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WORLD MARITIME UNIVERSITY

Malmö, Sweden

**AN ECONOMETRIC ANALYSIS FOR CARGO
THROUGHPUT DETERMINANTS IN
BELAWAN INTERNATIONAL CONTAINER
TERMINAL, INDONESIA**

By

TAUFIK HARIS

Indonesia

A dissertation submitted to the World Maritime University in partial
fulfilment of the requirement for the award of the degree of

MASTER OF SCIENCE

In

MARITIME AFFAIRS

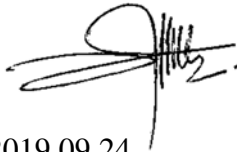
(PORT MANAGEMENT)

2019

DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

Signature : 
Date : 2019.09.24

Supervised by : Professor Dong-Wook Song

Supervisor's Affiliation: PM

ACKNOWLEDGMENT

First, I want to say Alhamdulillah, my deepest gratitude to Allah SWT for his blessings for me to be able to complete this dissertation. Also, I need to convey my greatest thanks to my company, Pelindo I, by giving me a full scholarship to conduct a Master of Science program at World Maritime University (WMU). I owe profound appreciation to my Human Resources Director, M. Hamied Widjaya and all his staff for giving me an opportunity and support to get the experience by study abroad in Malmö, Sweden. I also would like to thank World Maritime University for giving me great experience and knowledge during the program.

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ABSTRACT

Title of Dissertation: An Econometric Analysis for Cargo Throughput Determinants in Belawan International Container Terminal, Indonesia:

Degree: Master of Science

In this paper, the author investigates the key factors affecting throughput growth in Belawan International Container Terminal (BICT) by using econometric tests in the analysis of time-series data from 2006 to 2018 in quarterly. The analysis tries to find out the impact whether the positive or negative relationships between variables. Macroeconomic factors and port performance indicators are used as variables that come from external and internal of BICT to determine the significant factors. There are 26 variables used as a preliminary analysis, and it found that eight variables which significantly affects the throughput growth based on the empirical result. There are three variables from macroeconomics perspective: hinterland's GDP growth (China), exchange rate Malaysia and Thailand, and five variables from port performance indicators: ship calls, berthing time, yard occupancy ratio, crane productivity, and ship productivity. All these significant variables founded after conducted several tests in regression analysis such as unit root, co-integration, correlation, T-test, F-test, autoregressive moving average, normality, serial correlation, heteroscedasticity, and Ramsey reset. By identify the significant factors, it is expected that the company can use this insight as to their consideration in deciding the future planning and to making the port become more competitive among other players and to increase their throughput performance. Also, this research would be useful for those who want to make plans for commercial development and strategic investment.

Key Words: Cargo Throughput, Port Performance Indicator, Macroeconomic Factors, Regression Analysis, BICT

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LIST OF ABBREVIATION

ADF	Augmented Dickey Fuller
BICT	Belawan International Container Terminal
BLUE	Best Linear Unbiased Estimator
BOR	Berth Occupancy Ratio
CPO	Crude Palm Oil
CLRM	Classical Linear Regression Model
DEA	Data Envelopment Analysis
ECT	Error Correction Terms
EDI	Electronic Data Interchange
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
ILO	International Labour Organization
Pelindo	Pelabuhan Indonesia; Indonesia Port Corporations
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
MOT	Ministry of Transportation
OLS	Ordinary Least Square
PP	Phillips Perron
PSA	Port of Singapore
TEU	Twenty-foot Equivalent Unit
TPKDB	Terminal Petikemas Domestik Belawan
UNCTAD	United Nation Conference on Trade and Development
US	United States
YOR	Yard Occupancy Ratio

CHAPTER ONE – INTRODUCTION

1.1 Background

More than 80% of cargo volume of international trade is carried by seaborne trade, which makes ports crucial for international trade and commerce. The another role played by ports is as an economic booster for the markets in their regions, which could contribute to advantages for socio-economic wealth (Bichou, 2009). In the seaborne trade ports play a crucial role in moving goods and people. They are also crucial interfaces between sea transport and other modes transportation where trading, logistics flow, and economic activities are conducted. Ports should be more efficient in their operation because more time in port can cause additional costs for logistics and supply chain aspects.

In this globalized economy, the limit of supply chains extends beyond regional and international levels. Ports have a primary role in accommodating international trade in import and export supply chains. If there are risks that happen in ports they will affect not only port performance itself but the trade and supply chain as well. The port performance will have a significant impact on the flows of trade, and cargo delivery and will change national and global activities. Hence, it is necessary that ports be reliable in terms of reducing losses. (Mansouri et al., 2010).

The role of ports is defined not only in terms of being a geographic location in which ships and cargo are handled efficiently but also the value-added that they can give to shippers and other parties. In order to improve the level of service in the port sector, the Indonesian government has made some new regulations on shipping and port. In 2008, regulation No. 17/2008 on shipping and ports was ratified, allowing the private sector to take the opportunity to participate in port business. Since the new regulation has been implemented, ports are not only operated by the government or state-owned enterprise but also private sector operators.

Therefore, this condition will change the port sector, making it more competitive between terminal operators. Due to this competitive situation, a strategy is required

that considers the efficiency of the terminal, including operational aspects such as cargo handling, turnaround time, berth, and yard capacity. Furthermore, the commercial aspect needs to be considered as well, such as the selection of an appropriate governance model to attract customers and increase revenue (Pavlo, 2014).

In a study by Van den Berg and De Langen, (2015), one of the strategic goals for the primary performance of a terminal container is maximizing the throughput volumes. Throughput cargo is the main factor that could affect port performance and port competitiveness. Developments in information technology, changes in the market, political, and economic situation, and constitute fundamental changes in port sector (Pavlo, 2014). Therefore, increasing port performance either in the operational aspect or in the commercial aspect is a must to keep the port competitive in its region.

It is important for developing countries such as Indonesia to increase the level of performance of their port to support the logistics chain, leading to better maritime transport trade to increase economic growth at the regional and international levels as well (Munim and Schramm, 2018).

According to UNCTAD (1976), port performance generally measures two indicators, financial and operational. According to research, the amount of cargo or number of containers being handled per year or per month is used as one of the main indicators to measure port performance from the operational aspect (Armadi, 2017). The number of tons or number of containers handled by a port is called throughput. Cargo throughput is an important aspect that needs to be maintained to increase port revenue. According to Monteiro (2015), the higher the throughput of a particular terminal, the higher the level of efficiency of the terminal. Further aspects that could determine the efficiency of a terminal are terminal productivity, terminal accessibility, ship delivery services, terminal handling equipment, consumption forecasts, supply chain and logistics integration and also land transportation networks (Tongzon and Heng, 2005). When the terminal becomes more efficient, then the more customer will come to that terminal to do their logistics chain processes, and as a result, the terminal will gain more revenue and profit (Tongzon and Heng, 2005).

In general, port performance can be measured by productivity in handling of cargo at the berth and compared to the realization of throughput with a business plan over a certain period of time. It can also be evaluated by comparing actual throughput with optimal throughput (Armadi, 2017). The throughput number is commonly used as an indicator for terminal performance. In order to determine the competitiveness of a particular terminal container, some indicators need to be taken into consideration such as ship calls, port location, infrastructure, port dues, and speed in responding to customers (Tongzon, 2002).

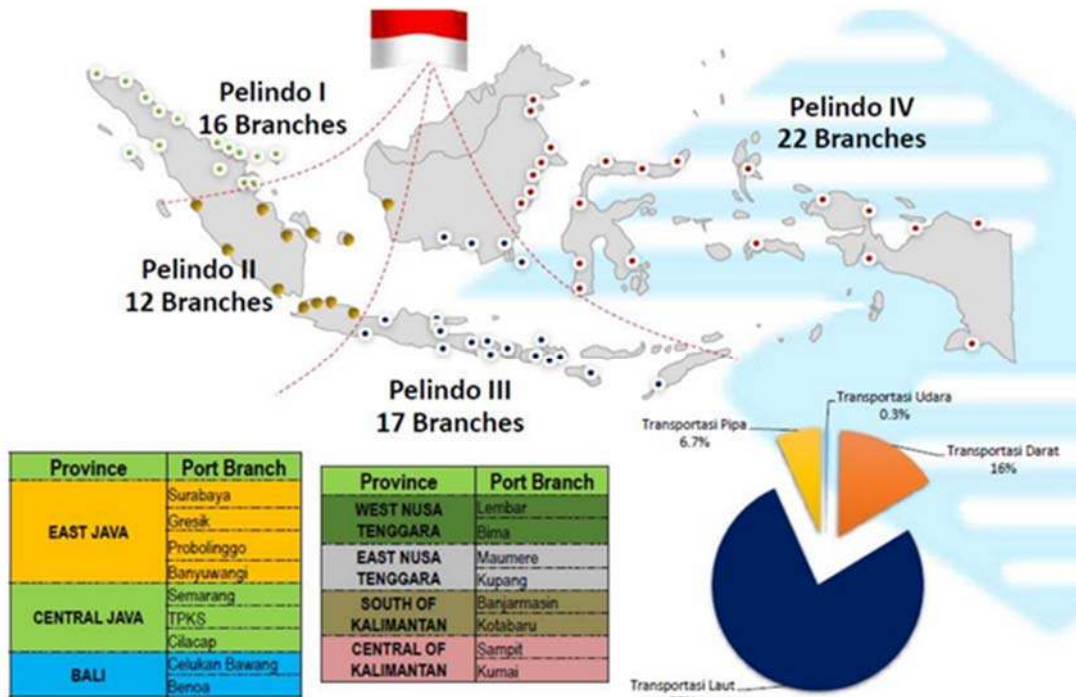
1.2 Problem Identification

Indonesia, as an archipelagic country, has a lot of ports to trade its goods from one place to another. Ports are essential for the country because the logistics chain mostly comes from maritime transport. They have an important role in delivering people, goods, and services to all of the islands in Indonesia at national level, at the regional level in Asia and Internationally. The port management is a hierarchical system that consists of more than 1,700 ports, including commercial and non-commercial ports. Some ports manage commercially, and the government has given authority to the big four major port companies in Indonesia and they are part of state-owned enterprises belonging to the Indonesian government, namely Pelindo I-IV or Pelabuhan Indonesia which manages the ports from the western to the eastern part of this country (Sutomo and Soemardjito, 2012).

As explained above, most of the ports in Indonesia are managed commercially by state-owned enterprises under the Ministry of Transportation. The division is based on the location; for example, the western part of Indonesia is managed commercially by Pelindo I and II. In this region, there are two main ports, which are the biggest in the western part. The first one is Port of Tanjung Priok which is managed by Pelindo II and the second one is Port of Belawan, which managed by Pelindo I.

The eastern part of Indonesia also has two main ports that are the largest ports in that region; The first one is Port of Tanjung Perak which is managed commercially by Pelindo III, and the other one is Port of Makassar which managed by Pelindo IV.

Figure 1. 1 Working Area of Indonesia Port Corporations



Source: Syafaaruddin, (2015)

The implementation of domestic law in Indonesia No.17/2008 on Shipping will eliminate the monopoly power of Pelindo as the leading terminal operator and will allow private sector to compete in port business as well. This situation brings significant influence to Pelindo regarding their commercial strategy and how to manage their customers regarding giving better services. Hence, to maintain its competitiveness with the private sector in port business, Pelindo needs to maintain its competitive position as the leading player in the port sector by offering efficiency to increase its throughput (Syafaaruddin, 2015).

Figure 1. 2 Location of Belawan Port



Source: Google Map (2019)

The port of Belawan is the third-largest port in Indonesia and is operated by Pelindo I. This port has a strategic location on an international shipping route close to Singapore, Malaysia, and the Malacca strait, one of the busiest routes in South East Asia. In Belawan, there is a container terminal called Belawan International Container Terminal (BICT) which is the third-largest container terminal in Indonesia after Tanjung Perak and Tanjung Priok. Based on an annual report from 2017, its throughput number is 526,039 TEUS, and since 2013 traffic has increased by 3.7% on average (Armadi, 2017).

Belawan International Container Terminal (BICT) has a strategic role as a gateway for cargo export and import flow in its region. Efficiency in this port is essential to maintain its performance and competitiveness and will give the value-added to the company. Presently, BICT is experiencing an increase in container throughput each year. To maintain this condition, BICT is expected to evaluate their performance according to throughput growth and to anticipate the implementation of domestic law No. 17/2008 on Shipping. It means the market is becoming more competitive.

Previous research on a similar subject, especially in this port, was done. The previous research was conducted to find out whether this terminal is efficient or not based on four types of infrastructure data namely berth, container yard, crane, and yard equipment by using DEA analysis. Therefore, it is interesting for the author to study this port by analyzing the factors affecting container throughput with econometric analysis by using Classical Linear Regression Model (CLRM). Hence, this research is expected to give advantage or new insight to the company or shareholders to increase the port performance regarding its throughput growth and to manage its commercial strategy to become more competitive in the port business.

1.3 Objectives

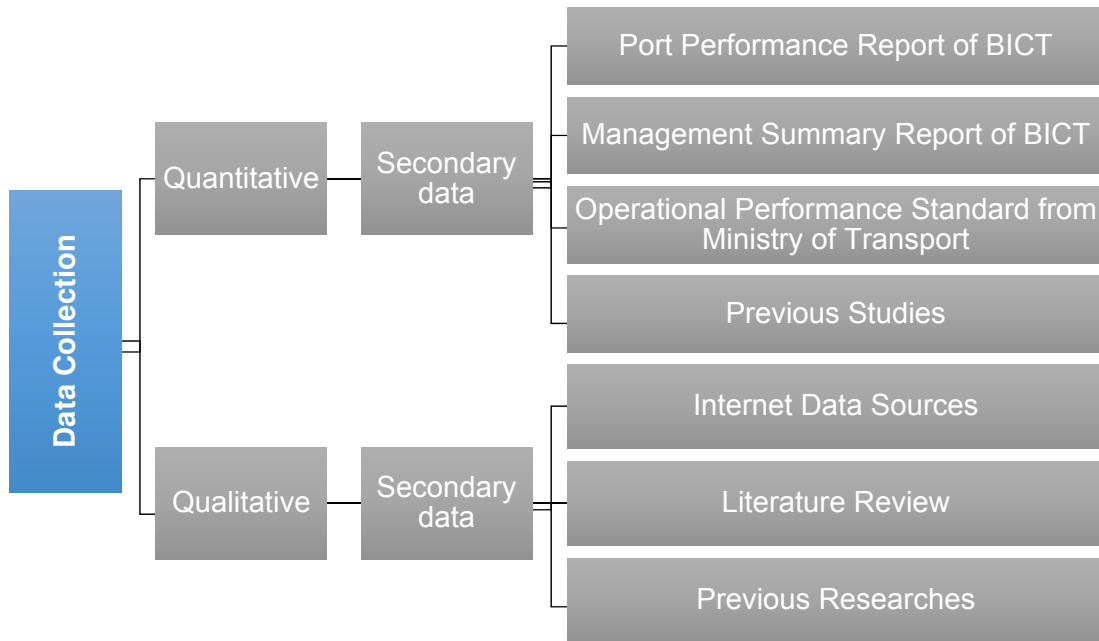
The background and problem identification described, the port performance and the existing situation and new regulations that could affect the throughput growth in BICT. In order to maintain the positive trend in throughput container traffic per year in the future and to become a more competitive port as the impact from the implementation of new regulation in Indonesia, it is required to make some proper strategies to capture the market in its hinterland. The first strategy is to identify the key factors, whether internal or external, that could affect the throughput growth in BICT. The second strategy is to anticipate future demand in the market, which will be useful for future development. Those strategies will become the objectives of this research.

