	P61				
55	P55	0.91209	0.818	Increasing	0.204	P31	0.000	P32	0.426	P40	0.188	P41		
56	P56	0.64537	0.845	Increasing	0.660	P33	0.070	P40	0.080	P41	0.035	P63		
57	P57	0.80111	0.763	Increasing	0.432	P40	0.070	P41	0.174	P44	0.010	P61	0.077	P63
58	P58	0.95280	0.951	Increasing	0.004	P31	0.089	P40	0.004	P41	0.843	P47	0.010	P61
59	P59	0.85079	0.916	Increasing	0.062	P31	0.565	P43	0.134	P44	0.155	P63		
60	P60	1.00000	1.000	Constant	1.000	P60								
61	P61	1.00000	1.000	Constant	1.000	P61								
62	P62	0.97115	0.817	Increasing	0.308	P31	0.221	P32	0.288	P61				
63	P63	1.00000	1.000	Constant	1.000	P63								
64	P64	0.77262	0.773	Increasing	0.044	P32	0.729	P44						

Appendix 1-2: Slack sheet in Nha Trang city

Inputs	Outputs	Second Stage
Input 1	Output 1	
Input 2	Output 2	
Input 3		
Input 4		
Input 5		

Input-Oriented
CRS Model Slacks

		Input Slacks					Output Slacks	
DMU No.	DMU Name	*Input 1*	*Input 2*	*Input 3*	*Input 4*	*Input 5*	**Output 1**	**Output 2**
1	P1	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2	P2	2.65416	0.00000	0.29544	0.02336	0.00000	23.69303	0.00000

3	P3	0.34574	0.96136	0.38418	0.00000	0.00000	0.00000	0.00000
4	P4	0.73624	1.00000	0.00000	0.00000	0.00000	0.00000	26.70778
5	P5	0.15955	0.26970	0.54319	0.00000	0.00000	0.00000	54.12943
6	P6	0.32691	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
7	P7	0.00000	0.00000	0.00000	0.01273	22.61350	0.00000	0.00000
8	P8	0.00000	2.20297	0.38188	0.00000	0.00000	0.00000	0.00000
9	P9	0.09904	0.00000	0.00000	0.05230	0.00000	0.00000	0.00000
10	P10	0.00000	0.67658	0.62606	0.00000	0.00000	1.72724	0.00000
11	P11	0.00000	1.90521	0.00000	0.12859	5.35466	0.00000	0.00000
12	P12	0.00000	0.25776	0.25776	0.00000	0.00000	9.76832	0.00000
13	P13	0.00000	1.45050	0.15930	0.26907	0.00000	0.25944	0.00000
14	P14	0.00000	0.34707	1.08359	0.00000	0.00000	0.00000	0.00000
15	P15	0.00000	0.89458	0.80157	0.00000	0.00000	0.00000	0.00000
16	P16	0.00000	0.00000	0.00000	0.00000	1.93651	0.00000	46.03175
17	P17	0.27015	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
18	P18	0.10210	0.00000	0.00000	0.02605	0.00000	0.00000	0.00000
19	P19	0.27850	0.00000	0.16679	0.02705	0.00000	0.00000	0.00000
20	P20	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
21	P21	0.00000	3.04745	0.00000	0.44247	5.50809	0.00000	0.00000
22	P22	2.04444	0.23280	1.59788	0.00000	0.00000	0.00000	203.17460
23	P23	0.57700	2.11169	0.00000	0.00000	0.00000	0.00000	0.00000
24	P24	0.49471	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
25	P25	0.41538	0.00000	0.00000	0.20769	12.25385	0.00000	150.00000
26	P26	0.02063	0.00000	0.49241	0.00000	8.68374	0.00000	0.00000
27	P27	0.00000	0.08496	0.87810	0.00000	0.00000	0.00000	0.00000
28	P28	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
29	P29	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
30	P30	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
31	P31	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
32	P32	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
33	P33	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
34	P34	0.19577	1.85175	0.00000	0.12808	0.00000	0.00000	0.00000
35	P35	0.00000	0.00000	0.00000	0.01726	17.62558	0.00000	0.00000
36	P36	0.00000	0.22222	0.00000	0.00000	1.50088	0.00000	159.08289
37	P37	0.00000	0.01732	0.00000	0.00000	0.72533	0.00000	0.00000
38	P38	0.06040	0.00000	0.00000	0.00000	0.00000	0.00000	61.17963
39	P39	0.91761	0.67018	0.00000	0.00000	0.00000	0.00000	0.00000
40	P40	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
41	P41	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
42	P42	0.00000	0.03255	0.00000	0.00000	0.00000	0.00000	0.00000
43	P43	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
44	P44	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
45	P45	0.00000	2.50747	0.22331	0.00000	11.70837	0.00000	0.00000
46	P46	0.00000	0.78103	0.00000	0.49411	0.00000	5.34527	0.00000
47	P47	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
48	P48	0.09099	1.07674	0.00000	0.11859	0.00000	0.00000	0.00000
49	P49	0.00000	0.59486	0.59486	0.14393	0.00000	0.00000	0.00000
50	P50	0.76571	0.20052	0.00000	0.00000	0.00000	0.00000	0.00000
51	P51	0.00000	0.60436	0.00000	0.00293	4.23689	0.00000	0.00000
52	P52	0.44888	1.93746	0.00000	0.00000	0.00000	0.00000	0.00000

