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Atika Aqmarina
Department of Economics, Universitas Indonesia., atikaaqmarina@gmail.com

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Determinants of Port Performance – Case Study of 4 Main Ports in Indonesia (2005–2015)

Atika Aqmarina[a,*], and Nuzul Achjar[a]

[a] *Department of Economics, Universitas Indonesia*

Abstract

Port plays significant role in supporting economic growth of a country. This study aims to analyze the determinant of port performance in Indonesia. In this research, the ports selected are four main ports in Indonesia which are Port of Belawan, Port of Tanjung Priok, Port of Tanjung Perak, and Makassar. These ports are designed as the hub ports in the national sea transport system of the country. The study used pooled OLS as the methodology to analyze the determinant. The result of this studies shows that total traffic is not influenced by operating surplus per ton, whereas the rest of variables such as turnaround time, idle time, berth of occupancy rate, rate of return, number of employee and cargo equipment have significant results and significantly influenced the total traffic.
Keywords: port; port performance; Indonesia; determinants of port performance; ports in Indonesia

Abstrak

Pelabuhan mempunyai peran penting dalam mendukung pertumbuhan ekonomi suatu negara. Tujuan diadakannya penelitian ini adalah untuk menganalisis faktor penentu kinerja pelabuhan di Indonesia. Dalam penelitian ini, empat pelabuhan utama dipilih sebagai sampel, yaitu Pelabuhan Belawan, Pelabuhan Tanjung Priok, Pelabuhan Tanjung Perak, dan Makassar. Penelitian ini menggunakan metoda OLS sebagai metodologi untuk menganalisis determinan. Hasil dari penelitian ini menunjukkan bahwa Total Traffic tidak dipengaruhi oleh Operating Surplus per Ton. Sementara itu, variabel-variabel lainnya yang digunakan seperti average ship turnaround time, idle time, berth occupancy rate, rate of return, number of employees dan cargo equipment terbukti memberikan pengaruh yang signifikan terhadap Total Traffic.
Kata kunci: *pelabuhan; kinerja pelabuhan; Indonesia; faktor penentu kinerja pelabuhan; pelabuhan di Indonesia*

JEL classifications: R41; R42

1. Introduction

Infrastructure is one of the key aspects supporting a country's competitive position in the global environment. Grigg (1988) defines infrastructure as the physical system that provides transportation, drainage, building and other public goods used to fulfill the needs of people in the nation. Under Global Competitiveness Index calculation methods, infrastructure is considered as a basic requirement for factor-driven economies and the second pillar of the required twelve.

Seaports, as part of infrastructure, are believed to have substantial role in managing the supply chain which involves the production and distribution of commodities, which would in turn affect the nation's development. Jouili & Allouche (2014) stated that seaports are seen as a factor of economic growth which have high contribution levels to the development of economic sectors, as well as to the gen-

* *Corresponding Author*: Department of Economics, Universitas Indonesia, Jl. Prof. Dr. Sumitro Djojohadikusumo, Beji, Kukusan, Beji, Depok, West Java, 16424, Indonesia. Email: atikaaqmarina@gmail.com.

eration of economic benefits. This is so for most countries in the world, particularly countries that are archipelagic in nature, such as Indonesia, Philippines, and the Caribbean countries. Port services is indisputably important for such countries due to the nations' nature that frequently relies on maritime systems to channel goods within or outside the country.

Seaports have quite lot of functions since it will help the country to distribute the goods domestically and internationally which served as the gateways of trade and influencing development and growth of nations. However, this great potential is yet to be utilized properly by Indonesia and is behind compared to other maritime countries in Southeast Asia. The condition of ports in Indonesia are categorized as below average compared to the rest of the world. In fact, The Jakarta Post[1] reported that the poor connectivity of infrastructure in Indonesia caused increases in logistic cost, resulting in logistics fees in Indonesia appearing more expensive compared to the ASEAN average. Based on the Logistics Performance Index (LPI) which ranks maritime sector improvements, Indonesia ranked 63rd out of 160 countries in 2016.