1.4 Research Methodology

Historical data of port performance indicators from Belawan International Container Terminal consist of some aspects such as traffic volume (cargo throughput, export and import cargo), service time (waiting time, approach time, effective time, berthing time), utilization (berth and yard occupancy ratio) and productivity (crane and ship productivity). Statistical software such as E-views and Microsoft Excel will be used for calculation in order to get the results. Besides, the historical data from BICT, in this research will try to include the macroeconomic factors such as seaborne trade, exchange rate, GDP, industrial production, export and import from neighboring countries will be part of the consideration in this research. For initial determination, these data will be used as independent variables based on actual historical data (port

performance indicators) and macroeconomic data. The data will be tested by doing a regression model, correlation test, and stationary test, and so on.

Figure 1. 3 Data Collection



1.5 Dissertation Structure

The research structure consists of seven chapters. Table 1.1 describes the content of each chapter.

Table 1. 1 Dissertation Structure

Chapter	Description
1. Introduction	This chapter will provide background on the study, problem identification, objectives, and research contribution.
2. Conceptual Review	Chapter two will undertake a literature review from a conceptual point of view, which means it will discuss

	factors that have an impact on port throughput, including external and internal factors.
3. Industrial Review	Chapter three undertakes a literature review from an industrial point of view, which means it will review Indonesian ports in general and BICT in particular. The review will discuss BICT from a geographical perspective, socio-economic, hinterland, and current condition.
4. Research Methodology	Chapter four; in this chapter will describe the conceptual framework, operationalization, explanation of the variables that will be used in data analysis, and time period.
5. Empirical Results	Chapter five will present and discuss the results of the data analysis.
6. Conclusions and recommendations	Chapter seven; this is the last chapter which will summarize all of the findings and discussions and will present recommendations for the future. It will briefly explain the limitations and suggest directions for future research.

CHAPTER TWO – LITERATURE REVIEW ON PORT THROUGHPUT DETERMINANTS

2.1 Port Throughput

Throughput in a container terminal is the main essential and direct factor with regard to measuring and evaluating the competitive strength of the port (Liu and Park, 2011). Throughput measures are the number of movements of the containers as they pass through the terminal and the effort involved in moving the cargo in terms of container movements per unit of time. This measurement gives a better indication rather than traffic measurement in terms of the effort expended in handling the containers through the terminal in a certain period of time (Shi, 2019).

According to (de Langen et al., 2007), throughput is one of the most commonly used performance indicators in port industries. Therefore, there are some factors that could have an impact on port throughput growth such as number of vessels, import, and export cargo (gateway cargo), utilization of berth and yard, crane and ship productivity, service time including waiting time, idle time, effective time, turnaround time, and non-operating time. All of these factors are internal factors that can be controlled directly or indirectly by the port company or port authority. It is not only the internal factors that can affect throughput growth, but the external factors based on macroeconomics must also be considered to assess the impact.

In a study by Paflioti et al., (2017), port throughput is the collection of output handles in a port and depends on the performance of relevant interdependent industries. In other words, it is the fluctuations of activities in the ports at the whole level that, require analysis on a separate level. This could become a critical factor in containers case because limited information is available on container content. According to Paflioti et al., (2017), the cycle of container business might be better to detected by knowing the path of its sectoral components.

2.2 External Factors

In the literature (De Oliveira and Cariou, 2015), the difference in efficiency scores is explained by several factors, for instance, the institutional environment (degree of

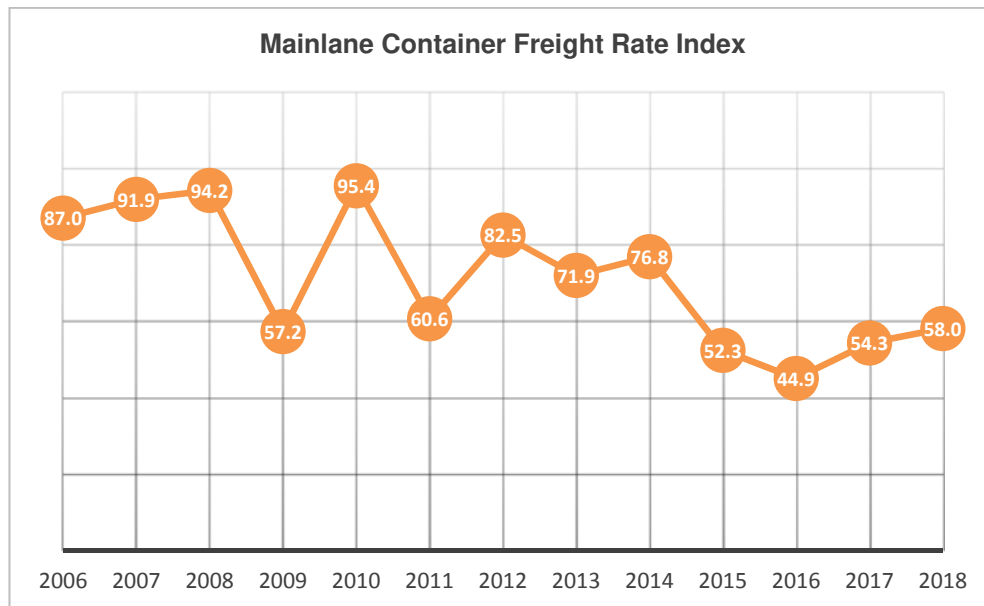
private vs public ownership), technical aspect, scale efficiency and macroeconomic factors (i.e. GDP, hinterland connections, port cluster). External factors are based on macroeconomics, for instance, seaborne container trade trends, export, and import neighbor country, shipping company, exchange rate, inflation index, bunker price, GDP neighbor country, time charter rate.

2.2.1 Seaborne Container Trade Trends

According to Clarksons Research, (2019), the mainline trade is predicted to grow approximately 1.7% in 2019, while the non-mainline growth in terms of volume is predicted to grow around 4.7%. Nevertheless, significant risks might be coming from current trends in the global economy, including economic trends in China, and also from the unresolved “trade war” between the US and China.

Global seaborne trade, especially in container trade, was projected to expand by 4.2% to total 196m TEU (3.2% growth in TEU-miles) in 2018, and still relatively positive pace following growth of 5.8% in 2017. Container trade was predicted to grow on the mainline east-west trades by approximately 2.4% within 2018. Moreover, for the non-mainline east-west routes growth was projected at 2.8% in 2018. On the north-south trades, container trade grew in 2018 by 4.5% which was supported by strong expansion of trade in Africa (Clarksons Research, 2019).

Figure 2. 1 Mainlane Container Freight Index



Source: Clarksons Research, (2019)

Based on Figure 2.1, the trend for mainline container freight rate index from 2006 to 2018. There are some spikes in the graph which can explain the situation at particular times. For instance, at the end of 2008, there was an economic crisis, which had a negative impact on the mainline container freight rate index. The index dropped from 94.2 in 2008 to 57.2 in 2009. In 2016, the index experienced the lowest point at 44.9 and started to increase in 2017 to 54.2, and the following year still had a positive trend at 58.0 in 2018 (Clarksons Research, 2019).

According to a study by Kalgora and Christian (2016), the freight rate has suffered a sharp decrease, and the demand for container vessel services has dramatically dropped. Before 2009, there was never a shortage. The sharp drop in consumption in the West and production in the East influencing the capacity of the global container fleet to be filled. The situation of economic crisis and financial crisis in 2009 had almost suppressed the growth of the container-fleet market. The strategy of port operators and shipping lines and the sensitivity of the supply chain process in terms of cost variations are fairly noted processes which could help explain how maritime transport trends could adapt to dynamic change. It can be seen that maritime transport has become highly connected to financial factors and macroeconomic

issues, including world economy, value chains, and the maritime transport industry (De Monie et al., 2009).

2.2.2 Industrial Production of China

Figure 2. 2 Industrial Production of China



Source: Clarksons Research, (2019)

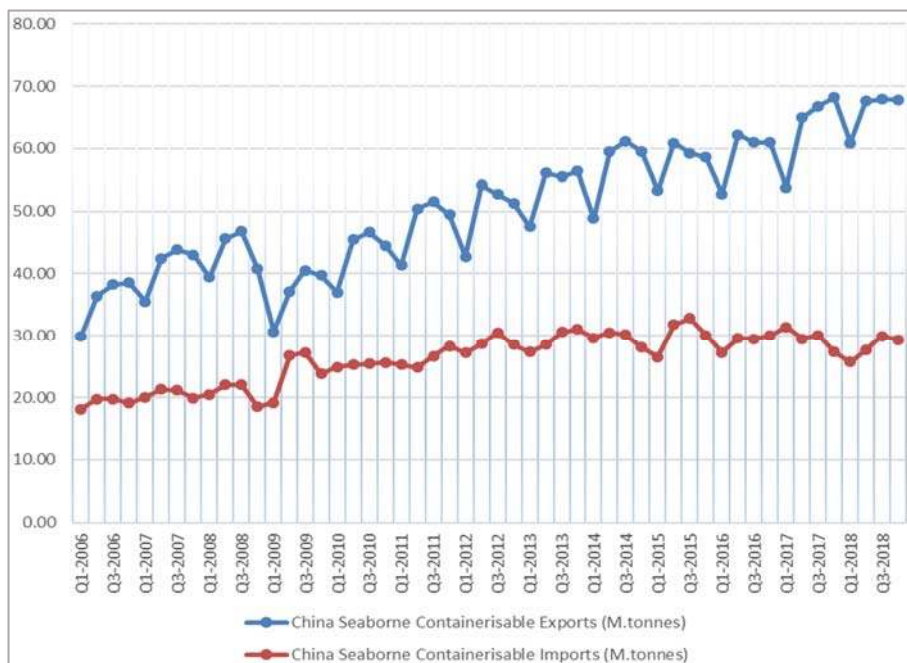
The fast growth of Industrialization and urbanization, affecting the internal demand for steel and manufacture industry has risen in China. After internal demand is sufficiently satisfied, then they may be employed progressively to export their industrial excess to the international market (Popescu et al., 2016). From the figure above, it can be seen that China's Industrial production dropped from the end of 2008 to the beginning of 2009; this is because of the economic crisis at that time. It rose again from 2009 to 2010. After 2010, it gradually dropped again because of overcapacity in the industrial sector, for instance, steel, and energy (The Guardian, 2016). Currently, Indonesia has many infrastructure projects, and this condition could be having an impact on throughput growth in BICT. Construction and manufacture are basically instruments of economic output and GDP are associated with steel usage (Popescu et al., 2016).

2.2.3 Hinterland's GDP

International trade between countries makes an important contribution to increasing the welfare of nations. According to UNCTAD (2015), over 80% of trade is carried out by seaborne trade. World trade volumes gradually increased by 2.3% in 2014, followed by the growth of global GDP (gross domestic product) by 2.5% in the same year. This indicates a close relationship between trade and GDP. It represents the total value of all goods and services produced within a country over a specific time period, often referred to as the size of the economy (Kampa, 2010). Moreover, Munim and Schramm, (2018) said, every 10% throughput increase in ports will create approximately 6% to 20% GDP enhancement in the region and can also have an impact on neighboring regions in the range of 5% to 18%. There is highly relationship between economic growth and container throughput. One of the most economic characteristics is foreign direct investment (FDI) which will be boosting industry activities, foreign export and import, and contributing to the GDP growth, mainly focusing to the containerized freight transport (Guoqiang et al., 2005).

2.2.4 China Seaborne Container Exports and Imports

Figure 2. 3 China Seaborne Containerisable Exports and Imports



Source: Clarksons Research, (2019)

China, as a leading country in terms of economic growth Asia, can have an impact on port throughput. Moreover, their export and import trends need to be considered as variables to assess the impact on BICT. From Figure 2.3 for both export and import data experiencing decline during the economic crisis from 2008 to 2009. After that, both of them start to grow in the following years. In addition, other things that could find from Figure 2.3 is growth trend for export is bigger than growth for import. In a study by Eichengreen and Tong, (2007), China takes import cargo from its neighbor countries, but this effect mainly in markets for capital goods. According to Yap & Lam (2006), international trade, especially in seaborne trade, has been an important pioneer as an economic booster in East Asia. The success of the export-oriented approach by Hong Kong, Taiwan, and South Korea helped to enhance their economic development which reinforced trade growth to grant the container ports in Hong Kong, Kaohsiung, and Busan to take advantage of container-handling performances. The fluctuations on the entire level are the output of co-movement across container sectors for both exports and imports, while at the same time they will respond differently. Eventually, the main macroeconomic determinants affecting the co-movement of sectors verify different signals and significance for imports and exports (Paflioti et al., 2017).

2.2.5 Exchange Rates

Globalization and integration of economies among several countries are important. Maritime transport has an important role in simplifying global trade flow. Based on UNCTAD (2014) data, greater than 90 percent of global trade is carried out by maritime transport. According to Kim (2016), various studies review the impacts that income and exchange rates have on export and import volumes and examines the impact of exchange rate fluctuation to international seaborne trade.

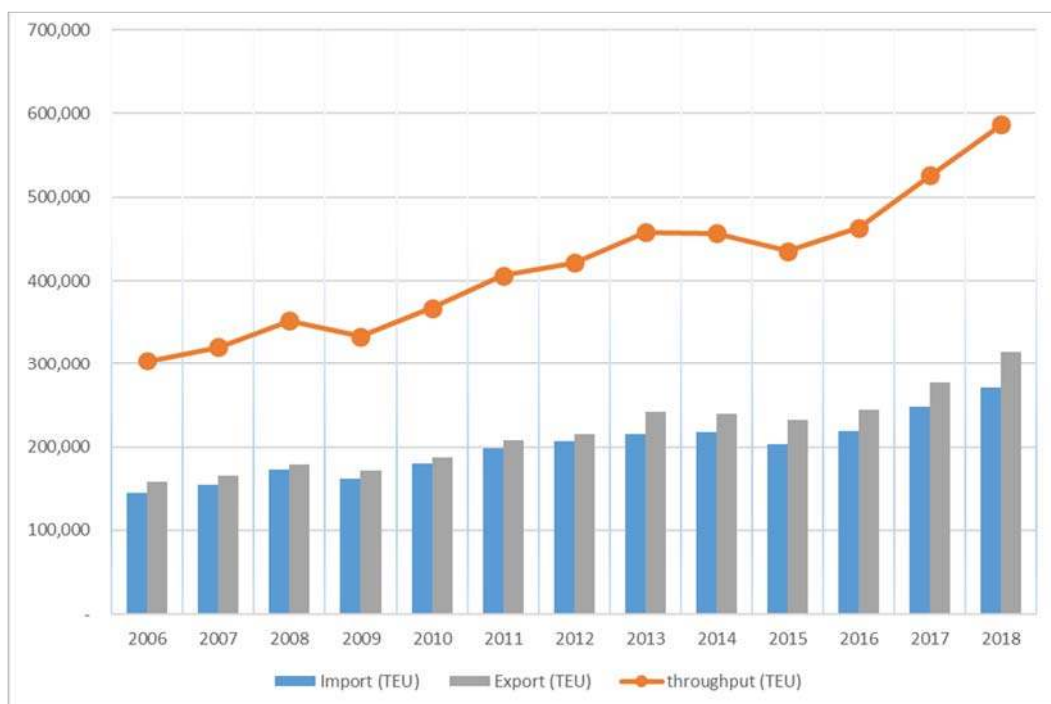
Some studies revealed that the elasticity of the relationship between exchange rate and export depends on the regional analysis. International seaborne trade in East Asia is discouraged by fluctuations in exchange rates, which are stronger than in Europe (Khalighi and Fadaei, 2017).

In a study by Kim (2017), exchange rate fluctuation causes some effects on international trade. If the exchange rate fluctuations have a higher cost and have more risk of the transaction, then it will bring a decrease in trade. On the other side, if the expected margin of export revenue is enhanced, then this situation will boost the trade volume. In addition, according to Côté (1994) an increase exchange rate volatility tends to reduce the level of trade, but when the effect is measured, it is discovered to be relatively small.

2.2.6 Traffic Volumes

Traffic is one of the crucial measurements regarding the performance of a port. Traffic can consist of several indicators such as number of throughputs (TEU), number of vessel calls, and number of import and export cargo. The most common indicator to evaluate the port performance or production is the annual throughput of containers in TEUs, as the main objective of any container terminal is to handle as many containers as possible (Kutin et al., 2017).