53	P53	0.10656	1.26604	0.00000	0.27025	0.00000	0.00000	0.00000
54	P54	0.17919	0.00000	0.00000	0.00113	0.00000	0.00000	0.00000
55	P55	0.47909	1.80907	0.00000	0.00000	0.00000	0.00000	0.00000
56	P56	0.00000	2.14721	0.13125	0.00000	0.00000	0.00000	0.00000
57	P57	0.00000	0.00000	0.73160	0.00000	0.00000	0.00000	0.00000
58	P58	0.00000	0.00000	0.00000	0.00000	7.66582	0.00000	0.00000
59	P59	0.00000	1.35398	0.00000	0.14759	0.00000	0.00000	0.00000
60	P60	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
61	P61	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
62	P62	0.00000	0.00000	0.30769	0.32596	32.81731	0.00000	0.00000
63	P63	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
64	P64	0.60271	0.00000	0.00000	0.16335	5.13213	0.00000	0.00000

Appendix 1-3: Target sheet in Nha Trang city

Inputs	**Outputs**	Second Stage
Input 1	Output 1	
Input 2	Output 2	
Input 3		
Input 4		
Input 5		

Input-Oriented

CRS Model Target

		Efficient Input Target					Efficient Output Target	
DMU No.	*DMU Name*	*Input 1*	*Input 2*	*Input 3*	*Input 4*	*Input 5*	Output 1	Output 2
1	P1	0.20000	2.00000	2.00000	0.80000	42.00000	50.00000	600.00000
2	P2	0.67196	2.12305	2.53530	1.10893	36.65805	58.69303	1700.00000
3	P3	0.27882	1.38074	1.95792	0.54649	27.71485	40.00000	550.00000
4	P4	0.26376	1.00000	1.00000	0.50000	11.25000	30.00000	426.70778
5	P5	0.16106	1.33333	1.86136	0.56106	11.46168	40.00000	354.12943
6	P6	0.38575	1.42533	1.42533	0.71266	23.51791	40.00000	1000.00000
7	P7	0.29477	1.96510	1.96510	1.16633	13.93740	60.00000	700.00000
8	P8	1.26865	3.65234	2.54578	0.68312	71.23967	40.00000	2100.00000
9	P9	0.77706	2.38935	2.38935	0.82379	46.99061	40.00000	2000.00000
10	P10	0.35034	1.55960	1.61012	0.74539	17.88945	41.72724	900.00000
11	P11	0.28578	1.90521	1.90521	1.20506	6.07662	60.00000	500.00000
12	P12	0.11964	1.33740	1.33740	0.79758	5.58307	39.76832	300.00000
13	P13	0.12912	1.13190	1.13190	0.63477	12.26639	30.25944	500.00000
14	P14	0.22096	1.12597	1.12597	0.58922	9.57476	32.00000	530.00000
15	P15	0.32520	1.89289	1.98591	0.92916	22.85726	50.00000	1000.00000
16	P16	0.40000	1.33333	1.33333	0.66667	21.06349	40.00000	646.03175
17	P17	0.42518	1.73833	1.73833	0.86917	21.38148	50.00000	1000.00000
18	P18	0.56311	1.33043	1.33043	0.77221	43.23910	42.00000	1000.00000
19	P19	0.73949	1.69664	2.37816	0.82127	51.74741	40.00000	2100.00000
20	P20	1.60000	5.00000	3.00000	0.70000	62.00000	40.00000	2200.00000
21	P21	0.25141	1.52372	1.52372	0.85269	40.96552	40.00000	1250.00000
22	P22	0.22646	1.33333	1.53439	0.62646	7.04762	40.00000	403.17460
23	P23	0.60703	1.83508	1.97339	0.78935	62.16168	45.00000	2000.00000
24	P24	0.37420	1.33679	1.33679	0.66839	18.04660	40.00000	620.00000

