Factors Affecting Efficiency Of Police Stations In Metropolitan Police Division 3

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Abstract

The objective of this research is to evaluate the relative performance efficiency and determine factors affecting the efficiency of 11 police stations in the Metropolitan Police Division 3. The first stage is to analyze the efficiency of the police station by Data Envelopment Analysis (DEA) that measures the variable return to scale (VRS) and considering output-orientation. Input variable is the number of police officers. Output variables are the percentage of arrests with remand in custody, the percentage of arrests with remand in traffic offences, average score of people's satisfaction on facilities of the police station, operational processes and service of staffs. For the second stage, factors affecting the performance efficiency of the police station are analyzed using multiple regression analysis. Efficient score calculated in the first stage is defined as the dependent variable. The results show that 4 police stations are technically efficient and there is only one police station with scale efficiency. In addition, the population density within the area responsible for the police station has affected the pure technical efficiency of the police station. The number of community resources within the area responsible for the police station has an effect on the scale efficiency of the police station.

Keywords

Police station, Pure Technical Efficiency, Scale efficiency, Data Envelopment Analysis, Multiple Regression Analysis

1. Introduction

The police station is an important operational unit of the Royal Thai Police (RTP) known as the national police of Thailand. Each police station has responsibility of an area and aims to keep the community in that area safe, prevent crimes, and facilitate in traffic control. Therefore, inefficient performance in the police station leads to social problem. There have attempted to improve the process of services to people who have suffered from crime and violence and require justice or fairness in term of one stop service to make satisfaction (Police department, 1998).

Neely (2004) stated that the appropriate performance measure indicates a well-defined structure of facilities for moving towards achieving an organization's goals and targets. Data Envelopment Analysis (DEA) has been used for evaluating efficiency of various types of the firms or entities called "Decision Making Units (DMU's)" based on the multiple inputs and the multiple outputs. The term DMU is used to wide variety of activities, including governmental, not-for-profit and business units and sub-units (Songsrirote and Singhapreecha, 2006).

Bangkok is the capital of Thailand and also the center of the administrative, political, and economic systems of the country. The police stations in Bangkok are the significant roles in the improvement of infrastructure in the nation and show performance which have affected on people's confidence in security and make investor's confidence in life, property, and business (Royal Thai Police, 2018). According to the organizational chart of the RTP, the metropolitan police bureau is the law enforcement agency for the police stations serving in Bangkok.

Since there are no scientific standard measures of evaluating police station's performance efficiency, this paper aims to measure the efficiency of a police station of the Metropolitan Police Division 3 consisting of 11 stations using DEA model. .In addition, the environmental variables are analyzed to explain the effect level on the efficiency of the police station using the multiple regression analysis. The second section shows the DEA model and efficiency

concepts and the next section shows the research framework. As for the fourth one, it presents the results of the analysis. There is the conclusion in the last section.All figure numbers must be mentioned in the body of the paper.

2. Literature Reviews

Data Envelopment Analysis (DEA) known as frontier analysis is used to evaluate the relative efficiency of decision-making units (DMU's) in the organisation. It is a non-parametric approach underlying linear programming (LP) to calculate the efficient score based on the multiple input and output variables. DEA produces a piecewise efficient frontier, which represents the frontier of best practice for the population of observations. This represents the maximum output that can be expected from any DMU in the population given the level of its inputs.

Technical efficiency (TE) refers to the ability to produce outputs given the fewest inputs, or resources. It depends on the input and output factors of the DMU. There are two approaches to measure the technical efficiency: input oriented and output oriented approaches. It can say that the DMU is the input-oriented technical efficiency if a decrease in any inputs requires the same outputs. In considering the output orientated approach, it will be considered that the DMU can increase the output under the existing input variables. Two classical models used to measure DMU performance are:

1) Charnels, Cooper and Rhodes: CCR-DEA model (Charnes et al.,1978)

Given DMU_k; k = 1, 2, ..., n, and considering the proportional increase in outputs when inputs increase under the concept of Constant Returns to Scale (CRS). The input-oriented CCR model can be written in a linear programming model with the objective function in equation (1) under constraint conditions in equations (2) - (4)
Objective function

$$\text{Max} \quad \tau_j = \sum_{r=1}^{s} u_r y_{rj} \tag{1}$$

Subjective to

$$\sum_{i=1}^{m} v_i x_{ij} = 1, \tag{2}$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0; \quad (j = 1, 2, ..., n), \tag{3}$$

$$u_r, v_i > 0; \quad (r = 1, 2, ..., s; i = 1, 2, ..., m), \tag{4}$$

, where

τ_j represents the efficiency of the DMU *j*

x_{ij} represents the input variable *i* of the DMU *j*

y_{rj} represents the output variable *r* of the DMU at *j*.