Figure 2. 4 Throughput Volumes (TEU)



Source: Pelindo I, (2018)

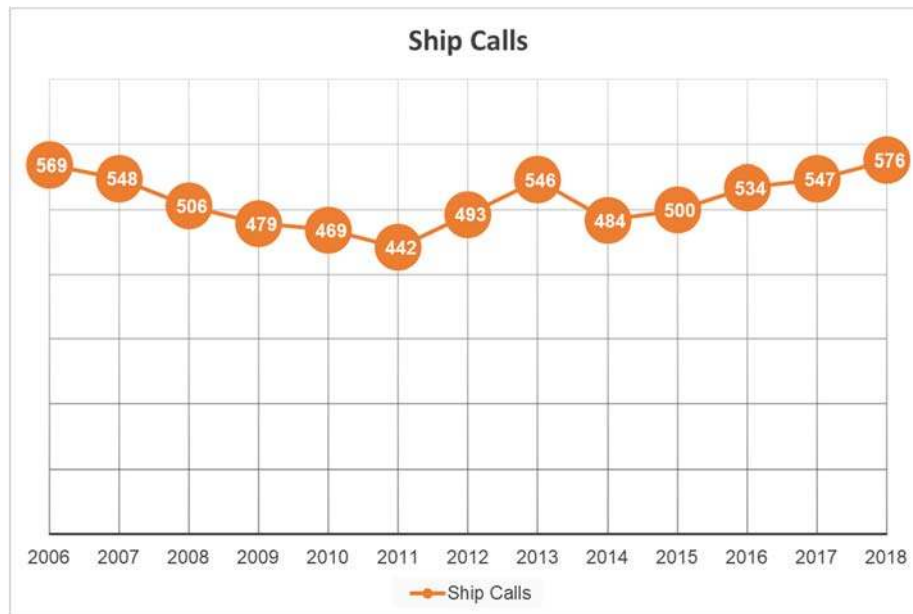
From Figure 2.4, it is described about historical data for annual throughput from 2006 to 2018 in BICT. From that figure, it can be seen that the trend from 2006 to 2018 grew positively an average of 6% per year, with some spikes in the throughput growth. At the end of 2008 there was an economic crisis, which affects the throughput growth in the following year 2009. In 2010, positive growth began and continued until 2014 an average of 7%, but there was a spike in 2014 to 2015 because of an internal policy in the company to split the terminal into two entities. One entity is focused only on international cargo, and the other is focused only on domestic cargo. In the following years the throughput growth from 2016 to 2018 increase by around 10%.

2.2.7 Number of Ship Calls

There are many propositions regarding the main players in determination of terminal or port choice. Shipping lines are the key players in determination of port choice. Ports are part of the value-driven chain system, and it is important for ports and their services to offer sustainable value to customers compared with their competitors in value-driven chain systems. Nevertheless, many industries share a view of cargo flows as, either determined by shipper or shipping lines, who will try to find the route that can offer the lowest cost for a given service level. As a node in the logistics chain, container ports that can achieve this service will be chosen as the ports of call (Yap and Lam, 2006).

According to Kutin, (2007), besides the annual throughput of container as the common indicator, the number of vessel calls is also another potential indicator with regard to measure the performance of port. The more number of vessel calls is the more attractive this port for exporters and importers. It means if we can attract more shipping line come to the port or terminal it will boost the cargo throughput and will affect to port performance (Song and Han, 2004). The historical data of ship calls in BICT is shown in the following table.

Figure 2. 5 Total Number of Ship Calls



Source: Pelindo I, (2018)

In a study by Kavirathna et al., (2018), by analyzing the market share, shipping services, size of vessel, growth of handling, and slot capacities among East Asian ports, we can identify the competitive dynamics. The result reveals that Chinese ports gradually become most attractive as direct calling ports rather than Taiwanese and Japanese ports. Furthermore, structural change in seaborne trade can be influenced by hub port competition. Previous studies said that port competition and network polarization in East Asia revealed the progress of secondary ports over their main competitors, while all the network structure tends to remain polarized by a few major hub ports which resist to external and internal threats.

2.3 Internal Factors

2.3.1 Port Performance Indicator

According to UNCTAD 1976, performance of port can be measured by two main indicators, financial indicator and operational. These indicators need to be measured to improve the port operations and to calculate the appropriate strategy for future planning in port development. Often, separate values for indicators will need to be specified based on different major categories of port traffic and vessel type (liquid and

dry bulk, breakbulk, containers). Some of the most common indicators of port operation and financial performance included in concession agreements and management contracts are presented below.

Table 2. 1 Port Performance Indicators

Operating Measures	
Average ship turnaround time	Total hours vessels stay in port (buoy-to-buoy time) divided by the total number of vessels
Average waiting time	Total hours vessels wait for a berth (buoy-to-berth time) divided by total time at berth
Berth occupancy rate	Total time of vessels at berth, divided by total berth hours available
Gross berth productivity	Number of container moves or tons of cargo (for breakbulk and bulk cargoes) divided by the vessel's total time at berth
Cargo dwell time	Cargo tones times days in port from time of unloading until the cargo exits the port, divided by total hours in port
Ship productivity indicator	Total number of moves (for containers) or tons handled (for breakbulk and bulk cargoes) divided by total hours in port
Tons per gang-hour	Total tonnage handled divided by total number of gang-hours worked
TEUS per crane-hour	Total number of TEUs handled divided by total number of crane-hours worked
Tons per ship-day	Total tonnage of cargo handled divided by total number of vessel days in port

Financial Measures	
Operating surplus per ton handled	Net operating income from port operations divided by total tonnage of cargo handled
Charge per TEU	Total charges for container handling divided by total TEU handled
Collected charges per billed charges	Total collected charges as a percentage of accounts billed

Source: World Bank (2007)

According to Lopez et al., (2019), there are two indicators classified such as efficiency and productivity indicators. Part of efficiency indicators are the mixed number of containers (proportion of twenty feet and forty feet), idle in trade and loading/unloading, crane efficiency, size of vessel and cargo exchange. Productivity indicators are the number of vessel calls, activity of economic, port dues, and the number of container being loaded and unloaded per berth per hour. Port performance indicators are very commonly being by port authorities or port companies at the international level.

To assess the performance of ports, port authorities/companies use indicators such as:

- Cargo transfer product: it is related to throughput volumes, the captive market in hinterland regions, value-added in port, number of vessel calls, stage of investment in port, EDI (electronic data interchange), traffic of hinterland, custom revenue from port, and price index of port dues.
- Port logistic product: it is related to warehousing, time to major consumer markets
- Port manufacturing product: it is related to value-added in port manufacturing, investment in port manufacturing, number of products related to manufacturing that are available in the port.
- Characteristic of the port in general such as value-added, level of investment, management programs certification, the average wage for port industries compare to the economy of regional, the number of accidents, water quality, employment in

port region, greenhouse gas emission and port economic impact (Lopez et al., 2019).

According to ILO PDP C6.2 (2018), there are four types of measurements, such as:

1. Production measures

The activity of the business calculated in quantity per unit time. For instance, output and turn over.

2. Productivity measures

The ratio of output to input, which means, efficiency checking, expressed in the quantity of production achieved per unit of resource in unit time.

3. Utilization measures

It tells about how intensively the resources of production are used and, the actual use of a resource, and the maximum possible use of that resource over a particular time period.

4. Service measures

The quality of service provided to the port’s customers and the capacity to solve problems as well as the reliability (i.e., security), the flexibility (i.e., the punctuality, the working hours), the rules application, and the time for solving conflicts and arguments.

2.3.2 Service Time

According to the Indonesia Ministry of Transportation (2018), there is a standard for a particular port in terms of the management of port operational performance. Part of this standard is related to time. As can be seen from Table 2.2, port operational performance standard for BICT is as follows:

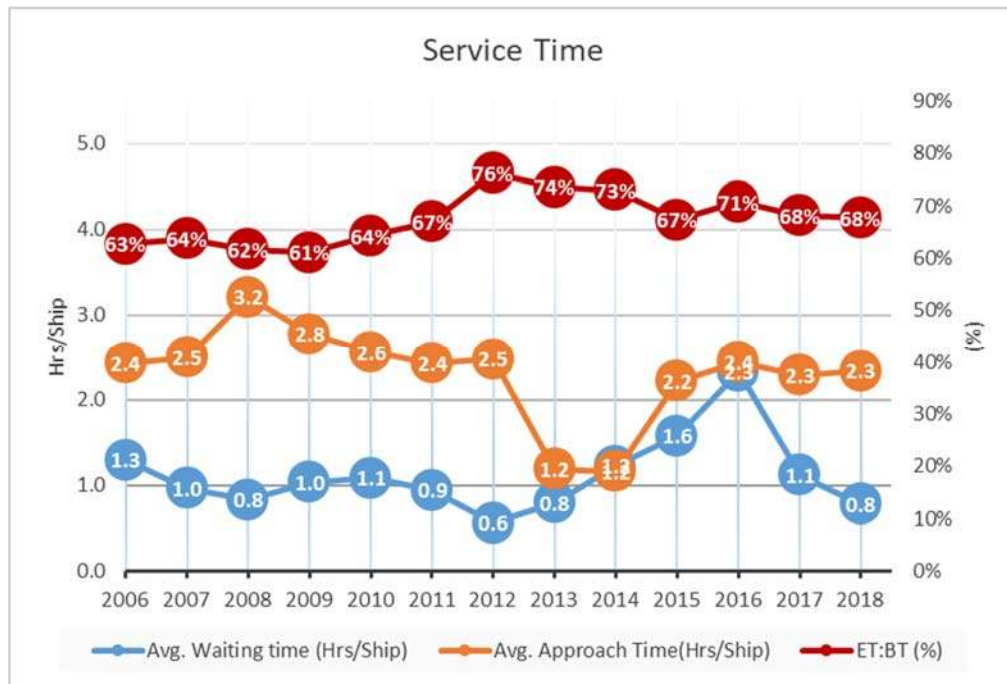
Table 2. 2 Port Operational Performance Standard for Service Time

No.	Indicator	Unit	Standard
1	Waiting Time (WT)	Hours	1.00
2	Approach Time (AT)	Hours	1.50
3	Effective Time : Berthing Time (ET:BT)	%	68.00

Source: Ministry of Transportation, Indonesia, (2018)

Time is one of the main factors in port business, and it is often related to cost. Therefore, this aspect is essential. There are typical ports that are sensitive to cost called lean ports and ports that are sensitive to time called agile ports (Song, 2019). Figure 2.6 shows historical data for actual service time in BICT as follows:

Figure 2. 6 Service Time in BICT

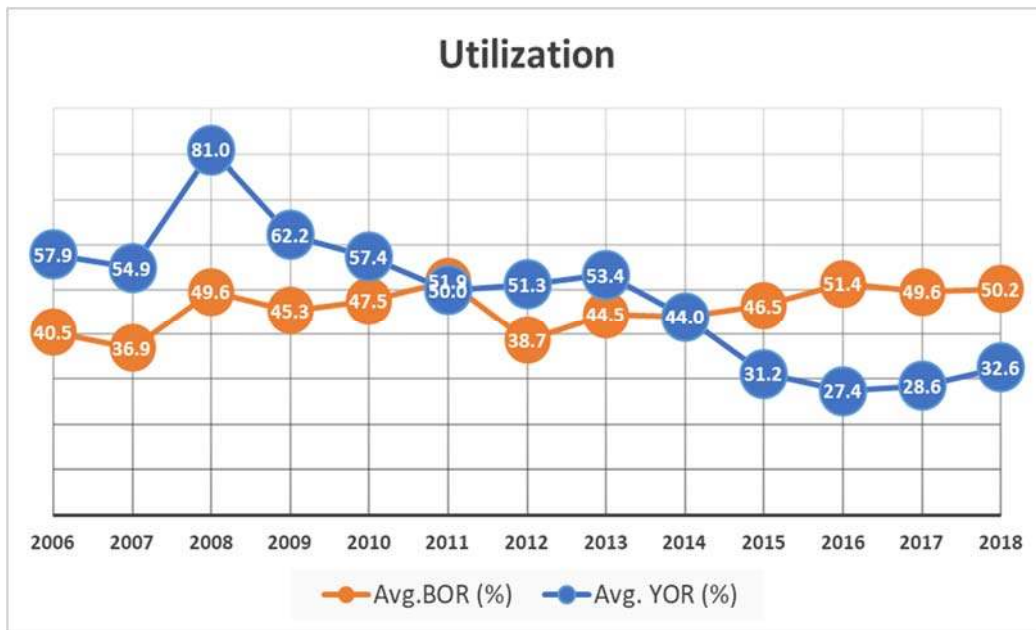


Source: Pelindo I, (2018)

2.3.3 Utilization

Another aspect that needs to be considered in terms of port performance is the utilization. It can be utilization of berth, yard, and other facilities in the port. This measurement shows the ratio between total service time at particular facilities (i.e., berth, yard, gate) in one year divided by available time for these facilities to provide services within one year (World Bank, 2007). By obtaining this figure, the occupancy of facilities or resources during a particular time (i.e., one year, one month) can be determined, which will provide more insight about the improvements to increase port performance. A study by Song and Han (2004) said that utilization, especially at berth utilization, is significantly affecting port performance, and this utilization is under control of the port company or port authority.

Figure 2. 7 Berth and Yard Utilization in BICT



Source: Pelindo I, (2018)

According to Figure 2.7, there were some fluctuations from 2008 to 2009 and in 2014. The first spike happened because there was a global crisis at the end of 2008, and the second spike in 2014 occurred because of internal regulation in BICT to split the cargo between international and domestic cargo. Therefore, yard occupancy ratio (YOR) in this specific terminal experienced a decline in that period.

Table 2. 3 Port Operational Performance Standard for Utilization

No.	Indicator	Unit	Standard
1	Berth Occupancy Ratio (BOR)	%	70.00
2	Yard Occupancy Ratio (YOR)	%	70.00
3	Equipment readiness	%	80.00

Source: Ministry of Transportation, Indonesia, (2018)

The Ministry of Transportation, Indonesia, regulates the standard of utilization for berth and yard. Usually, it called an occupancy ratio. Based on Table 2.3, as a standard for port operational performance, especially in BICT, there is a gap between actual data and the standard requirement, which means this terminal still has space to improve its performance (i.e., attract more cargo/more throughput). The standard from Indonesia Ministry of Transportation in 2018 is still aligned with UNCTAD,

(2012), which state if the berth occupancy ratio is above 70%, this condition will cause congestion, then port or terminal might be considered to expansion. On the other hand, if the occupancy ratio is still below 70%, then improvement in the performance is required to avoid the facilities being underutilized.

2.3.4 Productivity

Productivity can be considered the main indicator regarding port performance. It can be crane productivity, ship productivity, and berth productivity. It means the ratio of output over input. Optimization of production has been analyzed by many researchers by establishing the first measure of productive efficiency with the concept of coefficient of resource utilization. It is a similar approach to measuring efficiency by considering multiple outputs and inputs (Kutin et al., 2017).

This aspect can give impact to the flow of loading and unloading cargo within the terminal. The higher the number of this productivity, the bigger number of cargo can be handled. According to the Ministry of Transportation, Indonesia, in 2018, with regard to port operational performance for this terminal (BICT) the minimum standard for ship productivity is 32 (Teu/hours/ship), and for crane productivity is 22 (Teu/hours/crane). See Table 2.4 below.