25	P25	0.27692	1.38462	1.38462	0.83077	4.36154	45.00000	450.00000
26	P26	0.42404	1.48222	1.73092	1.11166	11.32622	50.00000	600.00000
27	P27	0.15863	1.50131	1.50131	0.87245	14.27648	42.00000	570.00000
28	P28	1.00000	5.00000	3.00000	0.80000	76.00000	40.00000	3000.00000
29	P29	0.65000	1.00000	2.00000	1.50000	22.00000	40.00000	700.00000
30	P30	0.08000	2.00000	2.00000	2.00000	4.50000	60.00000	100.00000
31	P31	2.00000	3.00000	2.00000	1.20000	250.00000	40.00000	8000.00000
32	P32	2.50000	2.00000	2.00000	1.00000	270.00000	60.00000	4000.00000
33	P33	0.17000	2.00000	2.00000	1.20000	7.00000	60.00000	400.00000
34	P34	0.29891	1.23999	1.23670	0.73761	10.51192	40.00000	500.00000
35	P35	0.33553	1.34213	1.34213	0.78802	25.99371	40.00000	1000.00000
36	P36	0.25926	1.33333	1.55556	0.62222	11.98060	40.00000	459.08289
37	P37	0.14026	1.38523	1.40255	0.84153	14.00149	40.00000	500.00000
38	P38	0.43960	1.66667	1.66667	0.83333	18.75000	50.00000	711.17963
39	P39	0.79418	3.60930	2.13974	0.85590	31.38285	37.00000	1500.00000
40	P40	0.40000	2.00000	2.00000	1.00000	6.50000	60.00000	650.00000
41	P41	0.20000	2.00000	3.00000	0.80000	20.00000	60.00000	500.00000
42	P42	0.15722	1.39673	1.42928	0.78610	10.29080	40.00000	460.00000
43	P43	1.00000	2.00000	3.00000	0.80000	79.00000	40.00000	3100.00000
44	P44	0.40000	2.00000	2.00000	1.20000	6.30000	65.00000	650.00000
45	P45	0.16879	1.71230	2.30855	0.92835	21.20587	50.00000	550.00000
46	P46	0.17964	1.56206	1.56206	0.91175	10.15341	45.34527	500.00000
47	P47	0.50000	2.00000	2.00000	1.00000	123.00000	40.00000	3400.00000
48	P48	0.35085	1.13249	1.10462	0.65464	20.98771	35.00000	700.00000
49	P49	0.11675	1.35094	1.35094	0.82897	5.83740	40.00000	300.00000
50	P50	0.35356	1.39843	1.59896	0.63958	25.58331	40.00000	800.00000
51	P51	0.31206	1.26797	1.24822	0.74600	12.61409	40.00000	600.00000
52	P52	0.40403	1.47418	1.70582	0.68233	22.17568	40.00000	1000.00000
53	P53	0.36628	1.68922	1.18210	0.61633	13.59418	30.00000	700.00000
54	P54	0.33355	1.28185	1.28185	0.76797	18.58676	40.00000	800.00000
55	P55	0.61542	1.83929	1.82418	0.82088	57.46161	45.00000	2000.00000
56	P56	0.18070	1.72500	1.80486	0.96805	10.97128	50.00000	500.00000
57	P57	0.32044	1.60221	1.67172	0.80111	16.02212	45.00000	800.00000
58	P58	0.47640	1.90561	1.90561	0.95280	106.67064	40.00000	3000.00000
59	P59	0.85079	2.04919	2.55238	0.87336	79.97449	40.00000	3000.00000
60	P60	1.00000	6.00000	3.00000	1.20000	6.40000	50.00000	1000.00000
61	P61	1.00000	2.00000	2.00000	1.20000	126.30000	50.00000	4000.00000
62	P62	1.45673	1.94231	1.63462	0.93654	173.06731	40.00000	4500.00000
63	P63	0.70000	3.00000	3.00000	1.20000	122.80000	40.00000	4300.00000
64	P64	0.40170	1.54525	1.54525	0.91833	16.50136	50.00000	650.00000