DMU_k is efficiency when $\tau_j = 1$ and it is optimal at $v_i > 0$ for all *i* and $u_r > 0$ for all *r*. The objective of the CCR-DEA model is to determine the maximum of the overall technical efficiency (TE_{CRS}) as Equation (1) considering the Constant Returns to Scale (CRS). The overall efficient score is from 0 to 1. If the efficient score is closer to 1, the DMU is more efficiency. If the efficient score is closer to 0, the DMU is inefficiency. Cooper et al. (2004) reported that the CCR-DEA has been utilized in the numerous applications of non-profit sector, the public sector and the private sector.

2) Banker, Charnes and Cooper: BCC-DEA model (Banker et al., 1984)

The CCR-DEA model has a limitation in its use for the DMU or organization in perfect competition. Later, in 1984, the Banker, Charnes and Cooper developed the model to solve such problems. This is called the BCC. The purpose is to find the value of the efficient score under the assumption of Variable Returns to Scale (VRS). The

efficient score is the pure technical efficiency (TEVRS). It can be written in linear programming model with the objective function as in the equation (5) under constraint conditions, equation (6) - (8)
Objective function

$$\text{Max} \quad \tau_j = w_j + \sum_{r=1}^{s} u_r y_{rj} \tag{5}$$

Subjective to

$$\sum_{i=1}^{m} v_i x_{ij} = 1, \tag{6}$$

$$w_j + \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0; \quad (j = 1, 2, ..., n), \tag{7}$$

$$u_r, v_i > 0; \quad (r = 1, 2, ..., s; i = 1, 2, ..., m), \tag{8}$$

, where

τ_j represents the efficiency of the DMU *j*
W_j represents the change in variables in the DMU at *j*.
x_{ij} represents the input variable *i* of the DMU *j*.
y_{rj} represents the output variable *r* of the DMU at *j*.
v_i represents the weighted value of the input variable *i*.
u_r represents the weighted value of the output variable *r*.
m represents the number of input variables.
s represents the number of output variables.
n represents the total number of DMUs.

Coelli et al. (1998) proposed the scale efficiency of the DMU. The scale efficient (SE) score ranges from 0 to 1. It can been calculated from Equation (9)

$$SE = \frac{TE_{CRS}}{TE_{VRS}} \tag{9}$$

, where

TE_{CRS} is the technical efficient score based on the Constant Returns to Scale.
TE_{VRS} is the pure technical efficient score based on the Variable Returns to Scale

The SE score is an indication of the efficiency of the DMU's production scale, by measuring how well the DMU's ability to convert inputs into yields compares to the best performance of a DMU. Equal If the SE value is 1.00, it means that the DMU is produced at the appropriate production size. That is, the output of the DMU is a return to fixed size, while the SE of less than 1 indicates the inefficiency of the DMU's output. That is, the DMU produces a return on size. Increase or decrease return on size.

Akdogan (2012) studied the efficiency of the police station in Ankara, Turkey using data envelopment analysis. The input variables are the area of responsibility (square meter), the number of important units in the area such as school, hospital, the number of incoming documents, the number of events in the area The output variables are the number of judicial and administrative documents processed the number of output documents, the number of lawsuits corrected. The results show that 19 police stations in Ankara are efficiency. It can say that 52.6 percent of all police stations are efficiency. Therefore, inefficient police stations in this study should reduce the number of incidents or crimes in the area. Crime prevention is achieved through the use of community peacekeeping strategies. Therefore, policemen should focus on the use of community policing strategies.

Wu et al. (2010) applied data envelopment analysis to evaluate performance levels for police forces operating over the island in Taiwan. Input variables include labor cost, operating cost, equipment purchasing cost. Six output

variables are divided into two main categories. The first set of variables cover reactive measures, such as the number of cleared up burglaries, the number of cleared up violent crimes and the number of cleared up for other crimes. The second set of variables involve proactive and preventive measures such as the number of road traffic accidents, the number of general and special services, and residents' satisfaction to public security. The environmental factors are incorporated into the DEA model. The results showed that most decision making units are technically efficient. Moreover, the average technical efficiency of all DMUs was increased when environmental factors are considered.