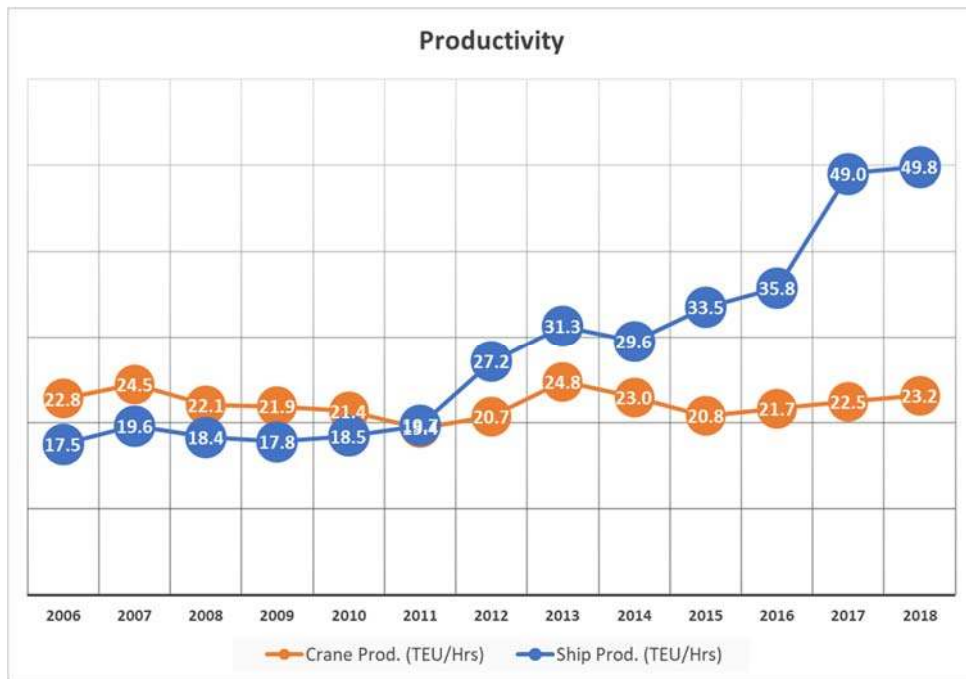
Table 2. 4 Port Operational Performance Standard for Productivity

No.	Indicator	Unit	Standard
1	B/C/H	B/C/H	22.00
2	B/S/H	B/S/H	32.00

Source: Ministry of Transportation, Indonesia, (2018)

Compared to actual data from BICT in 2018, the port's performance with regard to this productivity still meets the required standard. These aspects could be considered as variables that will affect to the throughput growth in BICT because service level is one of the most important factors that can influence the container throughput in ports (Liu and Park, 2011).

Figure 2. 8 Productivity in BICT



Source: Pelindo I, (2018)

CHAPTER THREE – BELAWAN PORT AS A CASE

3.1 Profile of Belawan Port

Port of Belawan is one of the main ports in Indonesia, which has a strategic location on the Malacca Strait. The location is approximately 13.5 km from the International shipping route in the Malacca strait can be seen in Figure 3.1. The Malacca strait is one of the busiest international shipping routes in the world, and close to this location, there are several big container terminals such as Port Klang and Tanjung Pelepas in Malaysia and PSA Singapore. These ports have long used and enjoyed significant growth opportunities within this region. This indicates the opportunity for the port of Belawan to achieve the same growth opportunities (Belawan port masterplan, 2018).

Figure 3. 1 Location of Malacca Strait



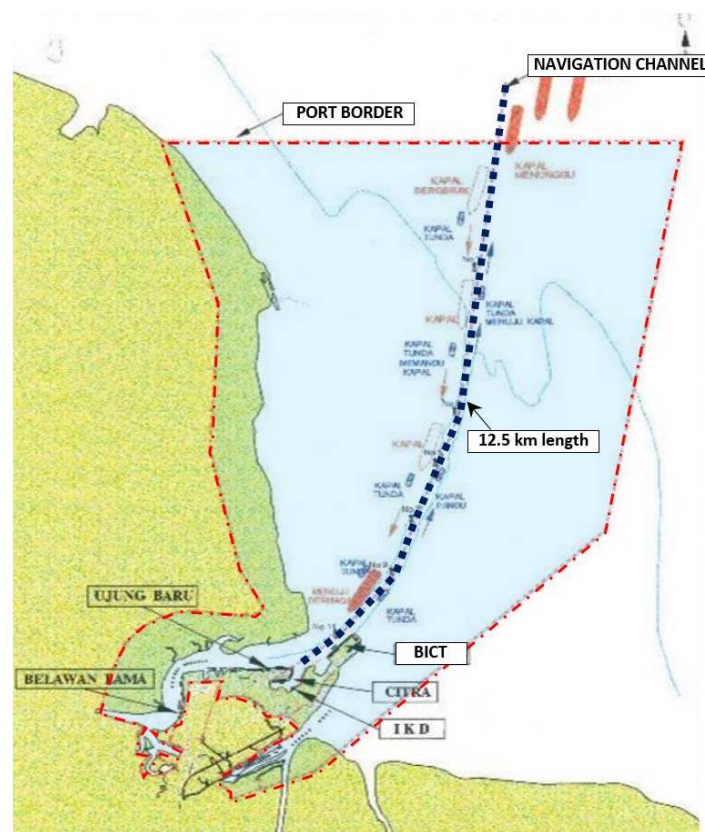
Source: Belawan Port Masterplan, (2018)

According to Belawan port's masterplan (2018), there is potentially provided by this strategical location in the Malacca Strait. An effort is still needed to capture a large

market, and in the hinterland of Belawan port, there are many potential commodities which require improvement. By considering this condition, it will affect and boost economic growth in Sumatera island, especially for North Sumatera province. The economic potential of this region will be empowered optimally if it can provide better services for commodity flow through the port of Belawan or surrounding ports within this region, not provided by other ports from foreign countries. This means this port is expected will have a significant role in increasing socio-economic growth (Bichou, 2014), especially in its capacity as a port where the cargo flow will be loaded and unloaded through this place. In this context, the port of Belawan needs to improve its capacity and capability in order to handle ships in general, including container ships sailing in the Malacca Strait.

3.2 Navigation Channel and Port Border of Belawan

Figure 3. 2 Channel Navigation and Port Border of Belawan



Source: Belawan Port Masterplan, (2018)

The port of Belawan has a navigation channel with a length of 12.5 km and width of channel profile at 100 meters with a slope at 1:5. This navigation channel has various drafts, starting from minus 8 m LWS to 10 m LWS. For draft of basin, it has different depths for each terminal within the port. For instance, BICT has draft of basin at minus 9 m LWS to 10 m LWS. Based on survey data, this navigation channel has an average sediment rate of 331.924 m³ per month. The shape of this navigation channel follows the natural depth of bathymetry contour to obtain the optimal draft for vessels and to minimize the cost of maintenance dredging (Belawan port masterplan, 2018).

3.3 Hinterland Connections of Belawan Port

The port of Belawan has intermodal transportation connected with highway and railway from the port area to the city center and to the airport as well. As a gateway port that handles import and export cargo, the flow of cargo can be delivered through this connectivity as can be seen from Figure 3.3. In logistics systems, the port is bidirectional which means it receives cargo from ships and will distribute it to its hinterland through multimodal transportation systems such as railway, highway, and state road, while at the same time the port also receives cargo from its hinterland to be delivered through ships. This bidirectional system requires advance coordination and capabilities in port system (Panayides and Song, 2008).

Figure 3. 3 Hinterland Connection Between Port of Belawan and City Center



Source: Regional Planning Institution, (2018)

3.4 Type of Cargo in Belawan Port

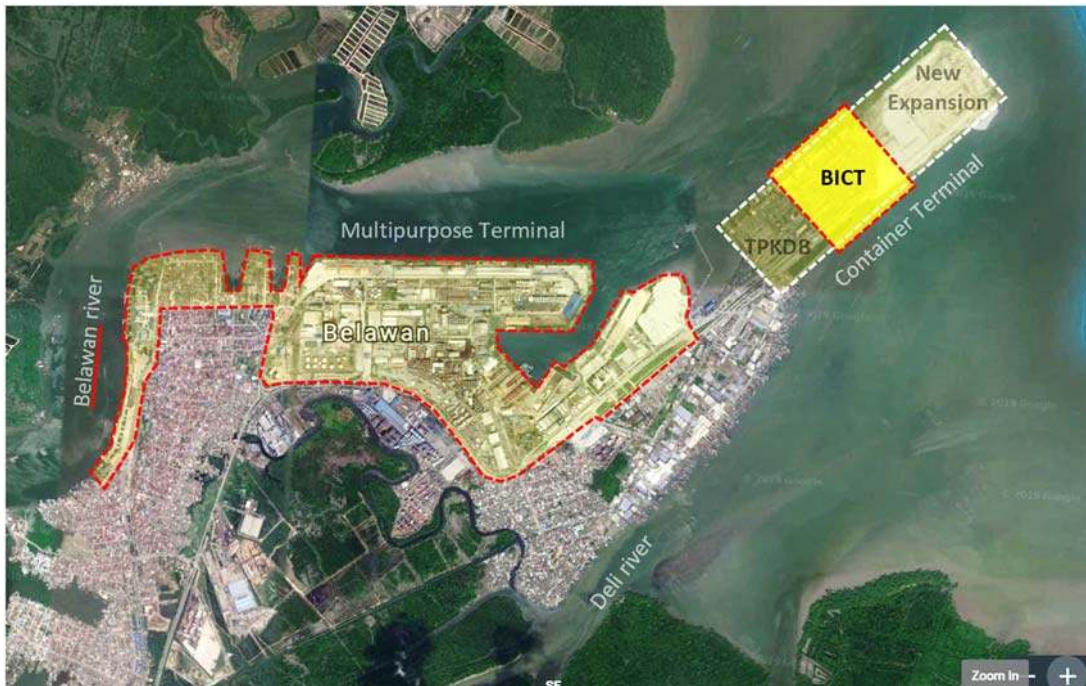
Belawan port has a multipurpose terminal which can handle various types of commodities and the total length of berth for this port, excluding container terminal, is approximately 3.2 km. Herewith, the type of cargo that can be handled by Belawan port is as follows:

- Liquid bulk: North Sumatera province has significant potential to produce crude palm oil (CPO). Most of this product (CPO and its derivatives) will be exported through the port of Belawan to other countries and regions. Besides CPO, another commodity handled by the port of Belawan is fuel. This commodity is an imported product from another country (i.e., Petronas Malaysia) that needs to be delivered and sold to customers in north Sumatra province and its hinterland.
- Dry bulk: For this type of cargo, there are two main dry bulk cargoes handled by the port of Belawan. Bulk cement is a dry bulk commodity handled by Belawan port. This cargo comes from other provinces and within Belawan port this cargo will be packaged in bags and will be distributed to the hinterland of North Sumatera province. The other dry bulk cargo is fertilizer: this cargo is basically the same as bulk cement. It comes from other provinces and will be packaged in bags, and distributed via north Sumatera hinterland.
- Besides liquid and bulk cargo, there are other cargoes which are handled in Belawan port. There are Breakbulk cargoes for project purposes and a car terminal dedicated to handling cars.

3.5 Type of Cargo in BICT (Belawan International Container Terminal)

BICT is located next to Belawan port and still in the same working area. The location of this terminal can be seen from Figure 3.4. From a geographical perspective, the location of BICT in coordinate position is 3°46'59"N - 98°41'26"E. This terminal only focuses on handling international container cargo. Besides, BICT, which only focus on international container cargo, there is one other container terminal which only focuses on domestic container cargo, called TPKDB.

Figure 3. 4 Location of Belawan Port and BICT



Source: Google Earth, (2018)

This container terminal is located in the East Sea of Sumatra coast between Deli river and Belawan river. BICT is a gateway container terminal in North Sumatera. This terminal focuses only on international cargoes, including both exports and imports. Most vessels come from southeast Asia such as Port Klang, Tanjung Pelepas, and Port of Singapore. This terminal has a navigation channel with the various drafts starting from -8 m LWS to -10 m LWS with a length at 12,5 km. It takes time for vessels to maneuver from the anchorage area to the terminal area, because of the tidal condition, and most of the time, vessels should rely on this situation. From Table 3.1, the current facilities at BICT as follows:

Table 3. 1 BICT's Facilities

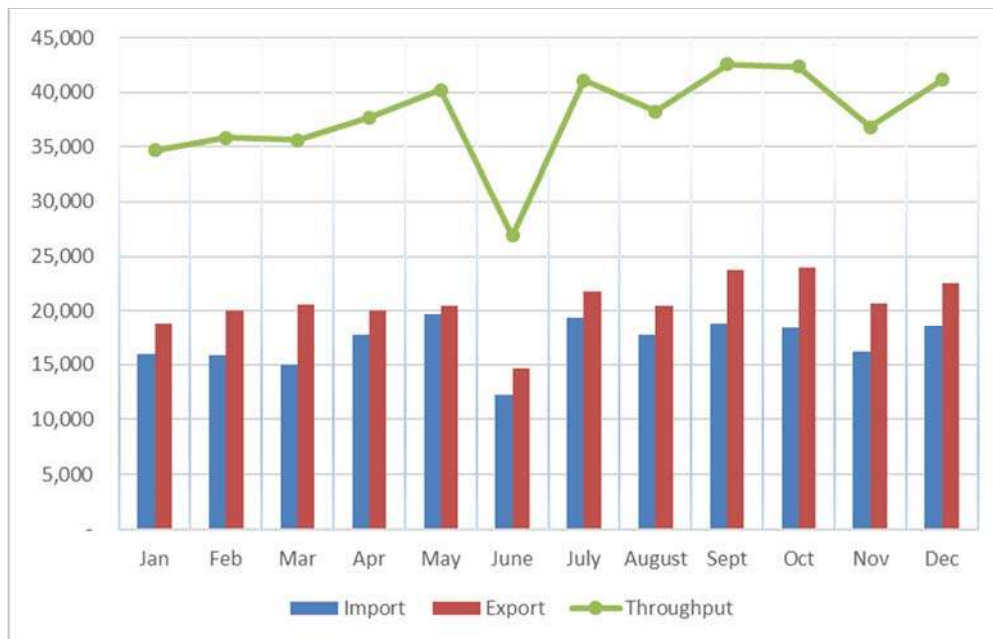
Facilities	Description
Berth length	550 meter
Depth of basin	10 – 11 m LWS
CY (container yard)	± 16 Ha
Workshop	1.452 m2
Reservoir	1.000 m3

Access road	72.200 m ²
Office	1.000 m ²

Source: Pelindo I, (2018)

The total number of throughputs for BICT in 2018 was 586.676 TEU with an average throughput per month of 48.889 TEU. There were some fluctuations in throughput data during 2018. For instance, throughput in June 2018 dropped for seasonal reasons (i.e., Ramadhan season). During this period, cargo flow within the terminal was relatively slow and will become stable again after this season over as seen Figure 3.5.

Figure 3. 5 Total Number of BICT Throughput (Teu) in 2018



Source: Pelindo I, (2018)

CHAPTER FOUR – RESEARCH METHODOLOGY

4.1 Method

Cargo throughput growth in BICT depends on the behavior number of independent variable factors. Therefore, to analyse the cargo throughput growth, the Classical Linear Regression Model (CLRM) is applied. For example, the equation can be illustrated as follows;

$$\text{BICT Cargo Throughput} = \alpha + \beta_1 * \text{seaborne container trade} + \beta_2 * \text{ship calls} + \dots + \mu$$

Or with the illustrated mathematic equation as follow;

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \mu$$

- Y = Dependent Variable
- X_i = Independent Variable
- α = Constant
- β = Coefficient
- μ = Error correction term

4.2 Data Selection

The selection of data to input the Classical Linear Regression Model (CLRM) is crucial. The accuracy of the empirical model depends on the quality of the data. In order to develop the CLRM, the historical data from BICT was received. In addition, the data from Clarksons Ship Intelligence and Economic Indicator Database (i.e., Asia Regional Integration Center) was obtained to prepare a reliable set of data. The details of the collected data are given below.