Hence, knowing seaports is an important factor that affect the distribution of goods, especially for Indonesia, it is such motivation for the author to conduct this research in order to examine the factors that might influence performance of port in Indonesia. This research will use 4 main ports in Indonesia as the sample. Additionally, this research will also examine the current conditions of ports in Indonesia, whether it is already in an efficient state and how they have changed in the 10 years 2005–2015.

[1] Inadequate infrastructure leads to increasing logistics cost since it will be more time consuming to move the goods to destination and also more cost consuming (e.g. oil expense, worker fee) https://www.pressreader.com/indonesia/the-jakarta-post/20150318/281951721299936/TextView.

2. Literature Review

2.1. Definition

Ports are the medium that connect ships with land for both passengers and logistic flows. Tarantola (2005) as cited by Roa et al. (2013) defined a port as an area connected to sea, ocean or river and considered as entities. Flere (1967) defines ports to exist in order to provide the facilities of terminals and services for ships to move goods and/or passengers. Referring to the definition by Tarantola (2005), it shows that ports are certainly important for a country in terms of facilitating the movement of goods (freight) or passengers. Port efficiency measures the effectivity of the port in terms of mobility and safety of goods (no defects detected from the goods distributed) and passengers (no accidents). One definition of port efficiency is as follows: Heyne (2008) as cited by Tossa (2016) defines efficiency as the condition where the wants could be achieved by using the minimum amount of resources that the producer has. Thus, to achieve efficient condition of ports, the determinants of port performance should also be efficient.

When the port is more efficient than before, it will be caused the transportation cost to decline also leads to the ability of facilitating the imports and exports of a country. Likewise, a previous study by Clarke, Dollar & Micco (2004) also shows that inefficient ports might lead to increasing handling cost as well. The findings by Clarke, Dollar & Micco (2004) comes from data on maritime transport costs, value and volume of imports, and shipping characteristics based on the U.S. Import Waterborne Databank (U.S. Department of Transportation) for the years 1996, 1998, and 2000. Hence, port efficiency means generating goods' movement using the minimum amount of fund in as little time as possible.

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2.2. Indicators of Port Performance

Performance indicators are needed in order to measure the performance and grasp the operations of ports in a country. By using indicators, port supervisors can assess how equipment is being used by the port authority and how good the management is in terms of operational performance and the cost needed. The determinants to measure the port performance varies throughout several literatures. There are several findings that argue about the indicators used to measure port performance. However, most of the findings take into account operational and financial indicators. Furthermore, United Nations also stated that there are two most important indicators used to measure port performance, which are financial indicators and operational indicators (Figure 1).

Financial indicators measure the use of funds and capital the port authorities have compared to the performance of ports. It refers to the cost used by the port to distribute the goods and how the allocation of funds by the port to support the operational system in the port area. The allocation of cost itself is varies amongst the countries since it depends on the structure and condition of economy of the country. For developing country, the composition of port expenditure is described in Figure 1. In most of developing country, half of the funds goes to capital, 1/3 is to funding the direct labor costs whilst the rest is spend for salary for the staff that employed in port area.

The other indicators is to measure the operation performance of port. Operational Indicators have a more direct relation to the port management and its performance compared to financial indicators. Basically, operational indicators measure the productivity of a port. Based on several past studies, it is shown that operational indicators are the most important indicators as it also affects the financial performance of the port and is important for decision making in medium- term planning and control.

The operational indicators show how the operational aspect of the port authority and takes into account the time needed for ships to distribute the goods from containers and how bureaucracy affects the time taken to process the containers. The operational indicators are more specific to time measurement whereas financial indicators more towards the cost needed and how efficient the port is in using the funds.

According to theory adopted by Rajasekar & Malabika (2014), in this findings, the performance of port is affected by several variables. The variables that expected to have impact on port performance are Turnaround Time, Idle Time, Berth of Occupancy Rate, Operating Surplus per Ton, Rate of Return, Number of Employee, Cargo Equipment and Operating Expense.