7.2 Ninh Hoa

Appendix 2-1: Efficiency sheet (Envelopment model) in Ninh Hoa district

Inputs	**Outputs**
Input 1	Output 1
Input 2	Output 2
Input 3	
Input 4	
Input 5	

DMU No.	DMU Name	Input-Oriented CRS Efficiency	□□	RTS								
1	P1	1.00000	1.000	Constant	1.000	P1						
2	P2	0.93186	0.932	Increasing	0.851	P1	0.081	P31				
3	P3	0.88585	0.673	Increasing	0.350	P13	0.110	P29	0.213	P33		
4	P4	0.96429	0.857	Increasing	0.225	P8	0.108	P13	0.415	P29	0.108	P33
5	P5	0.91371	0.755	Increasing	0.462	P13	0.134	P29	0.159	P33		
6	P6	0.81392	0.727	Increasing	0.317	P13	0.324	P29	0.087	P33		
7	P7	0.75086	0.640	Increasing	0.111	P8	0.371	P13	0.046	P29	0.111	P33
8	P8	1.00000	1.000	Constant	1.000	P8						
9	P9	0.83472	0.628	Increasing	0.152	P8	0.383	P13	0.093	P33		
10	P10	1.00000	1.000	Constant	1.000	P10						
11	P11	0.77617	0.737	Increasing	0.015	P1	0.071	P8	0.492	P13	0.158	P33
12	P12	0.73297	0.640	Increasing	0.128	P8	0.365	P13	0.053	P29	0.093	P33
13	P13	1.00000	1.000	Constant	1.000	P13						
14	P14	0.87433	0.651	Increasing	0.323	P13	0.105	P29	0.223	P33		
15	P15	0.84576	0.805	Increasing	0.047	P1	0.598	P10	0.159	P13		
16	P16	0.91223	0.760	Increasing	0.027	P1	0.733	P13				
17	P17	0.86680	0.722	Increasing	0.426	P1	0.296	P13				
18	P18	1.00000	1.000	Constant	1.000	P18						
19	P19	0.81456	0.759	Increasing	0.195	P8	0.088	P13	0.421	P29	0.056	P33
20	P20	0.75501	0.663	Increasing	0.376	P8	0.243	P13	0.044	P33		
21	P21	0.72547	0.572	Increasing	0.098	P13	0.321	P29	0.153	P33		
22	P22	0.96503	0.774	Increasing	0.440	P13	0.144	P29	0.191	P33		
23	P23	0.76105	0.761	Increasing	0.742	P13	0.019	P31				
24	P24	0.79176	0.792	Increasing	0.024	P1	0.210	P10	0.347	P13	0.210	P29
25	P25	0.88566	0.712	Increasing	0.007	P1	0.084	P8	0.515	P13	0.105	P33
26	P26	0.85302	0.701	Increasing	0.282	P13	0.267	P29	0.152	P33		
27	P27	0.98387	0.779	Increasing	0.437	P13	0.137	P29	0.205	P33		
28	P28	0.71698	0.674	Increasing	0.009	P8	0.558	P13	0.063	P29	0.043	P33
29	P29	1.00000	1.000	Constant	1.000	P29						
30	P30	0.76631	0.766	Increasing	0.221	P1	0.259	P10	0.114	P13	0.173	P33
31	P31	1.00000	1.000	Constant	1.000	P31						
32	P32	0.84474	0.735	Increasing	0.312	P13	0.312	P29	0.110	P33		
33	P33	1.00000	1.000	Constant	1.000	P33						