- Time period of the Data – January 2006 to December 2018
- Frequency – Quarterly
- Number of Observation – 52

4.3 Conceptual Framework

Table 4. 1 Conceptual Framework

Dependent Variable (Y)	Factors	Indicators	Independent Variables	X _i	
Cargo Throughput	External	Macroeconomic	Hinterland's GDP	China	X ₁
				Malaysia	X ₂
				Singapore	X ₃
				Thailand	X ₄
				Indonesia	X ₅
			Exchange Rate	China	X ₆
				Malaysia	X ₇
				Singapore	X ₈
				Thailand	X ₉
				Indonesia	X ₁₀
		Industrial Production of China	X ₁₁		
		Export of China Container	X ₁₂		
		Import of China Container	X ₁₃		
	Traffic	Number of Ship Calls	X ₁₄		
		Seaborne Container Trade Trends	X ₁₅		
		Export Cargo/outbound cargo	X ₁₆		
		Import Cargo/inbound cargo	X ₁₇		
	Internal	Service Time	Waiting Time	X ₁₈	
			Approach Time	X ₁₉	
			ET : BT	X ₂₀	
			Berthing Time	X ₂₁	
			Turnaround Time	X ₂₂	
		Utilization	Berth Occupancy Ratio	X ₂₃	
			Yard Occupancy Ratio	X ₂₄	
		Productivity	Crane Productivity	X ₂₅	
	Ship Productivity		X ₂₆		

Throughput growth in BICT is determined by some aspects such as operational aspects (i.e., service time, utilization, productivity, traffic volume), or internal factor and macroeconomic aspects (i.e. seaborne trade, hinterland's GDP, exchange rate, industrial production, export-import trade) or external factors. This research analyzes several variables that could affect the growth of cargo throughput in BICT. The simulation of individual container terminals by using the actual data for instance, number of vessels, number of containers handled and intermodal transport, suggest that the behavior of the market served can have a valuable impact to the growth of throughput in the container terminal (Cochrane, 2008).

4.4 Operationalization

Independent variables in this research will basically represent several aspects which are assumed will have an impact on cargo throughput, for example, operational, economic activities, traffic volume, utilization, and productivity. The justification for each variable was already explained in chapter two. In addition, the following table shows the variable terms and the explanation or definition about the terms for each independent variable which will be used in the data analysis.

Table 4. 2 Operationalization

No.	Variable Terms	Abbreviation	Explanation
1	Gross Domestic Product	GDP	The percentage growth rate year to year from the GDP of China, Malaysia, Singapore, Thailand, and Indonesia
2	Exchange Rates	ER	The difference of currency value in a particular country (China, Malaysia, Singapore, Thailand, Indonesia) compared to the US Dollar.
3	Industrial Production	IP	The percentage of growth year to the year of China Industrial production.
4	Container Export	CE	This is the number of million tonnes of China seaborne containerisable for export.

5	Container Import	CI	This is the number of million tonnes of China seaborne containerisable for import
6	Ship Calls	SC	Total number of vessels that come to the port (BICT) in certain periods of time (monthly, quarterly, annually)
7	Seaborne Container Trade Trends	SCTT	This is the index of mainline trade from East to West; this index will tell us about the trends in the global economy for a certain period of time
8	Waiting Time	WT	The average time spent for a vessel when arrived at the anchorage area until the vessel starts to sail to the terminal after getting confirmation about their berth allocation
9	Approach Time	AT	The average time spent for a vessel to get into the terminal from the anchorage area until berthing place based on their berth allocation (in BICT, it also depends on the tidal height)
10	Effective Time : Berthing Time	ET : BT	The ratio between effective time (working time) divided by berthing time (operating time+non working time) on average
11	Berthing Time	BT	The average time for a vessel spent at the berth including idle time, effective time, and non-operational time.
12	Turnaround Time	TRT	The average total time that a vessel spends at a port from arrival to departure including waiting time, approach time, berthing time, effective time, and idle time.
13	Berth Occupancy Ratio	BOR	The ratio between occupancy of the berth divided by the availability of the berth in certain period of time (on average).

14	Yard Occupancy Ratio	YOR	The ratio between occupancy of the yard divided by the availability of the yard in certain period of time (in average).
15	Crane Productivity	CP	The average number of containers are being handled within one hour per crane per hour.
16	Ship Productivity	SP	The average number of containers are being handled within one hour per ship per hour.

4.5 Data Analysis

To identify significant factors, ordinary least square (OLS) and classical linear regression model (CLRM) with some data series starting from 2006 to 2018 on a quarterly basis was used together with internal and external factors.

4.5.1 Unit Root Test

Before the data analysis is carried out, it needs to make all the variables at a stationary level. The unit root test was conducted to check the stationary level of each variable including the dependent variable (Y) and independent variables (Xi). There are two main tests to check the stationary test. Both of these are the Augmented Dickey Fuller (ADF) and the Phillips-Perron (PP) test. In these tests the hypothesis of the stationary test is as follows:

H_0 : variable has a unit root (non-stationary level)

If the probability is higher than 5%, then the hypothesis is accepted, it means the variable is non-stationary level.

H_1 : variable has no unit root (stationary level)

If the probability value is less than 5%, then the hypothesis is rejected, which means the variable is at the stationary level.

The author uses the probability value at 5%, which means it will use this model at 95% confidence level, instead of using the probability value at 10% or even 1%. This probability value is commonly used or not too pessimistic and not too optimistic. For the ADF and PP test, both should be checked and tested at the same level. Further, the result should be matched, for instance, if in ADF test the stationary level found in the 1st difference, then in the PP test the stationary level should be found in the 1st difference as well. Thus, it can be concluded that the variable is stationary at the 1st difference. In some cases, there are conflicts between the ADF and PP test. To solve the issue for that condition, the alternative test is the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test; this test has a different hypothesis compared to the ADF and PP test. The hypothesis is as follows:

H_0 : variable is stationary

If the probability is higher than 5%, then the hypothesis is accepted; this means the variable is at the stationary level.

H_1 : variable is non-stationary

If the probability value is less than 5%, then the hypothesis is rejected, which means the variable is at the non-stationary level.

4.5.2 Correlation Test

This test assesses the correlation between Independent variables and shows the percentage of correlation between each variable. Hence, the number will indicate how significant the correlation between two independent variables is. According to Sahoo, (2019) the limit that used is 80%, which means if the correlation percentage is above 80% then one of that variables needs to be removed because these two variables are too similar, and will give the same impact on the dependent variable, that being why it needs to remove one of them.

This test is conducted by Ms. Excel because it is more user-friendly, even though other software can also assess the correlation test, such as E-views. During this test, the independent variables are used based on their stationary level. If there is a

correlation higher than 80% between two independent variables, then it needs to choose one of them to be kept or dropped from the equation, based on the economic justification.

4.5.3 T-Test

The T-Test is used to check whether all the variables are significantly affected to the dependent variable. This test is conducted after all the independent variables are already at the stationary level. The regression model is then run, and the probability value from each independent variable is observed. In this test, the null hypothesis is the variable equal to zero. See the following explanation below.

$$H_0: \beta = 0$$

This means, if the probability value is more than 5%, then the null hypothesis is accepted because the coefficient is equal to zero. If it is equal to zero, this means the variable is not significantly affecting the dependent variable and therefore needs to be removed from the regression analysis.

$$H_1: \beta \neq 0$$

This further means, if the probability value is less than 5%, then the null hypothesis is rejected because the coefficient is not equal to zero. If it is not equal to zero, this variable is then significantly affecting the dependent variable, and it needs to be kept in the regression analysis.

4.5.4 F-Test

This test is similar to the T-Test; the only difference between them being the null hypothesis in F-Test is using multiple restriction variables, while in T-Test it is only using the single restriction variable. In this test, the Wald test is used as part of the coefficient analysis. Moreover, the null hypothesis in the Wald test as follows:

$$H_0: \beta_2 = 0$$

$$H_0: \beta_3 = 0$$

In this test, the multiple restriction variable is used. The F-Test uses two or more variables as the null hypothesis, while in the T-Test it is only using one variable in the null hypothesis. Thus, this test has more variables to be checked, whether the variables are significant or not. If the probability value is higher than 5%, then the null hypothesis is accepted.

$$H_0: \beta_2 \neq 0$$

$$H_0: \beta_3 \neq 0$$

This means, if the probability value is less than 5%, then we reject the null hypothesis. The variable in the regression analysis is kept.

4.5.5 Co-Integration Test

The co-integration test is carried out to make a linear combination between two pairs by creating the pairs between the dependent variable and independent variables. Both of these variables should be at the stationary level at the 1st difference. This test gives an impact on model performance; for instance, it increases the adjusted R-squared. Once the pairs between two variables are created, the residual will automatically generate in this regression. Then, the stationary level for each residual or error correction term from each pair needs to be checked. The same method in Unit Root Test is conducted by checking the stationary level of each residual.

The residual or error correction term will add to the regression to re-estimate model with lags to affect the yesterday errors to today's value. The error correction term will add as a new variable together with independent variables. If the probability value in the error correction term is more than 5%, it needs to be removed from the regression, which means this variable is equal to zero and is not significantly affecting the dependent variable. Moreover, if it is less than 5%, the variable in the regression model needs to be kept, which means this variable is significantly affecting the dependent variable. The same method is repeated to all pairs which are stationary at the 1st difference.

4.5.6 Auto Regressive Moving Average (ARMA) Test

The autoregressive (AR) was used to assess whether the value from yesterday has affected the present day, and the moving average (MA) was used to assess whether the yesterday error affects today's error. The application of the ARMA test starts from $AR_{(1-5)} MA_{(1-5)}$ into a regression model and assesses the significance level (Suriyakul and Ritthirungrat, 2018).

4.5.7 Jarque-Bera Test

This test is conducted to check whether the residuals are normally distributed or not. There are some criteria values that need to be observed from this normality test such as the value of kurtosis and skewness; for kurtosis, the value should be close to three, and for the skewness the value suggested close to zero (Sahoo, 2019). The hypothesis is as follows:

H_0 : Normally distributed

If the probability value from this normality test is higher than 5%, then the null hypothesis is accepted, which shows the model is normally distributed. It can also be seen by the mean value of this model should be close to zero, and the histogram shape is symmetric.

H_1 : Non-normally distributed

If the probability value from this normality test is less than 5%, then the null hypothesis is rejected, which shows the model is non-normally distributed. To make the model become normally distributed, it needs to add dummy variable in the regression. Adding dummy variable by checking the outlier or spikes from the residual fluctuation graph and adjust one or more particular outliers becoming close to zero (Brooks, 2014). Then the normality test can be checked again until the probability value is higher than 5%.

4.5.8 Heteroscedasticity Test

This test assesses the variance of the error, whether it is constant or not. If it is not constant, the standard error would be incorrect, and any judgment will make the model misleading ((Suriyakul and Ritthirungrat, 2018). The hypothesis is as follows:

H_0 : Homoscedasticity

The null hypothesis is accepted when the probability value is higher than 5%. Then, the variance of error is Homoscedasticity.

H_1 : Heteroscedasticity

The hypothesis is rejected when the probability value is less than 5%. Then, the variance of error is Heteroscedasticity. When the variance of error is Heteroscedasticity, this phenomenon is called autoregressive conditional heteroscedasticity (ARCH effect). This means the error is always changing over time (Brooks, 2008).

4.5.9 Serial Correlation Test

This test assesses the residual of error, whether the residual of error has a serial correlation or not. In the linear regression model, the error should be independent of one another, or it has no serial correlation. The hypothesis is as follows:

H_0 : No serial correlation

The null hypothesis is accepted when the probability value is higher than 5%. Then, the residual of error has no serial correlation.

H_1 : Serial correlation

The hypothesis is rejected when the probability value is less than 5%. Then, the residual of error has a serial correlation.

Since the residuals of error should be independent of one another or have no serial correlation, and to make the error variance constant, the correction matrix for homoscedasticity and serial correlation is created as follows:

Table 4. 3 Matrix Correction of Homoscedastic and No Serial Correlation

Scenario	Homoscedasticity	No Serial Correlation	Correction
1	√	√	-
2	X	√	White Correction
3	√	X	Newey-West Correction
4	X	X	Newey-West Correction

Source: Brooks, (2008)

4.5.10 Ramsey Test

This test assesses the linearity of functional form. The hypothesis is as follows:

H_0 : Linearity

The null hypothesis is accepted when the probability value is higher than 5%. Then, the functional form is linear.

H_1 : Non Linearity

The hypothesis is rejected when the probability value is less than 5%. Then, the functional form is non-linear. This condition can happen because the variables are too volatile. There are some options to cure the model so it becomes linear, such as using the “log” value and breaking the time period (Sahoo, 2019).

4.5.11 The Assumption of CLRM

According to Brooks, (2008), there are several assumptions to check the Ordinary Least Square (OLS), which is a Classical Linear Regression Model (CLRM). In addition, if the regression model can fulfill all the requirements below, then it can be called Best Linear Unbiased Estimator (BLUE). Here are the following assumptions that need to be achieved:

i. $E(\mu_t) = 0$

The mean of errors should be close to zero, by putting the interception in the regression, the mean of error is mostly close to zero.

ii. $\text{Var}(\mu_t) = \sigma^2 < \infty$

The variance of errors is constant (homoscedastic) and finite over all values of x . If the variance of errors is not constant, then it is called heteroscedastic. In addition, the model has an Auto Regressive Conditional Heteroscedasticity (ARCH) effect, because the error always changes overtime.

iii. $\text{Cov}(\mu_i, \mu_j) = 0$ (no autocorrelation)

The errors should be statistically independent of one another.

iv. $\text{Cov}(\mu_t, x_t) = 0$

The errors should have no relationship with the corresponding x variate.

v. $\mu_t \sim N(0, \sigma^2)$, Normally distributed.

The last assumption is to make sure the errors are normally distributed.

CHAPTER FIVE – EMPIRICAL RESULTS

5.1 Findings

There are 26 variables selected, and after conducting several tests to ascertain the regression and linearity of this model, it was only eight variables which significantly affected the BICT throughput. Hence, it is required to do several econometric tests in the analysis of time-series data such as co-integration and unit root to achieve reliable results (Serenis and Tsounis, 2014). Several tests describe as follows.