Several previous studies shows that efficiency of port performance plays significant role in economy activity influenced by several factors. Sanchez et al. (2003) examined transports costs in Seaports of Latin America by applying survey data on port performance. The survey conducted mostly focused on the productivity hours and terminal productivity and combining the variables along with country competitiveness (in terms of transport cost). It is shows that the function of transport costs has impact on trade flows. Clarke, Dollar & Micco (2004) stated that using survey by Global Competitiveness Report (GCR), the determinant of port performance is believed to be port management, policy variables, crime index and undoubtedly the proxy to measure the infrastructure quality of port infrastructure within the country. Ada & Chee (2007) carried studies which analyzing productivity of container ports in Malaysia using panel data from 2000–2005 in selected big port in Malaysia. Similarly, study conducted by Van Dyck (2015) in West Africa likewise using DEA. The input variables use for this study in-

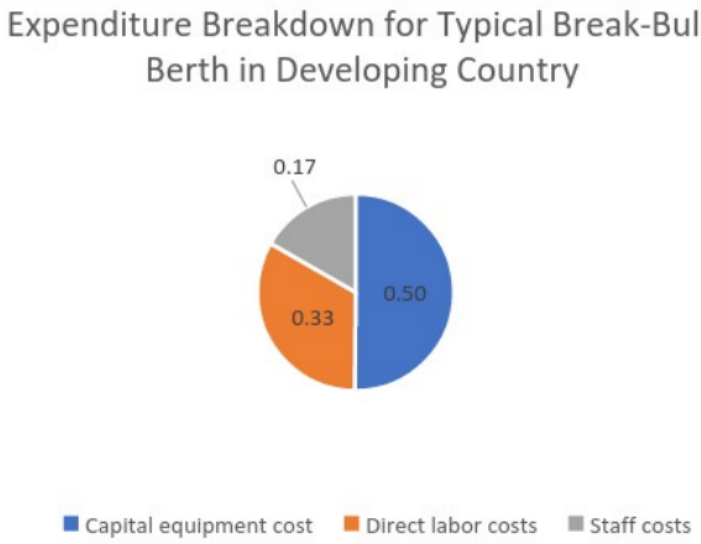

Figure 1: Expenditure Breakdown in Developing Country
Source: UNCTAD (1976)

clude the terminal area, berth length, the number of quay-side cranes, the number of yard gantry cranes and the number of reach stackers.

However, Bloningen & Wilson (2006) stated that both surveys analysis and DEA analysis have several drawbacks The author examined the port efficiency by using regression of import flows in the U.S. through 1991 until 2003. Later, the author was found out that the methodology used has similar effect on GCR from Clarke, Dollar & Micco (2004) with the possibility to provide more years in measuring port efficiency.

Lastly, Rajasekar & Malabika (2014) explained that there are several factors that has significant effect on performance of port which conducted in main ports in India from 1993–2011. The study conducted by performed pooled simple regression of total traffic, as the dependent variable, and considering several factors that believed to maintain the operational operators such as turnaround time, idle time, berth occupancy, berth throughput, operating surplus per ton, rate of return turnover, number of employee, cargo equipment, operating expense, net state domestic product, agriculture, industry and services. The result shows expected result as berth throughput, number of employees and operating expense have positive impact, while the rest has significant negative influence on the model.

3. Method

The methodology of this research is adapted from Rajasekar & Malabika (2014). The study adopting the pooled ordinary least square by using panel data of 4 main ports in Indonesia which are Port of Belawan, Port of Tanjung Priok, Port of Tanjung Perak, and Port of Makassar. The model is being modified due to the availability of data in Indonesia, and thus become as follows

$$\begin{aligned}\mathrm{TOTTR_{it}} = \alpha_0 + \beta_1 \mathrm{TRT_{it}} + \beta_2 \mathrm{IDLE_{it}} + \beta_3 \mathrm{BOCC_{it}} \\ + \beta_4 \mathrm{OSPT_{it}} + \beta_5 \mathrm{RROT_{it}} + \beta_6 \mathrm{NOE_{it}} \\ + \beta_7 \mathrm{CAREQUIP_{it}} + \beta_8 \mathrm{OPEXP_{it}} + \mathrm{e_{it}}\end{aligned} \quad (1)$$

where:

TOTR : total amount of loaded and unloaded goods in port area

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TRT : turnaround time
IDLE : idle time
BOCC : berth of occupancy rate
OSPT : operating surplus per ton
RROT : rate of return
NOE : number of employee
CAREQUIP : number of cargo equipment
OPEXP : operating expense
e : error terms

To conduct this research, the time period that has been considered in the research will be from 2005–2015. The data taken is annually data for all variables. The study used secondary data which taken from Indonesian Port Corporation (Pelindo) based on four main ports in Indonesia: Port of Belawan (Pelido I), Port of Tanjung Priok (Pelindo II), Port of Tanjung Perak (Pelindo III) and Port of Makassar (Pelindo IV). These ports are designed as the hub ports in the national sea transport system of the counstry.

In order to analyze the factor that determine port performance in Indonesia, a balanced data set is used. A balanced data is a set of data that has equal number of observation for each sample. In this case, the number of observation will be 44 since there are 4 samples within 11 years' time period, counted from 2005 until 2015.

3.1. Ports in Indonesia

Ports in Indonesia is existing since the Netherland colonization started and was known as *Haven Bedrijf* or Port in Dutch. After the independent, it was changed into *Pelabuhan Indonesia* (Indonesian Port) and changed its type of organization. Indonesian port is divided into 8 operational areas in 1960 based on the government regulation No. 19/1960 about public port management and organzide by port management agency (BPP). Later in 1964, Government reorganized the management of general port by dividing operational aspect and commercial aspect and its supervisor. The government merged eight operational areas into four companies in 1985 and the type organization changed into state-owned entrprises:

1. *Pelindo* I with Port of Belawan (based on Medan) as the main port of the 1st operational area
2. *Pelindo* II with Port of Tanjung Priok (based on Jakarta) as the main port of the 2nd operational area
3. *Pelindo* III with Port of Tanjung Perak (based on Surabaya) as the main port of the 3rd operational area
4. *Pelindo* IV with Port of Makassar (based on Makassar) as the main port of the 4th operational area

However, the current performance of Indonesian port is still low compared to other countries despite its deep relation with economic growth (Figure 2). Based on World Bank data in 2014, Indonesia has the highest number of days for the dwell time itself compared to neighbor country that has similar economic structure such as Malaysia and Thailand.

Another evidence shows that poor total traffic that Indonesia has. The world shipping council listed the top 50 container ports in the world and shows that Shanghai has the highest volume trade. Meanwhile, Port of Tanjung Priok only ranked as 27th out of 50 ports in terms of volume of containers. Despite it is on the top 50, the rank is still below the average of international main ports and even rank below the port of Hoi Chi Minh, Vietnam. In addition, the volume trade of Tanjung Priok Port is declining from 5.77 million TEUs in 2014 to 5.20 million TEUs in 2015. Followed by Port of Tanjung Perak which located in Surabaya and ranked as 47th in top 50 with total traffic 3.12 million TEUs as of year 2015. In the meantime, the other 2 main ports in Indonesia

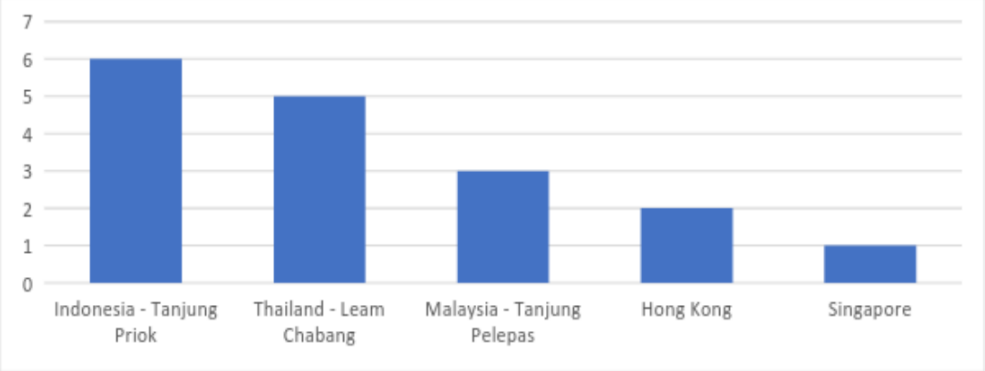

Figure 2: Dwell Time of 5 Asian Ports (2014)
Source: World Bank (2014)

(Port of Belawan and Port of Makassar) are not including in top 50 world containers port.