7.3 Van Ninh

Appendix 3-1: Efficiency sheet (Envelopment model) in Van Ninh district

Inputs	**Outputs**
Input 1	Output 1
Input 2	Output 2
Input 3	
Input 4	
Input 5	

DMU No.	DMU Name	Input-Oriented CRS Efficiency	□□	RTS	**Benchmarks**							
1	P1	1.00000	1.000	Constant	1.000	P1						
2	P2	1.00000	1.000	Constant	1.000	P2						
3	P3	1.00000	1.000	Constant	1.000	P3						
4	P4	1.00000	1.000	Constant	1.000	P4						
5	P5	0.97064	0.971	Increasing	0.083	P1	0.806	P4	0.083	P7		
6	P6	0.74157	0.742	Increasing	0.428	P1	0.035	P12	0.278	P22		
7	P7	1.00000	1.000	Constant	1.000	P7						
8	P8	0.88315	0.883	Increasing	0.747	P1	0.136	P12				
9	P9	0.94447	0.944	Increasing	0.064	P1	0.367	P12	0.041	P22	0.472	P32
10	P10	0.94367	0.933	Increasing	0.557	P1	0.011	P7	0.366	P13		
11	P11	0.99211	0.992	Increasing	0.382	P1	0.611	P12				
12	P12	1.00000	1.000	Constant	1.000	P12						
13	P13	1.00000	1.000	Constant	1.000	P13						
14	P14	0.83333	0.833	Increasing	0.833	P32						
15	P15	0.90751	0.908	Increasing	0.018	P1	0.802	P4	0.087	P21		
16	P16	0.87601	0.876	Increasing	0.640	P1	0.236	P12				
17	P17	0.83226	0.832	Increasing	0.404	P2	0.172	P21	0.255	P32		
18	P18	0.90271	0.903	Increasing	0.421	P1	0.434	P12	0.048	P22		
19	P19	0.87597	0.843	Increasing	0.451	P12	0.392	P21				
20	P20	0.97566	0.940	Increasing	0.517	P12	0.423	P21				
21	P21	1.00000	1.000	Constant	1.000	P21						
22	P22	1.00000	1.000	Constant	1.000	P22						
23	P23	0.98553	0.850	Increasing	0.136	P3	0.501	P4	0.213	P21		
24	P24	0.69603	0.696	Increasing	0.022	P21	0.117	P22	0.557	P31		
25	P25	0.94975	0.950	Increasing	0.297	P1	0.030	P21	0.001	P31	0.622	P32
26	P26	0.76903	0.769	Increasing	0.218	P2	0.082	P21	0.469	P32		
27	P27	0.88112	0.881	Increasing	0.629	P1	0.035	P7	0.217	P32		
28	P28	0.83333	0.833	Increasing	0.833	P32						
29	P29	0.76974	0.770	Increasing	0.296	P1	0.089	P12	0.385	P32		
30	P30	1.00000	1.000	Constant	0.200	P12	0.800	P31				
31	P31	1.00000	1.000	Constant	1.000	P31						
32	P32	1.00000	1.000	Constant	1.000	P32						
33	P33	0.83333	0.833	Increasing	0.417	P12	0.417	P32				