5.1.2 Unit Root Test

Table 5. 1 Unit Root Test

Variables		Stationary	ADF			PP		KPSS			
		Result	level	1 st diff	2 nd diff	level	1 st diff	2 nd diff	level	1 st diff	2 nd diff
Cargo throughput	Y	I(1)	-0.04	-7.43		-0.71	-20.5				
GDP_China	X ₁	I(1)	-1.87	-5.25		-1.57	-4.22				
GDP_Malay	X ₂	I(0)	-5.26			-3.21					
GDP_Sing	X ₃	I(0)	-2.99			-2.96					
GDP_Thai	X ₄	I(0)	-5.49			-3.81					
GDP_Indo	X ₅	I(1)	-1.61	-3.80		-2.45	-6.19				
ER_China	X ₆	I(1)	-2.55	-4.41		-2.52	-4.39				
ER_Malay	X ₇	I(1)	-1.06	-4.97		-0.81	-4.87				
ER_Sing	X ₈	I(1)	-2.29	-5.22		-2.41	-5.06				
ER_Thai	X ₉	I(1)	-2.64	-4.95		-2.75	-4.97				
ER_Indo	X ₁₀	I(1)	-0.21	-5.31		-0.24	-4.69				
IP	X ₁₁	I(1)	-1.61	-5.03		-1.54	-8.24				
CE	X ₁₂	I(1)	0.26	-3.37		-2.54	-16.7				
CI	X ₁₃	I(1)	-2.01	-10.4		-2.26	-9.24				
SC	X ₁₄	I(0)	-3.02			-2.81	-10.8	0.23			
SCTT	X ₁₅	I(1)	-2.48	-5.68		-2.59	-7.17				
Export Cargo	X ₁₆	I(1)	0.53	-8.79		-0.30	-14.1				
Import Cargo	X ₁₇	I(1)	-0.06	-13.5		-1.68	-28.3				
WT	X ₁₈	I(0)	-2.82	-12.9		-4.3		0.11			
AT	X ₁₉	I(1)	-2.49	-8.35		-2.40	-8.77				
ET:BT	X ₂₀	I(0)	-1.76	-8.13		-3.12		0.51			

BT	X ₂₁	I(0)	-4.07		-4.08	
TRT	X ₂₂	I(1)	-1.72	-8.85	-2.86	-14.4
BOR	X ₂₃	I(0)	-4.45		-4.45	
YOR	X ₂₄	I(1)	-1.14	-6.57	-0.96	-7.75
CP	X ₂₅	I(0)	-3.53		-3.44	
SP	X ₂₆	I(1)	-0.26	-9.34	0.16	-11.4

5.1.2 Correlation Test

Table 5. 2 1st Correlation Test

Variables	log_cargo_throughput_l(1)	Log_import_throughput_l(1)	Log_export_throughput_l(1)	log_SCTT_l(1)	log_IP_l(1)	log_ER_l(1)	log_CE_l(1)	log_CL_l(1)	log_GDP_l(1)	log_SC_l(0)	log_WT_l(0)	log_AT_l(1)	log_ET_BT_l(0)	log_BOR_l(0)	log_YOR_l(1)	log_CP_l(0)	log_SP_l(1)	log_TRT_l(1)	Log_BT_l(0)	Log-GDP Indo_l(1)	GDP Malay_l(0)	GDP Sing_l(0)	GDP Thai_l(0)	Log_ER Indo_l(1)	Log_ER Malay_l(1)	Log_ER Sing_l(1)	Log_ER Thai_l(1)			
log_cargo_throughput_l(1)	100%																													
Log_import_throughput_l(1)	94%	100%																												
Log_export_throughput_l(1)	92%	72%	100%																											
log_SCTT_l(1)	-13%	-20%	-4%	100%																										
log_IP_l(1)	9%	8%	8%	3%	100%																									
log_ER_l(1)	10%	11%	8%	22%	-4%	100%																								
log_CE_l(1)	0%	11%	-11%	-14%	1%	-2%	100%																							
log_CL_l(1)	10%	19%	-2%	-28%	9%	4%	43%	100%																						
log_GDP_l(1)	20%	19%	18%	-4%	51%	9%	27%	35%	100%																					
log_SC_l(0)	7%	2%	11%	13%	0%	19%	-4%	-16%	-9%	100%																				
log_WT_l(0)	0%	4%	-3%	-6%	5%	46%	-3%	-7%	10%	2%	100%																			
log_AT_l(1)	6%	18%	-11%	8%	-2%	7%	6%	1%	-3%	-2%	8%	100%																		
log_ET_BT_l(0)	20%	10%	29%	15%	-4%	21%	-7%	-9%	-3%	5%	-13%	-12%	100%																	
log_BOR_l(0)	28%	26%	26%	-17%	-15%	22%	0%	-3%	-2%	-15%	30%	0%	-8%	100%																
log_YOR_l(1)	35%	32%	34%	-14%	-13%	-16%	-2%	-2%	-7%	11%	12%	-24%	-1%	8%	100%															
log_CP_l(0)	6%	10%	-1%	19%	20%	-4%	5%	-3%	1%	54%	-14%	14%	1%	-50%	-7%	100%														
log_SP_l(1)	29%	21%	33%	23%	4%	9%	-38%	-25%	-14%	8%	-20%	24%	32%	-25%	-27%	24%	100%													
log_TRT_l(1)	-2%	10%	-15%	-32%	-17%	-4%	23%	22%	11%	-17%	19%	20%	-41%	35%	15%	-14%	-60%	100%												
Log_BT_l(0)	24%	23%	22%	-20%	-11%	0%	-3%	6%	3%	-67%	23%	3%	-27%	73%	8%	-71%	-23%	39%	100%											
Log-GDP Indo_l(1)	21%	15%	24%	25%	8%	-15%	32%	-13%	7%	2%	4%	1%	-4%	13%	21%	1%	-5%	3%	11%	100%										
GDP Malay_l(0)	7%	3%	10%	31%	-20%	-17%	15%	-22%	-22%	3%	-3%	4%	22%	-7%	24%	11%	-1%	12%	-7%	58%	100%									
GDP Sing_l(0)	10%	9%	9%	26%	4%	-25%	21%	1%	6%	-8%	-3%	-1%	-7%	-20%	17%	8%	-4%	4%	-1%	49%	70%	100%								
GDP Thai_l(0)	4%	2%	7%	28%	4%	-13%	13%	-17%	10%	16%	-13%	-11%	10%	-25%	15%	6%	2%	2%	-22%	43%	64%	60%	100%							
Log_ER Indo_l(1)	-28%	-30%	-21%	1%	-41%	11%	-39%	-30%	-60%	26%	-11%	-1%	19%	2%	-12%	0%	5%	-5%	-21%	-27%	-5%	-27%	-21%	100%						
Log_ER Malay_l(1)	-27%	-27%	-23%	2%	-29%	48%	-25%	-5%	-23%	1%	18%	-1%	8%	11%	-24%	-15%	5%	2%	1%	-16%	-16%	-36%	-31%	56%	100%					
Log_ER Sing_l(1)	-22%	-23%	-17%	6%	-36%	47%	-32%	-17%	-35%	14%	13%	-10%	14%	12%	-13%	-14%	10%	-5%	-2%	-21%	-14%	-33%	-29%	63%	85%	100%				
Log_ER Thai_l(1)	-11%	-10%	-10%	-1%	-19%	43%	-13%	4%	-26%	-8%	11%	-7%	21%	23%	-25%	-19%	-8%	-1%	12%	-15%	-15%	-39%	-36%	53%	75%	68%	100%			

In this correlation test, there are 26 independent variables, and it reveals that there are three variables which have more than an 80% correlation with other variables. Then, it needs to take out these three variables (the import throughput, the export throughput, and the exchange rate of Singapore). For import and export throughput, both have a strong relationship with cargo throughput. This is because in BICT their cargo is only for gateway cargo (export and import) without transshipment. This is why these two variables are strongly correlated with each other.

Furthermore, for the exchange rate of Singapore, the author decided to remove the exchange rate of Singapore from the regression instead of the exchange rate of Malaysia. This is because based on historical data, Malaysia has more economic growth than Singapore. After removing the correlated variables, it can be seen from the following table that the correlation for all variables are less than 80%. Then, the regression model in E-Views software can begin.

Table 5. 3 2nd Correlation Test

Variables	log_throughput_l(1)	log_SCTT_l(1)	log_IP_l(1)	log_ER_l(1)	log_CE_l(1)	log_CI_l(1)	log_GDP_l(1)	log_SC_l(0)	log_WT_l(0)	log_AT_l(1)	log_ET_BT_l(0)	log_BOR_l(0)	log_YOR_l(1)	log_CP_l(0)	log_SP_l(1)	log_TRT_l(1)	Log_BT_l(0)	Log-GDP Indo_l(1)	GDP Malay_l(0)	GDP Sing_l(0)	GDP Thai_l(0)	Log_ER Indo_l(1)	Log_ER Malay_l(1)	Log_ER Thai_l(1)	
log_throughput_l(1)	100%																								
log_SCTT_l(1)	-13%	100%																							
log_IP_l(1)	9%	3%	100%																						
log_ER_l(1)	10%	-22%	-4%	100%																					
log_CE_l(1)	0%	-14%	1%	-2%	100%																				
log_CI_l(1)	10%	-28%	9%	4%	43%	100%																			
log_GDP_l(1)	20%	-4%	51%	9%	27%	35%	100%																		
log_SC_l(0)	7%	13%	0%	19%	-4%	-16%	-9%	100%																	
log_WT_l(0)	0%	-6%	5%	46%	-3%	-7%	10%	2%	100%																
log_AT_l(1)	6%	8%	-2%	7%	6%	1%	-3%	-2%	8%	100%															
log_ET_BT_l(0)	20%	15%	-4%	21%	-7%	-9%	-3%	5%	-13%	-12%	100%														
log_BOR_l(0)	28%	-17%	-15%	22%	0%	-3%	-2%	-15%	30%	0%	-8%	100%													
log_YOR_l(1)	35%	-14%	-13%	-16%	-2%	-2%	-7%	11%	12%	-24%	-1%	8%	100%												
log_CP_l(0)	6%	19%	20%	-4%	5%	-3%	1%	54%	-14%	14%	1%	-50%	-7%	100%											
log_SP_l(1)	29%	23%	4%	9%	-38%	-25%	-14%	8%	-20%	24%	32%	-25%	-27%	24%	100%										
log_TRT_l(1)	-2%	-32%	-17%	-4%	23%	22%	11%	-17%	19%	20%	-41%	35%	15%	-14%	-60%	100%									
Log_BT_l(0)	24%	-20%	-11%	0%	-3%	6%	3%	-67%	23%	3%	-27%	73%	8%	-71%	-23%	39%	100%								
Log-GDP Indo_l(1)	21%	25%	8%	-15%	32%	-13%	7%	2%	4%	1%	-4%	13%	21%	1%	-5%	3%	11%	100%							
GDP Malay_l(0)	7%	31%	-20%	-17%	15%	-22%	-22%	3%	-3%	4%	22%	-7%	24%	11%	-1%	12%	-7%	58%	100%						
GDP Sing_l(0)	10%	26%	4%	-25%	21%	1%	6%	-8%	-3%	-1%	-7%	-20%	17%	8%	-4%	4%	-1%	49%	70%	100%					
GDP Thai_l(0)	4%	28%	4%	-13%	13%	-17%	10%	16%	-13%	-11%	10%	-25%	15%	6%	2%	2%	-22%	43%	64%	60%	100%				
Log_ER Indo_l(1)	-28%	1%	-41%	11%	-39%	-30%	-60%	26%	-11%	-1%	19%	2%	-12%	0%	5%	-5%	-21%	-27%	-5%	-27%	-21%	100%			
Log_ER Malay_l(1)	-27%	2%	-29%	48%	-25%	-5%	-23%	1%	18%	-1%	8%	11%	-24%	-15%	5%	2%	1%	-16%	-16%	-36%	-31%	56%	100%		
Log_ER Thai_l(1)	-11%	-1%	-19%	43%	-13%	4%	-26%	-8%	11%	-7%	21%	23%	-25%	-19%	-8%	-1%	12%	-15%	-15%	-39%	-36%	53%	75%	100%	

5.1.3 T-Test

In this test, the probability value less than 5% is required, which means the coefficient is not equal to zero, then it will significantly affect the dependent variable (Cargo Throughput). There are several independent variables that have been found at this stage which have the probability value higher than 5%, which means not significantly affect to dependent variable.

The dependent variable is Cargo Throughput

Table 5. 4 T-Test Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.7084	1.3992	-2.6503	0.0133
SCTT	-0.0975	0.0645	-1.5107	0.1425
IP	-0.0116	0.0733	-0.1590	0.8748
ER_CHINA	1.1450	0.8794	1.3020	0.2039
CE	0.0686	0.1296	0.5291	0.6010
CI	0.0548	0.1581	0.3470	0.7313
GDP_CHINA	0.2572	0.1890	1.3606	0.1849
SC	0.2823	0.2147	1.3148	0.1996
WT	-0.0353	0.0284	-1.2442	0.2241
AT	0.0077	0.0540	0.1433	0.8871
ET_BT	0.3222	0.2792	1.1538	0.2587
BOR	0.0141	0.1498	0.0945	0.9254
YOR	0.2527	0.0887	2.8482	0.0083
LOG_CP	0.3802	0.1982	1.9174	0.0658
SP	0.4020	0.1468	2.7374	0.0108
TRT	0.0137	0.0593	0.2322	0.8181
BT	0.3382	0.2029	1.6667	0.1071
GDP_INDO	0.0466	0.1434	0.3249	0.7477
GDP_MALAY	0.0017	0.0074	0.2380	0.8137
GDP_SING	0.0001	0.0038	0.0443	0.9650
GDP_THAI	0.0010	0.0046	0.2289	0.8206
ER_INDO	-0.0041	0.5298	-0.0078	0.9938
ER_MALAY	-0.7990	0.5771	-1.3845	0.1775
ER_THAI	1.0800	0.7493	1.4413	0.1610
R-squared	0.7668	Mean dependent var		0.0139
Adjusted R-squared	0.5683	S.D. dependent var		0.0913
S.E. of regression	0.0600	Akaike info criterion		-2.4836
Sum squared resid	0.0972	Schwarz criterion		-1.5745
Log likelihood	87.333	Hannan-Quinn criter.		-2.1362
F-statistic	3.8620	Durbin-Watson stat		2.5466
Prob(F-statistic)	0.0005			

5.1.4 F-Test

According to the T-Test, it shows some variables with a probability value of more than 5%. Then, it needs to be removed in the F-Test by using multiple restriction variables. As can be seen from Table 5.5, there are eight significant variables which have probability values of less than 5%. These variables are China's GDP, Ship Calls (SC), Yard Occupancy Ratio (YOR), Crane Productivity (CP), Ship Productivity (SP),

Berthing Time (BT), and the Exchange Rate of Malaysia and Thailand. By doing this F-Test, it is also giving an impact on our adjusted R-squared from 57% to 62%, which means this regression model has a confidence level at 62% adjusted R-squared, and able to predict the growth of BICT cargo throughput at a confidence level at 62%.

Table 5. 5 F-Test Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.9797	0.8753	-4.5466	0.0000
GDP_CHINA	0.3554	0.0969	3.6663	0.0007
SC	0.3632	0.1222	2.9714	0.0049
YOR	0.3126	0.0667	4.6819	0.0000
CP	0.3212	0.1410	2.2768	0.0280
SP	0.4619	0.0762	6.0563	0.0000
BT	0.3778	0.0743	5.0811	0.0000
ER_MALAY	-1.1041	0.3618	-3.0511	0.0039
ER_THAI	1.7071	0.5255	3.2482	0.0023
R-squared	0.6810	Mean dependent var		0.0139
Adjusted R-squared	0.6202	S.D. dependent var		0.0913
S.E. of regression	0.0562	Akaike info criterion		-2.7583
Sum squared resid	0.1330	Schwarz criterion		-2.4174
Log likelihood	79.337	Hannan-Quinn criter.		-2.6280
F-statistic	11.209	Durbin-Watson stat		2.5314
Prob(F-statistic)	0.0000			

5.1.5 Co-Integration Test

In this test, the author tries to make two stationary combinations or pair variables between the dependent variable (cargo throughput) and significant independent variables which are stationary at 1st difference. This test is used to assess the long relationship between variables (significant variables). As the result, this model has three significant variables which are stationary at 1st difference such as China's GDP, Ship Productivity and Yard Occupancy Ratio. The new regression was made for each pair between the dependent variable and the independent variable and then checked the residuals. If the residual is not stationary at level, then variables should be removed from this regression. Also, if the residual is stationary at level, then the variable will be added as an error correction term in this regression. The following table will give the information about the co-integration result based on the residual check.

Table 5. 6 Co-Integration Result

No.	Pair Variables	ADF	PP	Stationary	Co-integration Result
		Level	Level		
1	Cargo throughput and China's GDP	-3.10	-3.08	I (0)	There is co-integration
2	Cargo throughput and Ship Productivity (SP)	-4.26	-4.23	I (0)	There is co-integration
3	Cargo throughput and Yard Occupancy Ratio (YOR)	-3.17	-3.12	I (0)	There is co-integration

From the table above, those three pairs of variables had a stationary at level or I (0) process, then an error correction term (ECT) variable was added in this regression model with lag (until lag 1), which means to make sure the error from the previous day does not exist in the present day. The result, after adding three error correction term can be seen in the following table.