Gorman and Ruggiero (2008) conducted the research study to evaluate the efficiency of state police services in 49 continental states of United States using a multiple-stage data envelopment analysis approach. Input variables are the following: the number of police officers, the number of vehicles, whereas output variables are the number of murders, the number of violent crimes. The results show that most states are technically efficient, but almost 50% of police stations are smaller than the optimal scale size.

Drakea and Simper (2000) studied the efficiency of the police forces in England and Wales using data envelopment analysis and evaluate the scale effects using multiple discriminant analysis (MDA). Input variables in the model consist of employment costs, premises-related expenses and capital financing costs including costs associated with equipment. Output variables are clear-up rates, the total number of traffic offenses. The results reveal that police forces in Surrey, England have 38% less efficient than the efficient reference and only 3 police forces (Cleveland, Dorset and Leicestershire) are regularly efficient.

3. Research Methodology

The population in this study is the police stations which operate in setting the direction of the Metropolitan Police Division 3 consisting of 11 police stations

1. Minburi Police Station
2. Romklao Police Station
3. LatKrabang Police Station
4. Chorakaenoi Police Station
5. Chalong Krung Police Station
6. NongChok Police Station
7. Lumpakchee Police Station
8. Suwinthawong Police Station
9. Nimit Mai Police Station
10. Lamhin Police Station
11. PrachaSamran Police Station

The data used in this study are based on both primary and secondary data. Primary data is the residence's satisfaction to services of the police stations. The sample size is approximately 490. Secondary data used in the analysis are: the number of police officers, the number of volunteers, the number of litigations issued and the number of cleared-up cases. They have been recorded in the police database between January and December 2017, including the area size covering the police station, the population in the area, the number of communities.

The approach to conduct this research is divided into two phases. First stage starts with the evaluation of the efficiency of the police station using the BCC-DEA model considering the output-orientation because the output does not increase in proportion to the increase in input variables. It is focus on increasing productivity under existing resources. After, the analysis of the relationship between the independent variables and the pure technical efficient scores and the scale efficient score viewed as the dependent variable is performed using the multiple regression analysis. The variables used in each step of analysis can be described as follows.

Step 1: The output variables used to study the efficiency of the police station are a percentage of the number of cleared up criminal cases, the percentage of the number of cleared up traffic crashes that occurred, an average score of satisfaction on police station facilities, process flow and service of the police officers. The output factors indicate the successful achievement of the police station in keeping the peace in the community. The input variable of production performance is the number of officers. The limitation has the impact on capability to handle the problems that arise with the people and leads to greater public satisfaction. Table 1 and Table 2 show the inputs and outputs used in this study.

Table 1. Input variable

No.	Variable	Notations
1	Numbers of officers	x_1

Table 2: Output variable

No.	Variable	Notations
1	The percentage of arrests with remand in custody from the total amount of arrests	y_1
2	The percentage of arrests with remand in traffic offences from the total amount of traffic offences	y_2
3	An average score of people's satisfaction on facilities of the police station, operational processes and the service of the staffs (Out of 5)	y_3

Step 2: The external factors affecting the efficiency of the police station are analysed using the multiple regression analysis. The pure technical efficient score calculated from the first step is assigned to be the dependent variable Y. All independent variables are shown in Table 3.

Table 3: Independent variables

No.	Variable	Notations
1	The population density (people per square meters)	X_1
2	The number of communities	X_2
3	The number of police volunteers	X_3

4. Results

There are 1,351 police officers over police stations of the Metropolitan Police Division 3. It reveals that Minburi Police Station has the highest number of police officers, while Lamhin Police Station has the lowest number of police officers. An average number of police officers is 112 and a standard deviation of police officers is 51.12.

Chalong Krung Police Station has the highest percentage of arrest rate for criminal cases and traffic offences, whereas, Romklao Police Station has the smallest percentage of arrest rate for criminal cases. Meanwhile, LatKrabang Police Station has the smallest percentage of arrest rate for traffic offences.

The minimum, maximum, average and standard deviation of the people's satisfaction score (out of 5 points) for all of 11 police stations are shown in Table 4. The police station with the lowest satisfaction score is Chalong Krung Police Station and the police station with the highest satisfaction score is Lumpakchee Police Station.