7.4 Cam Ranh

Appendix 4-1: Efficiency sheet (Envelopment model) in Cam Ranh district

Inputs	**Outputs**
Input 1	Output 1
Input 2	Output 2
Input 3	
Input 4	
Input 5	

		Input-Oriented												
	DMU	CRS												
DMU No.	Name	Efficiency	□□	RTS	**Benchmarks**									
1	P1	0.70538	0.705	Increasing	0.407	P3	0.045	P5	0.053	P28	0.192	P32	0.009	P33
2	P2	0.74340	0.856	Increasing	0.056	P3	0.239	P15	0.048	P17	0.364	P20	0.150	P30
3	P3	1.00000	1.000	Constant	1.000	P3								
4	P4	0.85792	0.858	Increasing	0.299	P17	0.396	P30	0.163	P32				
5	P5	1.00000	1.000	Constant	1.000	P5								
6	P6	0.84412	0.844	Increasing	0.175	P5	0.083	P12	0.586	P32				
7	P7	0.64421	0.594	Increasing	0.162	P12	0.050	P15	0.001	P26	0.381	P32		
8	P8	0.80020	0.776	Increasing	0.362	P12	0.168	P17	0.025	P20	0.146	P30	0.074	P32
9	P9	0.92674	0.927	Increasing	0.733	P12	0.015	P29	0.179	P32				
10	P10	0.97239	0.944	Increasing	0.775	P12	0.058	P15	0.096	P26	0.015	P32		
11	P11	0.80045	0.800	Increasing	0.024	P3	0.044	P12	0.166	P32	0.566	P33		
12	P12	1.00000	1.000	Constant	1.000	P12								
13	P13	1.00000	1.000	Constant	1.000	P13								
14	P14	0.95380	0.954	Increasing	0.462	P12	0.402	P13	0.089	P32				
15	P15	1.00000	1.000	Constant	1.000	P15								
16	P16	0.97258	0.973	Increasing	0.119	P13	0.030	P24	0.665	P26	0.158	P32		
17	P17	1.00000	1.000	Constant	1.000	P17								
18	P18	0.98313	0.891	Increasing	0.185	P3	0.108	P5	0.215	P26	0.383	P32		
19	P19	0.99855	0.930	Increasing	0.208	P30	0.303	P32	0.419	P34				
20	P20	1.00000	1.000	Constant	1.000	P20								
21	P21	0.78431	0.784	Increasing	0.157	P12	0.627	P32						
22	P22	0.94604	0.946	Increasing	0.388	P12	0.248	P26	0.310	P32				
23	P23	0.93828	0.899	Increasing	0.201	P5	0.039	P15	0.313	P26	0.347	P32		
24	P24	1.00000	1.000	Constant	1.000	P24								
25	P25	0.83205	0.800	Increasing	0.241	P12	0.033	P15	0.171	P26	0.355	P32		
26	P26	1.00000	1.000	Constant	1.000	P26								
27	P27	0.85100	0.851	Increasing	0.490	P12	0.361	P32						
28	P28	1.00000	1.000	Constant	1.000	P28								
29	P29	1.00000	1.000	Constant	1.000	P29								
30	P30	1.00000	1.000	Constant	1.000	P30								
31	P31	0.67059	0.671	Increasing	0.035	P5	0.635	P32						
32	P32	1.00000	1.000	Constant	1.000	P32								
33	P33	1.00000	1.000	Constant	1.000	P33								
34	P34	1.00000	1.000	Constant	1.000	P34								
35	P35	0.64066	0.601	Increasing	0.156	P12	0.079	P15	0.005	P20	0.361	P32		
36	P36	0.92229	0.667	Increasing	0.373	P12	0.274	P13	0.019	P24				

7.5 Questionnaire

Sumary about questionnaire: This questionnaire is used by Dr. Pham Xuan Thuy for his thesis about commodity Black Tiger Prawn (*Penaeus monodon*) aquaculture. Following name and address of the producer, part 1 is general information about aquaculture such as the level of education, sex, technical level of the producer, number labour in aquaculture farm, aquaculture land form and origin of land of the producers, etc. The part 2 is shrimp aquaculture actual state such as pond characteristic, breed shrimp source, number of crop, food, feed time, environmental management, the aquaculture crop result and economic efficiency, etc. The part 3 is difficult, developed trend and gives recommened of the producers.

BO GIAO DUC VA ÑAO TAO
TRÖÔNG ÑAI HOC THUY SAN
....ooo0ooo....

TAP PHIEU ÑIEU TRA TRANG TRAI
NUOI TOM

Ho va ten chu trang trai :

....

Thon, ban, ap:

....

Xa:

....

Huyen:

....

Tỉnh:
....

Ngay .....thang.....nam ......
Can bo ñieu tra, nghiem thu
(ky, ghi ro ho, ten)

Chu trang trai
(ky, ghi ro ho, ten)

Ngay .....thang.....nam .....
Ñieu tra vien
(ky, ghi ro ho, ten)

BANG ÑIEU TRA KINH TE –XA HOI VA HIEN TRANG KY THUAT NUOI TOM SU THÖÔNG PHAM

PHAN I: THONG TI N CHUNG VE TRANG TRAI

1.Ho va ten chu trang trai :...tuoi.......................

2.Giôi tính cua chu trang trai : (ghi so thích hôp vao o trong)

1.Nam

2.Nö

3.Dan toc: (ghi so thích hôp vao o trong)

1.Kinh

2.Khac

4.Trình ño hoc van cua chu trang trai: (ghi so thích hôp vao o trong)

1.Khong biet chö

2.Cap I

3.Cap II

4.Cap III

5. Trình ño chuyen mon cua chu trang trai: (ghi so thích hôp vao o trong)

1. Khong bang cap
2. Sô cap
3. Trung cap
4. Ñai hoc

1. Nganh kinh te
2. Nganh nuoi trong thuy san
3. Ky thuat khac
4. Nganh khac

6.Nhan khau hien co cua gia ñình chu trang trai (ngöôi)