Table 5. 7 Co-Integration Result and Additional Error Correction Term

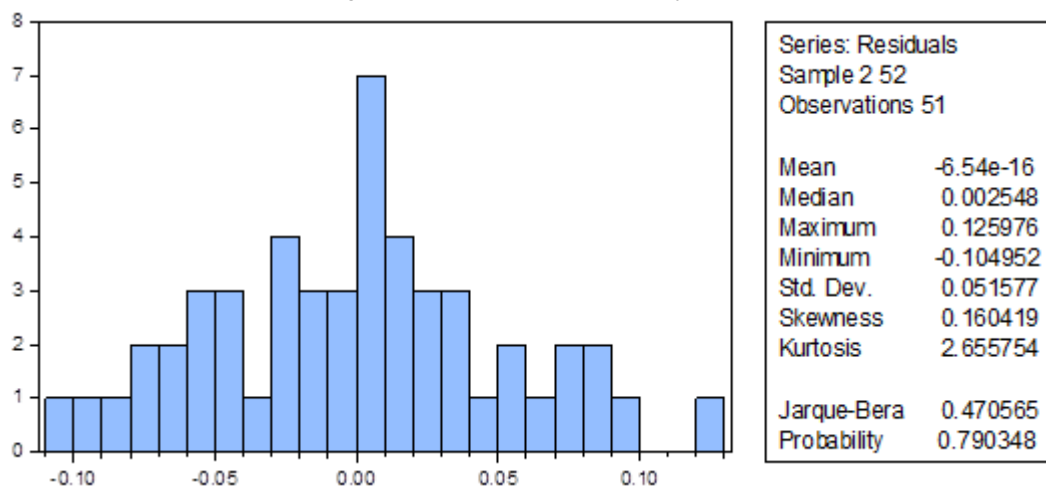
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.6508	0.8925	-2.9699	0.0051
GDP_CHINA	0.2139	0.0952	2.2463	0.0304
SC	0.2408	0.1182	2.0362	0.0486
YOR	0.2351	0.0650	3.6176	0.0008
CP	0.0940	0.1415	0.6648	0.5101
SP	0.5586	0.0766	7.2900	0.0000
BT	0.3664	0.0655	5.5876	0.0000
ER_MALAY	-0.9822	0.3262	-3.0105	0.0046
ER_THAI	1.4213	0.4929	2.8831	0.0064
ECT_SP(-1)	-0.6307	0.1888	-3.3397	0.0019
ECT_YOR(-1)	0.1989	0.0982	2.0245	0.0498
ECT_GDP_CHINA(-1)	-0.0112	0.0841	-0.1337	0.8943
R-squared	0.7723	Mean dependent var		0.0139
Adjusted R-squared	0.7081	S.D. dependent var		0.0913
S.E. of regression	0.0493	Akaike info criterion		-2.9779
Sum squared resid	0.0949	Schwarz criterion		-2.5233
Log likelihood	87.937	Hannan-Quinn criter.		-2.8042
F-statistic	12.028	Durbin-Watson stat		1.9812
Prob(F-statistic)	0.0000			

According to the result above, after adding three error correction terms (ECT), the author can observe that one of the significant variables, which is Ship Productivity (SP) becomes insignificant or the probability value is more than 5%. In addition, the adjusted R-squared becomes higher than before from 62% to 71%, but it needs to confirm all of independent variables should be significant or not equal to zero. Hence, the author tried to remove the error correction terms, which started from the highest probability value, one by one. The same procedure is carried out for each error correction term variable until all the variables have a probability value of less than 5%, which means all the variables should become significant. If there are no variables with the probability value of less than 5% for the error correction term, then there is no need to put these error correction terms in this regression model (Sahoo, 2019). In this regression, all of the error correction terms are not significant variable. Thus the author decides not to include these variables in the regression model.

5.1.6 Jarque-Bera Test

In the Jarque-Bera test, there are some parameters which need to be observed for example, standard deviation, the value of kurtosis and value of skewness. For mean value and skewness, the value should be close to zero, and for the kurtosis value it should be close to three. The null hypothesis in the Jarque-Bera test is the residuals should be normally distributed. From Figure 5.1, it can be seen that the probability value is more than 5%, which means the residuals in this regression model are normally distributed. Therefore, for this condition no dummy variable is to be added.

Figure 5. 1 Jarque-Bera Normality Test



5.1.7 Heteroscedasticity Test and Serial Correlation Test

The result from the heteroscedasticity test reveals that this model is Homoscedasticity or the variance of error is constant, and for the serial correlation test, it reveals that this model has no serial correlation, which means the residual of error is independent of one and another. According to Table 4.3, there is no need to make a correction for these tests.

5.1.8 Ramsey Test

The Ramsey (RESET) test was conducted to ascertain whether a non-linear combination of the fitted values actually helped explain the Throughput variable; the result shows that the probability of the F-statistic is 59% which demonstrates that this model is linear. At this point, based on the analytical procedures carried out, this model can be used for forecasting or projecting cargo throughput at an adjusted R² value of 62%.

5.1.9 The Assumption of CLRM

To assess this ordinary least square (OLS) is it a classical linear regression model (CLRM) or not, several tests are needed. The decision cannot be made in OLS, that is why it needs to convert into CLRM. If the model can meet with all the assumption in CLRM requirements, then the model can be called a BLUE or Best Linear Unbiased Estimator. According to Brooks, (2008) there are five main assumptions to obtain the BLUE from the CLRM, and the result from the following table reveals that this regression model is best linear unbiased estimator.

Table 5. 8 BLUE Test

No.	Type of Test	Status	
		Yes	No
1.	$E(\mu_t) = 0$	√	-
2.	Variance of errors $(\mu_t) = \sigma^2 < \infty$	√	-
3.	Covariance $(\mu_i, \mu_j) = 0$	√	-
4.	Uncorrelated – $Cov(x_i, \mu_i) = 0$	√	-
5.	$\mu_t \sim N(0, \sigma^2)$,	√	-

5.2. Discussion and Implication

Based on the previous explanation about the empirical results from the regression it was proved that from 26 independent variables, which assumed will give an impact on throughput growth in BICT, it was only eight variables which were significantly affecting throughput growth. In addition, regression analysis helped the author to find out the significant variables from many variables which were assumed previously. By conducting some tests in the classical linear regression model, eventually, some variables were significant. These variables come from external and internal factors and will be described in the following table.

Table 5. 9 Regression Result

Dependent Variable	Factors	Indicators	Significant Variables	X _i	
Cargo Throughput	External	Macroeconomic	Hinterland's GDP	China	X ₁
			Exchange Rate	Thailand	X ₂
				Malaysia	X ₃
		Traffic	Number of Ship Calls	X ₄	
	Internal	Service Time	Berthing Time	X ₅	
		Utilization	Yard Occupancy Ratio	X ₆	
		Productivity	Crane Productivity	X ₇	
			Ship Productivity	X ₈	

After all the variables were tested together and checked at a significant level, the final result and equation for this regression model can be highlighted as follows.

$$\text{Cargo Throughput} = -3.979 + 0.355 \cdot \text{GDP_C} + 1.707 \cdot \text{ER_Thai} - 1.104 \cdot \text{ER_Malay} + 0.363 \cdot \text{SC} + 0.377 \cdot \text{BT} + 0.312 \cdot \text{YOR} + 0.321 \cdot \text{CP} + 0.462 \cdot \text{SP}$$

Whereas:

GDP_C = GDP of China

ER_Thai = Exchange Rate of Thailand

ER_Malay = Exchange Rate of Malaysia

SC = Number of Ship Calls

<i>BT</i>	= Berthing Time
<i>YOR</i>	= Yard Occupancy Ratio
<i>CP</i>	= Crane Productivity
<i>SP</i>	= Ship Productivity

5.2.1 China's GDP

As one of the macroeconomic indicators, the GDP of China is proven through the regression analysis result to be a significant variable which affects the container throughput in BICT. According to the International Monetary Fund, China is the second world's largest economy after the United States. One percent increase of cargo throughput in port can raise GDP growth per capita at 7.6%, and the port throughput of a country will have a positive effect to their neighboring economies (Munim and Schramm, 2018). The construction and manufacture businesses are basically instruments in economic output and GDP as associated with steel usage (Popescu et al., 2016). Recently, Indonesia has a lot of infrastructure projects, and this condition can be having an impact on the throughput growth in BICT.

5.2.2 Exchange Rate of Malaysia and Thailand

The fast growth of industrialization, freight development, and cooperation in seaports multimodal infrastructure with intra-regions such as Indonesia, Thailand, Brunei, and Singapore have become a factor that assists container trade development in Malaysia since 1980 to 2010 (Jeevan et al., 2015). According to BICT's historical data, most of the vessels which come to this terminal are using Malaysia's and Thailand's flag state, then followed by Singapore. It is also indicating that their exchange rates affect the trade flows between these countries which gives some influence on the number of throughputs in BICT. Based on statistic data from Ministry of Industry (2019), since 2012 Malaysia and Thailand are among the top ten countries conducting trade in Indonesia. Thus, their economic activities obviously will give an impact on cargo flows including export and import through BICT. This is also confirmed from the regression analysis result.

The Malaysian exchange rate reacts differently from the Thai exchange rate to the BICT throughput. Unlike the other external factors, the cargo throughput of BICT is being negatively affected by the Malaysian exchange rate. If Malaysia has a higher exchange rate, it means higher costs and a high risk of the transaction, thus this will decline the trade. Hence, if the trade declining, then it will give a negative impact on throughput growth in BICT. On the other hand, if the exchange rate of Thailand shows a positive impact on the throughput of BICT it is because of an increase in the Thai exchange rate or local currency depreciation will trigger a higher foreign demand. A local currency depreciation makes export commodities become cheaper whereas import commodities are more expensive (Krugman, 1986). If Thailand has a higher exchange rate, they will export more because of the higher foreign demand; one of their major commodities exports is tapioca flour (Spilimbergo and Vamvakidis, 2003). Therefore, their export can be part of a cargo throughput growth in BICT.

To maintain this relationship between these countries in a positive way, the exchange rate policy and monetary policy is suggested, especially for those who want to avoid a future exchange and financial crisis in the global market. By doing this, it will give a better position to resist the unexpected adverse consequences and flexible movements in the global capital. Furthermore, this policy cooperation will enable these countries to use their bargaining positions to give important influence towards the future of global trade (Oh and Harvie, 2001)

5.2.3 Ship Calls

The number of ship calls is prominent as it affects the cargo volume, which moves through a terminal or port. By increasing the number of ship calls it will be more attractive to exporters and importers (Tongzon, 1994). Based on the regression analysis result which revealed that Ship Calls (SC) is significantly affecting throughput growth in BICT it is confirmed from historical data since 2011 that an increase of the number of vessels is also followed by an increment number of throughput in the terminal. Even though the number of vessels could be reducing, but the number of throughputs could still be increasing because the capacity of the vessel has recently become bigger than before. The vessel delivering cargoes with bigger capacity, then

will reduce the ship calls in the terminal and it was shown in historical data from 2006 to 2011. In addition, if the port or terminal enables to give more added value and complements to the shipping lines, and the shippers will be determining for the flows of container cargo which will make it a competitive port. Moreover, alliances of liner shipping and the upsizing of vessels make a strong connection between container shipping lines and container terminals. Thus, shipping alliances can make decisions to come to the port which can give more benefit for them regarding the capacity deployed, port of call and the structure of network and so on (UNCTAD, 2018).

5.2.4 Berthing Time

In BICT, berthing time consists of two main parameters, operating time and non-operating time. In operating time, there are two indicators, idle time (IT) and effective time (ET). Idle time means how many hours for the terminal cannot provide their services to the customers because of some reasons, for instance, a crane might be break down during the loading or unloading operation, there may be a force majeure, and so on. Whereas effective time means how many hours the terminal can serve the customer since the cargo starts to be loaded and unloaded from the ship until it is finished. While, non-operating time is the terminal not giving their services because of work shift hours or when work cannot proceed because gangs cannot be recruited as, for instance, in ports where only one or two shifts per day are worked or where no work is carried out on Sunday or public holidays, and so on (World Bank, 2007).

Berthing time is one of the significant variables which give an impact to throughput growth. From the shippers and ship operators perspective, berth rentals are highly significant impact to port dues, therefore this aspect needs to be kept to a minimum time to keep down the cost (Tongzon, 1994). Hence, BICT needs to improve efficiency in this aspect to maximize the utilization of berth by optimizing the arrangement of non-operating time and try to arrange maintenance schedules properly to reduce the idling time. Effective time also needs to be improved by reducing time-consuming at the berth during loading and unloading cargoes. According to the Ministry of Transportation in 2018, the ratio between effective time and berthing time (ET:BT) is 68%. Consequently, we need to keep this standard as per requirement from the government, or even higher than this.

5.2.5 Yard Occupancy Ratio

The utilization of container yard in BICT has proved in the regression result. It reveals that this variable is significantly affecting the throughput growth in BICT. The high number of yard occupancy ratio gives a high number of throughput in this terminal because the yard occupancy ratio will give information about how much the container yard is occupied at a particular time. Yard occupancy ratio also has a relationship with the berth occupancy ratio, but since berthing time and berth occupancy ratio were already incorporated in this regression analysis and the result revealed that berthing time is more significant than berth occupancy ratio. Hence the berth occupancy ratio was removed as a significant variable. It is important to maintain the number of yard occupancy ratio in a certain number; according to the Ministry of Transportation it should be less than 70%. That is why the terminal needs to give some incentives or proper tariffs regarding the duration of a container which stays in the container yard to maintain the dwelling time in the port. In addition, it is better that the terminal could optimize its yard layout and yard stacking policy in order to get a better performance (Wajira, 2018).

Figure 5. 2 Container Yard Layout



Source: Pelindo I, (2019)

5.2.6 Crane Productivity and Ship Productivity

Container terminal productivity can be measured by two types of operations. One type is the ship operations, which means containers are handling loaded and unloaded to the ship. The other one is receiving and delivering operations, which means containers are sent from and to the outside trucks (Kim and Park, 2004). The speed of cargo flows for loading/unloading from vessels at the quayside will affect the overall port performance through the charges paid by the ship-owners and actual throughput handled (Tongzon, 1994). The indicator of how well working time is being used in the terminal is called crane efficiency. The effectiveness of crane operations refers to crane productivity which is measured based on TEUs/hour/crane. In addition, for ship productivity, it depends on the number of cranes allocated which are being used to load/unload for one ship, which is measured based on TEUs/hour/ship.

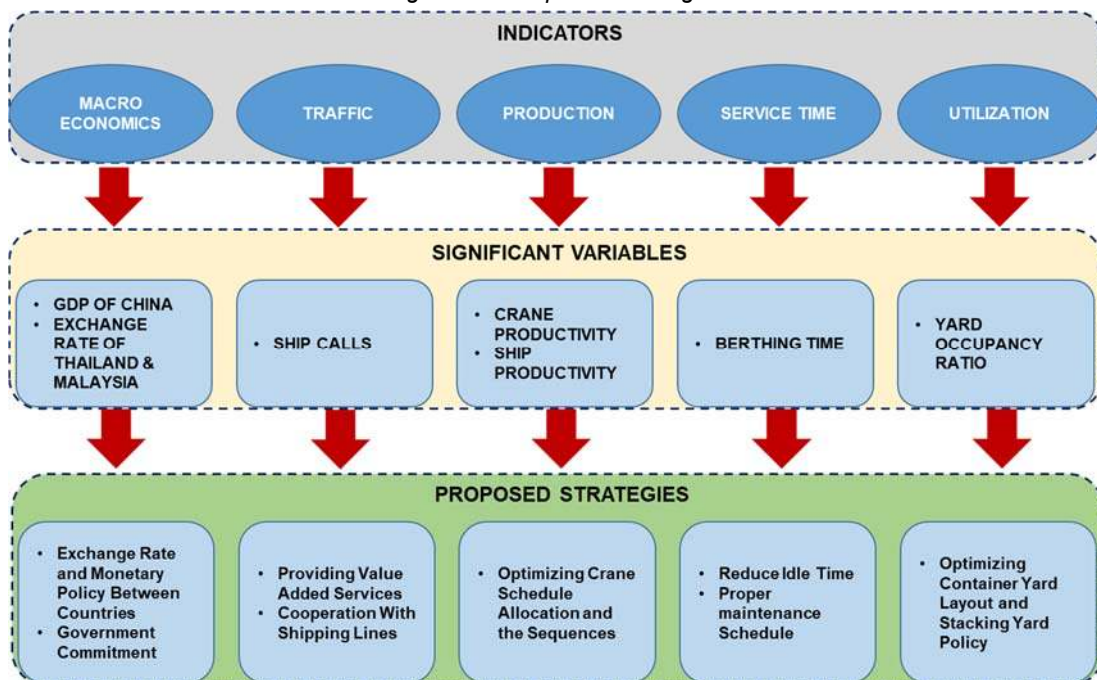
In BICT, the number of ship productivity in 2018 was more than twice the crane productivity, because in average this terminal allocates two quay cranes for a ship to handling load/unload cargoes. The quay crane is one of the most critical equipment items in port terminals. By increasing the productivity of the quay crane and ship, it will enable the terminal to become more attractive for customers. In order to improve their performance, BICT needs to optimize the crane schedule allocation by trying to find out the best sequence of loading and unloading operations which the crane will operate, then the time of completion from the ship operation can be minimized (Kim and Park, 2004). The type and age of cranes, terminal layout, practices of related work, and management are also part of the consideration to improve crane and ship productivity.