Comparing logistics cost of Indonesia with other countries, based on research centre of logistic and supply chain ITB, it was found out that the logistic cost of Indonesia is twice higher compared to Malaysia, and the total logistic cost is 26.4% of GDP whereas Malaysia approximately 15% of total GDP. Indonesia is the highest compared to Malaysia, South Korea, Japan, European Countries, and the United States.

Moreover, based on Logistics Performance Index (LPI) by World Bank, Indonesia is ranked at the 63rd in the world and placed as 4th amongst ASEAN countries. The factors that has the lowest rank is infrastructure. Poor infrastructure might drive to inefficiency in transporting goods and services that resulting logistics cost to escalate and lower the performance of ports. By comparing Indonesia and Malaysia' performance of port, Indonesia is still behind Malaysia's port. Started from its dwell time, which shows than Indonesia has longer time to release the goods until its infrastructure rank and logistics costs which shows poor performance of Indonesia. Besides time consuming, the longer dwell time can resulting defected items, thus increasing cost in average and the customer also suffering financial loss.

Likewise, comparing with Malaysia, the capacity of port in Indonesia also lower. Based on Table 1, the highest capacity is in Port Klang with capacity approximately 16.6 TEUs. Meanwhile, the highest capacity in Indonesia is approximately only 5.8a9 TEUs which even lower than half of Malaysia's Port Klang capacity. Hence, it shows that the performance of port in Indonesia is still below average of Southeast Asia country and the rest of the world.

In addition, the corruption and illegal money collection level in authorize port area is considerably high compared to other country. For example, in 2017, it was found out that there were an illegal money collection in port of Samarinda and causing the logistics and handling cost to be raising.

Overall, Indonesia has quiet poor performances compared with several ports in other countries, especially with neighbor country and similar economic structure as Malaysia. The inadequate infrastructure, lofty logistics cost also high dwell time in Indonesian seaports leads to inefficiency of port performances. However, there are still room for improvement by Indonesian government to revise the performance of port in Indonesia to be better and more efficient that what is appear currently.

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Table 1: Comparison of Port Capacity in Indonesia and Malaysia

Malaysia	Capacity (in TEU)	Indonesia	Capacity (in TEU)
Port of Klang	16.6	Port of Belawan	1.3
Port of Tanjung Pelepas	10.5	Port of Tanjung Priok	5.89
Penang Port	2.0	Port of Tanjung Perak	1.1
Johor Port	1.2	Port of Makasar	1.2
Kuantan Port	0.6		

Source: Australia Indonesia Partnership and Kuantan Port

4. Results and Analysis

Prior conducting the research, methodology selection is conducted. There are 3 possibilities of method: Pooled OLS, Random Effects Model (RE) and Fixed Effect Model (FE). To check which methodology is the best fit for the model, general F-test and haussman test is being run. General F-test is used in order to select methodology between Pooled OLS and RE, whereas Haussman test (Hausman 1978) is to choose between FE and RE.

Based on the result of General F-Test (Table 2), it is shows that the Prob > F is equal to 0.5858 which appear to be larger than significance level of 1%, 5% and 10% and indicates that the data set fail to reject the null hypothesis and suitable to use pooled OLS rather than FE or RE. Hence, the methodology used to estimate the data will be pooled OLS.

Nonetheless, the heteroskedasticity test also run to avoid any abnormal symptoms caused by heteroskedasticity in the data and multicollinearity test to check the degree of correlation between dependent variable. In the model used, it was found out no heteroskedasticy in the model and the data is moderately correlated with each other.