7. So lao ñong trong ño tuoi cua gia ñình chu trang trai (ngöôi)

8. So lao ñong tren ño tuoi cua gia ñình chu trang trai (ngöôi)

9. So lao ñong döôi ño tuoi cua gia ñình chu trang trai (ngöôi)

ÑAT ÑAI CUA CHU TRANG TRAI

Ñôn vò tính: Ha

TT	Chæ tieu	Ma so	Nam		
			1999	2000	2001
	A	B	1	2	3
I	**Tho cö**	**01**			
II	**Ñat nong nghiep**	**02**			
1	Ñat trong cay hang nam	03			
2	Ñat trong cay lau nam	04			
	+Cay cong nghiep	05			
	+Cay an qua	06			
3	Ñat dung cho chan nuoi	07			
III	**Ñat lam nghiep**	**08**			
1	Röng khoanh nuoi	09			
2	Röng trong	10			
3	Ñat trong ñoi troc	11			
V	**Mat nöôc nuoi trong thuy san**	**12**			
	Cong = (01 + 02 + 08 + 12)				

NGUOÀN ÑAÁT NUOÂI TROÀNG THUÛY SAÛN CUÛA CHUÛ TRANG TRAÏI

Ñôn vò tính: Ha

Thöù töï	Chæ tieâu	Maõ soá	Maët nöôùc nuoâi troàng thuûy saûn
I	**Ñaát ñaõ ñöôïc giao**	**01**	
II	**Ñaát chöa ñöôïc giao**	**02**	
1	Ñaát nhaän thaàu HTX		
2	Thueâ cuûa tö nhaân		
3	Nhaän chuyeån nhöôïng		
4	Nhaän caàm coá		
5	Töï khai hoang		
6	Thaàu cuûa noâng laâm tröôøng		
7	Nhaän khoaùn cuûa döï aùn		
8	Nguoàn khaùc		
Coäng (01+02)			

PHAÀN II: HIEÄN TRAÏNG NUOÂI TOÂM

1. Ñaëc ñieåm ao nuoâi toâm:

-Dieän tích maët nöôùc / dieän tích ñaát........................

-Hình daïng ao........................daøi...............m; roäng......................m

-Soá löôïng coáng......................chieác

-Khaåu ñoä coáng.......................m

-Heä thoáng caáp nöôùc (ghi soá thích hôïp vaøo oâ troáng)

1. Chung ☐
2. Rieâng

-Ñoä saâu ao nuoâi.....................m

-Chaát ñaùy ao nuoâi (ghi soá thích hôïp vaøo oâ troáng)

1. Cat bun
2. Bun cat
3. Bun
4. Cac loai ñay khac

2.Hình thöc nuoi: (ghi so thích hôp vao o trong)

1. Quang canh truyen thong
2. Quang canh cai tien
3. Ban tham canh
4. Tham canh

3.Xö ly ao (ghi so thích hôp vao o trong)

-Thôi gian cai tao: Vu 1.............ngay; Vu 2...........ngay; Vu 3...........ngay

-Co vet bun ñay khong :

1.Co

2.Khong

-Co cay sôi khong

1.Co

2.Khong

-Co phôi ñay khong :

1.Co

2.Khong

-Co khö trung voi khong

1.Co, (khoi löông ....kg/m^2)

2.Khong

-Diet tap:

1.Khong diet tap

2.Diet tröôc vu nuoi

3.Diet giöa vu nuoi

Thuoc diet................................lieu löông..........................

4.Con giong:

Chat löông giong: (ghi so thích hôp vao o trong)

1.Toát 3.Trung bình

2.Xaáu 4. Khoâng coù yù kieán

-Soá löôïng.........................con

-Maät ñoä...........................con/m^2

-Kích thöôùc gioáng......................

-Nguoàn gioáng............................

1.Töï mình ñeán traïi mua

2.Ngöôøi khaùc mang ñeán

3. Hình thöùc khaùc

5. Soá vuï nuoâi (ghi soá thích hôïp vaøo oâ troáng)

1. 1 Vuï (töø thaùng.........ñeán thaùng...........)

2. 2 Vuï (töø thaùng.........ñeán thaùng...........)

3. 3 Vuï (töø thaùng.........ñeán thaùng..........)

