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A study of container terminal capacity at Boom Baru Palembang container terminal

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A STUDY OF CONTAINER TERMINAL CAPACITY AT BOOM BARU PALEMBANG CONTAINER TERMINAL

By

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DECLARATION

I certify that all the material in this research paper 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.

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ABSTRACT

Title of Dissertation : A Study of Container Terminal Capacity at Boom Baru Palembang Container Terminal

Degree : Master of Science in International Transport and Logistics

Economic growth in a region indicated by increasing the growth of population and Gross Domestic Product (GDP). These two factors are used in determining variable takes into account forecasting container throughput in Palembang, South Sumatra. Container Terminal which is the parallel activities of the Berth and the Yard needs adequate capacity as benchmark capability in the meet of demand in the future. This Study analyzes the berth capacity and yard capacity in which both these factors determining the ability of a container terminal in serving the demand for 2013 to 2030.

The Proper Container Throughput Capacity (PCTC) on Boom Baru Palembang Container Terminal (BCT) is Yard Capacity, because the result of annual throughput in yard capacity has a lower figure compared to the berth capacity throughput. Therefore, at the end of this study some alternatives for short term and long term became part of the analysis results is certainly the tools management in thinking about the steps that must be executed in maintaining and improving the performance of BCT in upcoming.

Keywords : Container Terminal, Forecasting, Berth capacity, Container Yard capacity, Proper Container Throughput Capacity.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AGV	Automated Guided Vehicles
BCH	Box Crane Hour
BCT	Boom Baru Palembang Container Terminal
BOA	Berth on Arrival
BOR	Berth Occupancy Ratio
CFS	Container Freight Station
CY	Container Yard
GDP	Gross Domestic Product
IPC	Indonesia Port Corporation
PCTC	Proper Container Throughput Capacity
QC	Quay Crane
RMG	Rail Mounted Gantry
RTG	Rubber Tired Gantry
YOR	Yard Occupancy Ratio

Chapter 1. INTRODUCTION

1.1. Background

The increasing traffic of containers in the world requires improvements in all services that are related with container activities. The vessel's turn round time should be minimized to accommodate the needs of vessels for transporting the containers, where it is so dependent on activities in containers terminal as the operator which responsible for the containers loading and unloading services. The container terminal should well perform in its activities at the quayside and landside of the terminal and container terminal should increase its performance to achieve a balance in operations. The Container Terminal is a complex system that works is only efficient when it is designed in such a way that the process of loading and discharging can run smoothly (Brinkmann, 2011). Vis and de Koster (2003); Steenken et al. (2004); Henesey (2006) stated that the container terminal operation partially divided into four activities such as ship to shore activities; transfer from quay to the Container Yard (CY), CY to CY, CY to Gate; stacking container in the CY; and receiving/delivery container to/from outside the container terminal (Vacca, Bierlaire, & Salani, 2007).

A container terminal should be able to provide service to the container from seaside to the destination of the container on the landside. To perform such activities, container terminal should have the quayside that has function for the container vessels berthing, CY for stacking containers and gate as the main gateway of the container terminal. The right selection of the operations system is a key factor to a successful terminal (Brinkmann, 2011). To minimize the waiting time of the ship, it needs an adequate capacity of facilities and equipment at the terminal for containers.

In line with the increasing growth of containers, the container terminal capacity will reach the maximum point. When the maximum point reached capacity and can no longer afford to cope with the increasing cargo, it will cause low level productivity and congestion at the port. As a result, due to the low level of service, container terminal is not able to compete in business. This issue needs to be anticipated with the careful planning of its development through doing analysis of optimum capacity in the container terminal.

1.2. The Research Problem

This research focuses on the state-owned Port of Boom Boom Palembang in Indonesia, located along the Musi River (the longest river in Sumatra with a length 750 km) which is a part of the Indonesia Port Corporation II (IPC-II) and being one of the interface between land and sea transportation system also responsible for a large part of economic activity and development in South Sumatra.