Table 4**:** A descriptive Statistical Analysis for input and output variables

Variable	Parameter	Value
Numbers of police officers	Minimum	51.000
	Maximum	239.000
	Mean	112.182
	Standard deviation	51.117
The percentage of arrests with remand in custody from the total amount of arrests	Minimum	56.102
	Maximum	100.000
	Mean	83.546
	Standard deviation	13.635

Variable	Parameter	Value
The percentage of arrests with remand in traffic offences from the total amount of traffic offences	Minimum	72.727
	Maximum	100.000
	Mean	89.804
	Standard deviation	11.291
An average score of people's satisfaction on facilities of the police station, operational processes and the service of the staffs (Out of 5)	Minimum	2.833
	Maximum	3.943
	Mean	3.371
	Standard deviation	0.312

The study will be divided into two phases as discussed in Section 3. The details of the results obtained from the analysis at each stage can be displayed as follows.

Step 1: The efficient score of 11 police stations are analysed using DEAP 2.1 software. As a result, there are 4 police stations with VRS pure technical efficiency (TEVRS) or operational efficiency, while there is only one police station is CRS technical efficiency (TECRS) and scale efficiency. The Technical Efficiency (TECRS), Pure Technical Efficiency (TEVRS) and Scale Efficiency (SE) score of each police station are showed in Table 5, and the frequency of each efficient score interval obtained from both models is presented in Table 6.

Table 5: TE_{CRS}, TE_{VRS} and SE

Police Station	TE_{CRS}	TE_{VRS}	SE	Returns to scale
Minburi	0.205	0.960	0.213	drs
Romklao	0.308	0.785	0.393	drs
LatKrabang	0.384	0.910	0.421	drs
Chorakaenoi	0.414	0.990	0.418	drs
Chalong Krung	0.395	1.000	0.395	drs
NongChok	0.420	0.890	0.472	drs
Lumpakchee	0.709	1.000	0.709	drs
Suwinthawong	0.689	1.000	0.689	drs
Nimit Mai	0.408	0.960	0.425	drs
Lamhin	1.000	1.000	1.000	-
PrachanSamran	0.744	0.905	0.822	drs

Table 6: The frequency table of 11 police station's efficient score

Class of efficient score	The number of police stations			
	CCR-DEA Model		BCC-DEA Model	
	Frequency	Percentage	Frequency	Percentage
1 (Efficiency)	1	9.10	4	36.36
0.81-0.99	0	0.00	7	63.64
0.61-0.80	3	27.27	0	0.00
0.41-0.60	3	27.27	0	0.00
0.21-0.40	4	36.36	0	0.00
0.00-0.20	0	0.00	0	0.00

It is found that 10 police stations are not scale efficiency. The scale efficiency of the police station is influenced by the operational process. It shows that there are decreasing returns to scale (drs) in these police stations. It can say that the scale of the police station is too large. The output is expected to increase in less proportion to the increase in

inputs. It is not economical to expand the number of police officers. Furthermore, 7 police stations are not technically efficient. Namely, the increase of the percentage of cleared up criminal cases and traffic offences should be in line with the number of police officers working in each police station.

Step 2: Stepwise method is applied to select the variables. It reveals that the external factors affecting the pure technical performance of the police station is the population density within the responsible area of the police station. It can see the negative coefficients of the variables. It can explain that the pure technical efficiency of the police station decreases when the density of population within the area responsible for the police station increases. The coefficient of determinant (R2) is 35.81%. The pure technical efficiency can be predicted in Equation (10).

$$Y_1 = 0.9923 - 0.000024 \times (X_1) \quad (10)$$

The external factors affecting the scale efficiency of the police station is the number of communities within the area responsible for the police station. The coefficients of the variables were negative that is the scale efficiency of the police station decreasing as the number of community resources within the police station area increasing. The coefficient of determinant (R2) is 29.85%. The prediction equation is shown in Equation (11).

$$Y_2 = 0.7173 - 0.00687 \times (X_2) \quad (11)$$

5. Discussion

This study aims to measure the relative efficiency of the police stations under Metropolitan Police Division 3 using DEA technique.

1) The results of comparative studies of efficiency's eleven police stations are summarized as follows. Based on CCR and BCC efficient scores, only one police station: Lamhin Police Station is efficiency in both two models, including the scale efficiency. Ten police stations have decreasing return on size. In practice, the inefficient police station should increase outputs. Namely, there is increasing the cleared-up arrest rate of crimes and traffic offences. On the other hands, there is reducing the number of crimes and traffic offences.
2) Environment factors affecting the pure technical efficiency of the police station include are the population density within the responsible area of the police station. Whereas the environment factors affecting the scale efficiency of the police station are the number of communities within the area responsible of the police station. The coefficients of both variables are negative. It can say that the efficiency of the police station decreases when the value of both variable increases.

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