Furthermore, in analyzing the data, the research shows that the dependent variable used in the model shows the variables are significant in influencing the dependent variable except for operating surplus per ton. However, there are some variables that generate unexpected results, which summarize as shown in Table 3.

As noted by Rajasekar & Malabika (2014), Idle time is expected to negatively affect the dependent variables and it shows the similar results. When Idle time decreasing, the total traffic will increasing. De Langen, Nijdam & van der Horst (2007) defines that the longer idle time or waiting time the ship had, the longer the completion of cargo handling and causing the delays to the other ships to unloading the containers, affecting the amount of throughput that a port able to generate.

Operating surplus per ton, appear to have negative correlation with dependent variable. The negative correlation means when operating surplus per ton increasing, the total traffic will decrease. The expectation about operating surplus per ton still not certain at first since it may lead to higher traffic or lower traffic, depends on the port itself on how to allocate the surplus generate by the port. This also applied for rate of return, number of employee and cargo equipment. For example number of employment. The higher the number of employment might help port to manage the port faster. However, at certain number of employee, when the number of employee is overload, not all employee will do their jobs properly but the port authorize still have to pay them, resulting inefficient in cost.

On the other hand, the result of turnaround time, berth occupancy and operating expense turned out is not as expected. Turnaround time is shows to be positively related while the expectations is turnaround time have negative correlations with total traffic in the port. Conversely, berth occupancy and operating expense which expected to have pos-

Table 2: General F-test Results

TOTRA	COEF	Std. Err	T	P > | t |	95% Confidence Interval	
TRT	23799.42	41443.61	0.57	0.571	-61555.29	109154.1
IDLE	-1732258	321013.1	-5.49	0.000	2393397	-1071119
BOCC	-107085.8	81293.04	-1.32	0.200	-274512	60340.32
OSPT	-1.131.712	5.247.995	-2.16	0.041	-2.212.557	-.05086754
RROT	38779.45	94218.1	0.41	0.684	-155266.4	232825.3
NOE	55146.72	4.728.346	11.66	0.000	45408.51	64884.94
CAREQ UIP	8.189.355	7672.08	1.07	0.296	-7.611.591	23990.3
OPEXP	-5.547.471	1.066.524	-5.20	0.000	-7.744.018	-33.509.923
_CONS	156974	4468618	0.04	0.972	-9046317	9360265

Note: Sigma_u = 2779599.1
Sigma_e = 3825141.7
rho .034556814 (fraction of variance due to u_i
F test that all u_i=0: F(10, 25) = 0.85 Prob > F = 0.5858
**Confidence Interval: 1%, 5%, 10%

Table 3: Initial Expectations and Generated Results

Description	Expectation	Result
Turnaround Time	-	+
Idle Time	-	-
Berth Occupancy Rate	+	-
Operating Surplus per Tonne	+/-	-
Rate of Return	+/-	+
Number of Employees	+/-	+
Cargo Equipment	+/-	+
Operating Expense	+	-

itive correlations with the performance of port appear to have negative correlation with the total traffic in four main ports in Indonesia.

The abnormality of dependent variables above might be because of several external factors that happened in Indonesia. Johnson & Styhre (2014) stated that for turnaround time, the longer time needed could be because of extreme weather changes which causing cargo cannot loaded - unloaded or causing longer waiting time for ships to sailed. In Indonesia itself, the weather is unpredictable and several natural disasters happened between 2005 until 2015 (e.g. Tsunami in Aceh and Nias, Earthquake, etc) which resulting infrastructure and equipment breakdown in several ports. The positive correlation might be because the size of port is in average increasing throughout the years which resulting more containers able to be loaded and unloaded despite its rising turnaround time. So, despite high turnaround time, many containers able to fit in the port and generate more traffic. In fact, the size of main ports in Indonesia is increasing throughout 10 years, 'causing the three times increasing on container throughput. Furthermore, size of the ship also one of the consideration of the positive correlation that happened in this model. The larger size of ship resulting longer time needed to process the goods, but the traffic will be higher as well.