6. Thöùc aên : (ghi soá thích hôïp vaøo oâ troáng)

1.Thöùc aên cheá bieán

2.Thöùc aên coâng nghieäp

3.Thöùc aên töôi soáng

4. Thöùc aên hoãn hôïp

7. Thôøi gian cho aên (ghi soá thích hôïp vaøo oâ troáng)

1. Moät laàn; thôøi gian cho aên............. giôø

2. Hai laàn; thôøi gian cho aên.............. giôø

3. Ba laàn; thôøi gian cho aên.............. ..giôø

4. Boán laàn; thôøi gian cho aên.............. giôø.

-Caùch cho aên

1.Raûi ñeàu

2.Cho aên theo khu vöïc

-Heä soá thöùc aên..

8. Quaûn lyù moâi tröôøng: (ghi soá thích hôïp vaøo oâ troáng)

1.Hình thöùc thay nöôùc :

Coù ao chöùa laéng:

1.Coù

2. Khoâng

Coù söû lyù nöôùc tröôùc khi thay nöôùc khoâng

1. Coù
2. Khoâng

Thay nöôùc haøng ngaøy

1.Coù

2.Khoâng

Thay nöôùc haøng tuaàn

1.Coù

2.Khoâng

Thay theo con nöôùc

1.Coù

2.Khoâng

Coù maùy bôm nöôùc khoâng

1.Coù

2. Khoâng

Soá maùy..................................

Teân maùy...............................

Coâng suaát.............................

Coù maùy quaït nöôùc hoaëc maùy suïc khí khoâng

1.Coù

2. Khoâng

Soá maùy..................................

Teân maùy...............................

Coâng suaát.............................

Maøu nöôùc ao nuoâi toâm ....

9. Caùc beänh thöôøng gaëp vaø muøa vuï xuaát hieän

Beänh	Vuï 1	Vuï 2	Vuï 3

	(Thang 1,2-4,5)	(Thang 5,6-8,9)	(Thang 9,10-11,12)
Vi rus SEMBV			
Vi rus MBV			
Vibro			
Sinh vat bam			
Ñen mang			
Mem vo			
Bao tö nho			
Phong mang			
Nam			
Ño than			
Thieu oxy			
Ñen mang, thoi mang			
Cut ñuoi rop than			
An mon vo kitin			
Rong bam ban than			
Ñau vang			
Cac loai benh khac			

10.Cac loai thuoc thöông sö dung

- Tron Vitamin B1; C vao thöc an......................
- Tron khang sing vao thöc an............................
- Cac loai hoa chat khac....................................

KET QUA NUOI VA HIEU QUA KINH TE

Khoan muc	Ma so	Nam		
		1999	2000	2001
1.Tong dien tích ao/so ao	01			

2.So vu nuoi	02			
3. Tong san löông	03			
+ San löông cao nhat	04			
+ San löông thap nhat	05			
4. Loai tom thu hoach	06			
+Loai lôn nhat	07			
+Trung bình	08			
5.Tong thu nhap	09			
6.Chi phí vat chat va dòch vu	10			
-Gong	11			
-Thöc an	12			
-Phong trö dòch benh	13			
-Nang löông	14			
-Khau hao tai san co ñình	15			
-Thue may moc phöông tien	16			
-Chi phí vat chat khac	17			
-Chi phí dòch vu khac	18			
7. Chi phí lao ñong	19			
+Trong ño: lao ñong thue	20			
8. Chi phí khac	21			
Tong chi (10+19+21)				

PHAN III: KHO KHAN, HÖÔNG PHAT TRIEN VA KHUYEN NGHÒ CUA GIA ÑÌNH

1.Kho khan gap phai trong nuoi tom(ghi so thích hôp vao o trong)

1.Thieu von 2 Thieu ky thuat

3. Thò tröông 4 Chat löông con giong

5.Thieu lao ñong 6.Kho khan khac

2.Höông phat trien nuoi tom trong cac trang trai (ghi so thích hôp vao o trong)

1. Khong ñoi 2 Tang dien tích nuoi

3. Tang trang thiet bò 4 Nang cap ao ñìa

5.Thay ñoi hình thöc 6.Höông khac

3.Kien nghò cua gia ñình (ghi so thích hôp vao o trong)

1. Giup ñô von 2.Giup ñô ky thuat

3.Giup ñô con giong 3.Kien nghò khac

Chu trang trai, ky ten Ngöôi ñieu tra, ky ten