The purpose of the container terminal as part of the Port of Boom Baru Palembang is providing service by giving the adequacy of facilities where the activities of loading and unloading of containers with the shortest possible time and maximum results in fulfilling smooth transport of commodities and manufactured goods from the hinterland are owned and to handle large amounts of cargo routed to other ports such as the Port of Singapore and Tanjung Priok in Jakarta.

The main question addressed in this study is how the Boom Baru Palembang Container Terminal (BCT) can meet the demand for the next 10 years or more. To answer this question, will be performed an assessment to ensure that the Container Terminal Boom Baru Palembang can serve its customers without shortage of capacity.

1.3. The Expected Contribution

In this paper an analysis will be done to answer the question above so that the results of this paper can be used as a contribution to anticipate that must be prepared by Container Terminal management in the face of a surge in the growth of containerization and competition from similar businesses in the future. In addition to this, it is expected that the analysis is performed can be a reference material for the terminal management in the conduct of investment plans or containers terminal facilities expansion.

1.4. Problem Limitation

In this study required the limitation in order to perform analysis and sharpen the scope of research. These limitations can be explained as follows:

a. The object of research in BCT that only handle Full Container Load.
b. The scope of activity of container handling is start from the arrival of the container ship in the terminal, loading/unloading operations, quay transfer operations, lift on/off at the container yard and finish with receiving/delivery of container operations, without the gate operation. In other words, the focus of activities will be analyzed only Berth and Container Yard.
c. The primary data for this study is collected from several institutions base on the data in the year of 2002 - 2012.

1.5. Structure of Thesis

Chapter 1 INTRODUCTION

This chapter explains a brief background of the topic study followed by research problem formulation and an explanation of the purpose of study.

Chapter 2 LITERATURE REVIEW

This chapter will be discussed regarding the important findings from the scholarly literature as an indicator to measure the performance and operating container terminal, variable and method of container terminal capacity projections. The results of the literature review is to be used to support decision making in this research.

Chapter 3 RESEARCH METHODOLOGY

This chapter presents a detail explanation for several methods which will be applied in this research.

Chapter 4 PORT OF BOOM BARU PALEMBANG

In this chapter will be shown the data pertaining to this study as data from the port of Palembang, Hinterland, and all supporting data which will then be analysed in Chapter 5.

Chapter 5 ANALYSIS OF BOOM BARU PALEMBANG CONTAINER TERMINAL CAPACITY

In this chapter will be conducted the analysis of data that have been discussed in the previous chapter, such as the analysis of forecasting socio-demographic factors, container throughput capacity analysis will be associated with the use of formulas obtained from literature review and research methodology which ultimately expected to be an alternative that can be used as a result.

Chapter 6 CONCLUSIONS AND RECOMENDATION

Finally, in this chapter will be shown from the overall study conclusions and some recommendations as to alternatives that may be used as a reference.

Chapter 2. LITERATURE REVIEW

In this chapter focuses on the important findings from the scholarly literature concerning the operation of the container terminals and container terminal capacity projection method, where the results of this literature review is to be used as a supporting decision making in this research.

2.1. Container Terminal Operation

A successful container terminal is designed and be operated with the objective to decrease the cost of operation. In the same time, service quality and effectiveness of operation have to be increased (Brinkmann, 2011). Vis and de Koster (2003), Steenken et al. (2004), Günther and Kim. (2005), and Kim (2005), as well as Murty et al (2005) in their literatures overview the four main areas of the Container Terminal i.e ship operation area; quayside operation area, for the loading and unloading of vessels which is equipped with quay cranes; yard operation area, for stacking import and export containers; and also special areas for special purpose containers, such as reefer container or hazardous goods. Separate areas are also reserved for empty containers. In some terminals, provide area for stuffing and stripping containers or additional logistic services named Container Freight Station (CFS). According to Steenken, Vob, and Stahlbock (2004), container terminals can be devided into two sides, quay side where the activities of loading and unloading container to/from the ships and the other is landside where conducted the activities of loading/unloading to/from road transport modes i.e. the truck or the train.