CHAPTER SIX – CONCLUSION

6.1. Summary

The aim of this research is to find the key factors that could affect cargo throughput growth in BICT. The factors can be national or international, economical or political, and system of transport itself, such as operations of ports, management strategies, shipping company and competitive situations as well (Guoqiang et al., 2005). Therefore, it is assumed that factors are coming from two aspects, the external and internal factors. These two main aspects were chosen because the author wished to look at them from a comprehensive perspective. The external factors means the variables are beyond BICT control, and the internal factors means the variables are controllable. CLRМ was used to find out the result. At the beginning of the regression analysis, there were 26 variables which were assumed to be significant independent variables. These consist of 17 external variables (macroeconomics, traffic) and nine internal variables from various indicators such as service time, utilization, and productivity. After carrying out some tests, the significant variable for the final result became eight variables, because some of the variables were not significant at 95% confidence level. The result of the regression analysis are shown in the following figure.

Figure 6. 1 Proposed Strategies



Macroeconomic and traffic are indicators that are beyond BICT control. Based on the regression result, China's GDP, exchange rate Thailand and Malaysia are part of the macroeconomic indicators, and the number of ship calls is part of the traffic indicator. Moreover, there are three main indicators which are under the control of BICT, namely production (crane productivity and ship productivity), service time (berthing time) and utilization (yard occupancy ratio). These variables need to be considered in a particular approach in order to anticipate future global markets and capturing the opportunities in the future global markets, especially in the containerized freight trade.

After obtaining the main aim from this research, it also needs to provide some proper strategies for these variables, including the external and internal variables to optimizing the throughput growth in BICT as the second objective of this research. From the macroeconomic perspective, it was found that China's GDP growth and the exchange rate of Malaysia and Thailand have a significant relationship with the throughput growth. It would be useful if among these countries could make a monetary and exchange rate policy cooperation. This would require political commitment from each country to have strong coordination and integration regarding the monetary and economic policy. Furthermore, another variable comes from the productivity indicator as, for example, crane productivity and ship productivity. In 2018, the average number of crane productivity was 23.2 TEUs/hour/crane, and for the average ship productivity it was 49.8 TEUs/hour/ship. If this number is compared to the standard from the Ministry of Transportation (MOT) in 2018, this performance is still above standard, which means it is excellent. To maintain this positive performance, BICT needs to optimize the crane schedule allocation by trying to find out the best sequence of loading and unloading operations to increase its productivity.

Berthing time is another variable, which has significant relationship with throughput growth in BICT. In 2018, the ratio between effective time and berthing time (ET:BT) was 68%, and it still meets the MOT standard of 68%. BICT needs to continue to improve this performance by optimizing the arrangement of non-operating time (shift working), reduce idle time by making a proper schedule for maintenance activities, and maintaining good communication among the workers to avoid misunderstandings during operations. Further, the next significant variable is the yard occupancy ratio

(YOR). In 2018, the ratio for this variable was 32.6% with the maximum standard from MOT of 70%. This means this aspect still has some space to make improvements by giving incentives or proper tariffs to optimize the number of duration container stays in the yard, and need to optimize yard layout, and stacking yard policy. In addition, to increase the number of YOR it also needs to consider the number of ship calls. Consequently, BICT needs to provide more value-added services to attract more vessels and generate new cooperation with the shipping lines to make BICT as their port of destination by providing privileges and giving benefits for them.

6.2. Contributions and Limitations

This research is expected to identify the key factors (external and internal factors) that could significantly affect the throughput growth in BICT. By knowing the key factors, it is expected that the company could use this insight as to their consideration in deciding the future planning and to making the port become more competitive among other players as well as to increase their throughput performances. Therefore, this research will be useful for the company, especially for those who want to make plans for commercial developments including forecasting, budgeting, and strategic investment.

The scope limitations of this dissertation focus on Belawan International Container Terminal (BICT) as a study case. There are other qualitative factors that can affect port performance, including port throughput. For instance, balancing between various subsystems in the terminal, the quality of personnel in terminal containers, the motivation of personnel and other human elements that could be influential. For further research purposes, there are other unexplored and key variables that were not included in this model. Therefore, the accuracy of this model can be improved by using other analytical methods by adding on other variables, while at the same time adding new measures to making it relevant for market applications.

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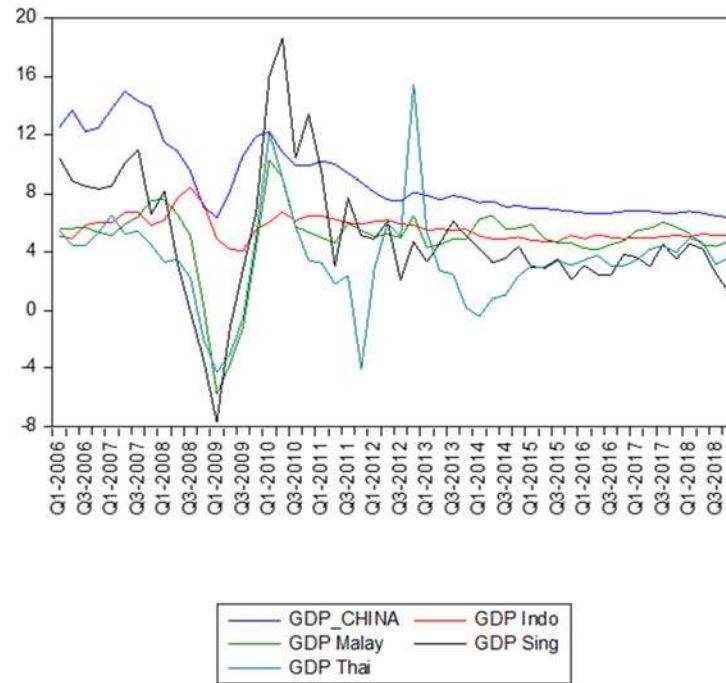
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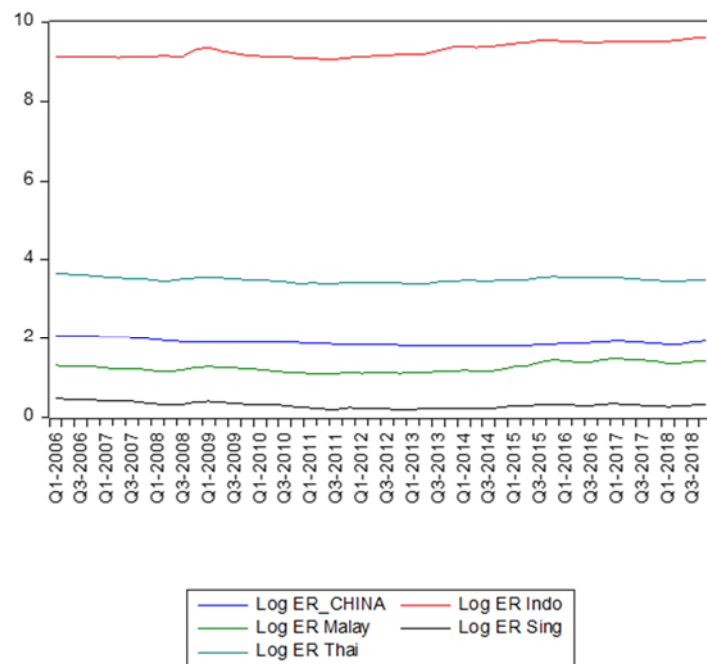
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APPENDICES

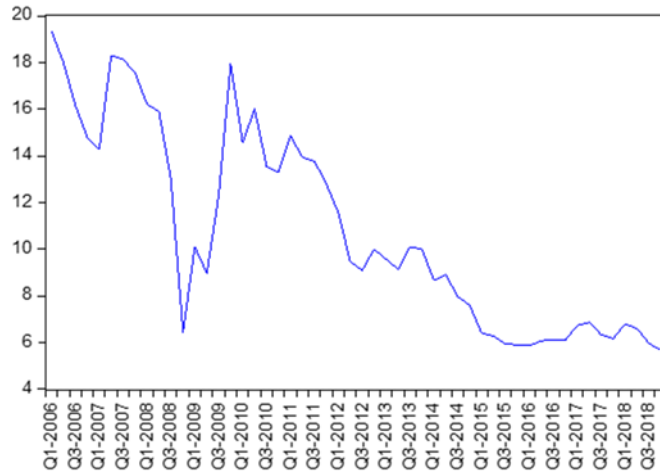
1. Hinterland's GDP



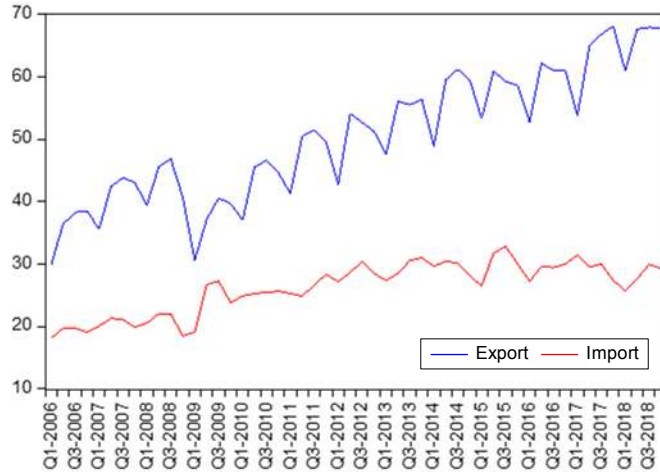
2. Exchange Rate



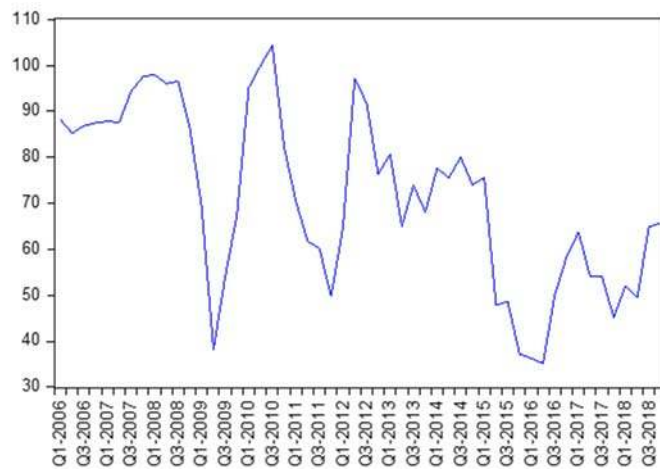
3. China's Industrial Production



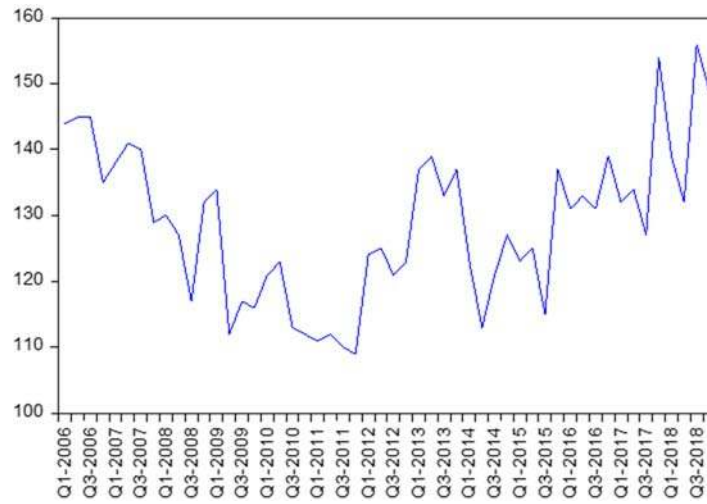
4. China's Export and Import



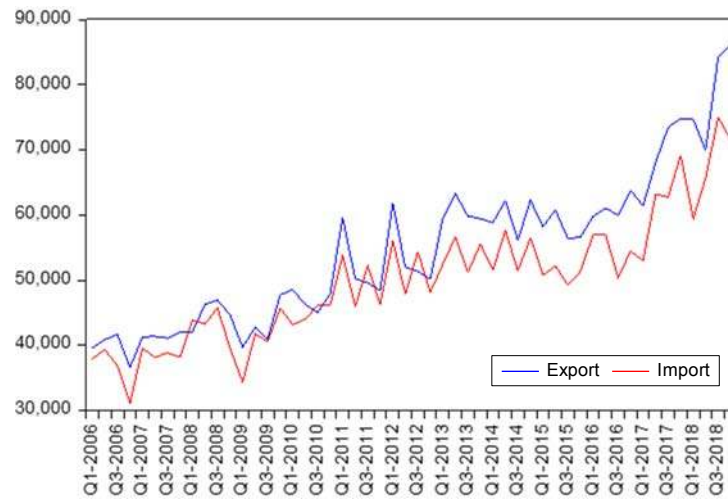
5. Seaborne Container Trade Trends



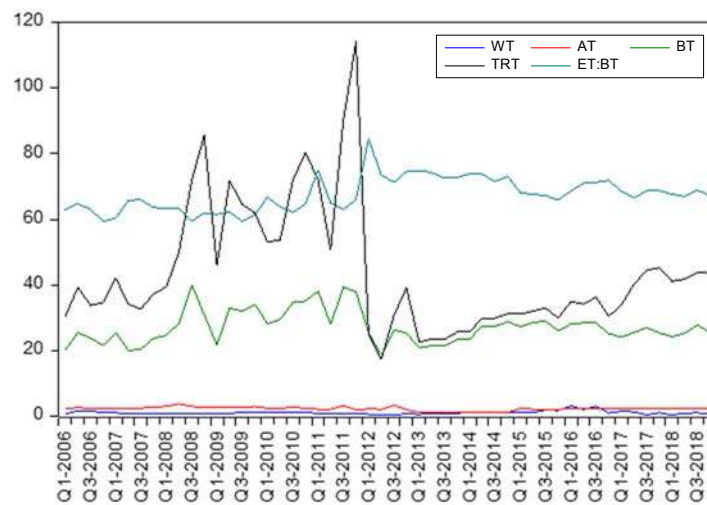
6. Ship Calls



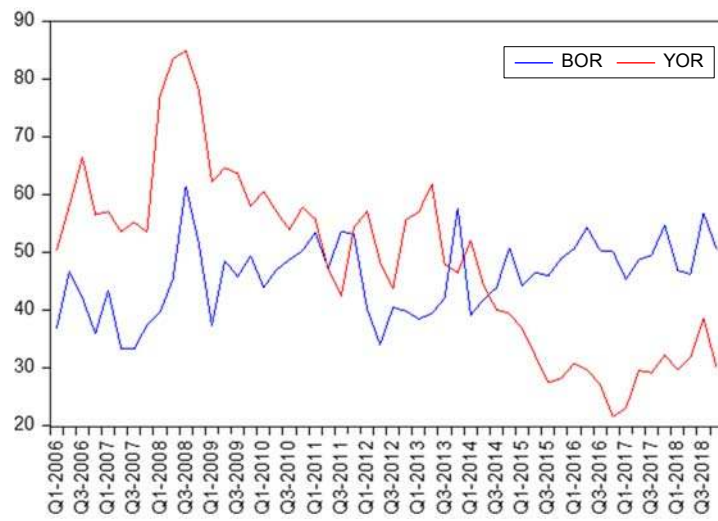
7. Export and Import Throughput



8. Service Time



9. Utilization



10. Productivity