Berth Occupancy rate (BOCC) shows negative correlation with the amount of total traffic in the model. The negative correlation means when the BOCC increase, the amount of traffic will be decreasing, vice versa. The negative correlation might be depends on how the ports using its facilities to occupied the loading and unloading goods. According to UNCTAD (1982), the low Berth Occupancy referring to under-used terminal and wasting the resources that available. Thus, due to the difference on how goods and ship berth condition at some ports, this might affecting the impact of berth occupancy in general. Tanjung Priok known as the biggest and busiest

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port, while the rest of ports in average has similar total traffic in average, leads to abnormality in the regression model. In addition, the biggest reason is might be because of the increasing in number of equipment and significant development of berth in Tanjung Priok and Belawan. Increasing number of equipment causing loaded and unloaded containers is faster than before, thus resulting low occupancy rate of berth. The addition of berth in Jakarta International Container Terminal (JICT) and Belawan International Container Terminal (BICT), increasing capacity of ships resulting low occupancy of berth but the traffic generated is steadily increasing.

Lastly, operating Expense (OPEXP) that expected to have positive correlation with total traffic shows negative correlation in the result. Rajasekar & Malabika (2014) expected OPEXP to have positive correlation since the author believed that higher operating expense generate higher traffic. The negative correlation might be because of the new technology that the ports have, lowering the cost of operation since the new technology able to generate more containers and resulting faster turnover. Furthermore, the negative correlation generated from the model of 4 main ports in Indonesia is make sense since it means that the port is using the funds of operation as few as possible to generate efficient condition with high traffic.

5. Conclusions

To conclude, this research is to determine the factors that has significant effect on port performance in Indonesia using data generated from 4 main ports. The secondary data is used in order to determine the factors that affected port performance in Indonesia. The data taken from Indonesian Port (PELINDO) from 2005–2015.

This research use total traffic as the dependent variable and 8 independent variables. The independent variables are turnaround time (TRT), idle time (IDLE), berth of occupancy rate (BOCC), operating surplus per ton (OSPT), rate of return (RROT), number of employee (NOE), number of cargo equipment (CAREQUIP) and operating expense (OPEXP). By using the pooled ordinary least square (OLS) model, the results shows that most of the variables are generating significant result in the model. The only variable that appear to be insignificant is operating surplus per ton (OSPT). TRT, IDLE, BOCC, OSPT, RROT, NOE, CAREQUIP, and OPEXP are appear to have significant correlation with the dependent variable. The correlation between independent variables and independent variables also shows some abnormality if it is compared with result by Rajasekar & Malabika (2014). The reason and justification already listed on previous chapter.

Furthermore, the condition of port in Indonesia is still inadequate in some aspects compared to other Southeast Asian countries (e.g. Malaysia and Thailand). The dwell time is appear to be the highest and the infrastructure itself still inadequate as the supporting facilities. Since Indonesia is an archipelagic country that mostly relies on maritime industry, port is a crucial sector that needs to be efficient in terms of time and cost. If the performance of port in Indonesia is efficient, it will help the development of nation and promote economic growth.

There are still many shortcomings appear in Indonesian port. However, there are still room for improvement. To overcome the obstacles that appear in Indonesian Port, there are 3 aspects of recommendation that author suggest:

1. Increasing infrastructure quality in Indonesia by Indonesian government. The infrastructure might be one of the biggest obstacles in port performance. When the nation has adequate infrastructure, it will help the movement of goods faster and less cost consuming.

2. Reforming bureaucracy and regulation by ministry of transportation. The current regulation is known to be complex and long time needed to receive permit for releasing the goods. This causing delayed goods and the port generating low number of throughput. Reforming regulation by increasing the amount of permit and documents might be effective to increase the performance of port since the turnover of goods will be faster and generate more throughput compared to current regulation.
3. Lastly, the Port management by PELINDO also should prevent illegal money collection in authorize port area. The illegal money collection could causing the cost of loaded and unloaded containers to enormously raising and giving disadvantage to many parties involved in the activity.

In conducting this research, the limitation of carrying out this research is the availability of data and for some ports, the bureaucracy to get the data is more complex. In addition, the limited time the writer has also become one of the limitation to further analyze about all the ports in Indonesia.

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