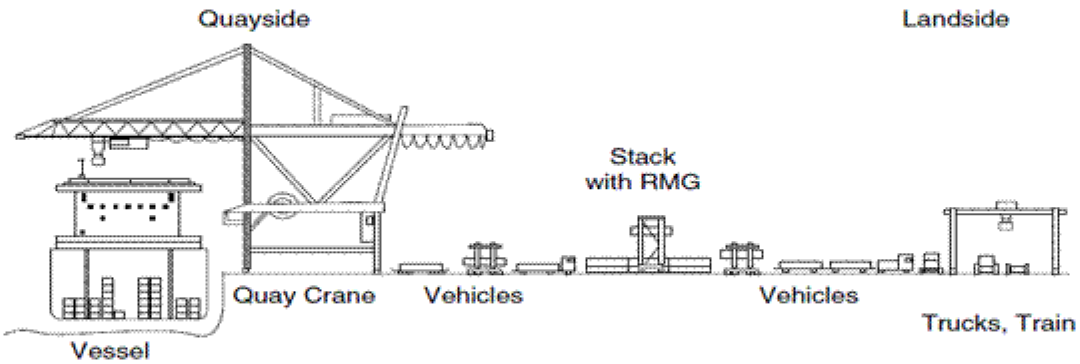


Figure 1 Container Terminal System
Source: Steenken et al. (2004), p. 13

The container terminal activities is started from serving vessel using a Quay Crane (QC) to load and to unload containers in the quay side. When a container vessel berthing, quay cranes will undertake activities to load and unload containers. The discharging containers are transfered to the place where its will be transshipped next. For import or inbound containers, after being discharged from the ship, the containers are then transferred from the quay to the stacking yard by internal transportation equipment. At the container yard, containers are picked up by internal equipment and distributed.

On the landside, there are three activities i.e transfer operation, storage/stacking and receiving/delivery. The Transfer operation is an activity to move containers from one place to another as needed. Liu (2010) explain that there are two activities in the container yard i.e stacking of container and transfer the containers to the different area in the terminal. The equipments for stacking containers such as Straddle Carriers, Rubber Tired Gantry Cranes (RTGs), Rail Mounted Gantry Cranes (RMGs), Reach stackers, and Front Loaders for Empty Containers. Horizontal terminal transport is the transfer or movement of containers between the sea side, the stacking area, and the landside operation. Equipment for horizontal transport includes trucks, trailers, straddle carriers, automated guided vehicles (AGV), and reach stackers.

This activity is carried out by internal equipment belonging to the terminal and be part of the service provided by the terminal. Some transport vehicles have a double function of transporting and stacking containers such as Straddle Carriers, forklifts and reach stacker. However trucks, multi-trailers and Automatic Guided Vehicles are purely used for transportation and therefore require additional equipment for stacking containers (Steenken, Vob and Stahlbock, 2004). Transfer activities can use the straddle carrier or can also use trucks and chassis assisted by front end loader for lift on/off. In the yard, all containers are stacked and organized into numerous blocks, each block reflecting the owner or destination of the container(s) and are stored for a certain period before proceeding further. Container will be stacked using RTG or RMG or Reach Stacker to get maximum capacity for the stacking. Activities in a container yard are one of the important activities in the terminal, because smooth or not the activities in the yard will affect all activities in the terminal. Beskovnik (2008) stated, the most important problem in a modern maritime container terminal is the coordination between the loading and unloading operations of the vessels and the storage of the containers into the yard.

The owner of the container will pick up and deliver their containers through the gate complex where at the gate containers will be checked to make sure whether the containers are in good order. The movement of the container from vessel to land transport can also be performed in a reverse order i.e. by loading the container onto the ship (Vis and Koster, 2003).

2.2. Container Terminal Capacity

The capacity of a port terminal can be defined as the maximum traffic it can handle in a given scenario. Capacity calculation is an important terminal planning tool, as it does not only establish a terminal’s limits, but also different scenarios to see how the terminal would respond in those situations (Soberon, 2012). Huang et al. (2008) explained container terminal capacity as the level of throughput where the terminal cannot sustain their operations due to the overflow of containers at the yard exceeds certain acceptable levels or the Berth-On-Arrival (BOA) rate drops below the target percentage. Moreover, Ding (2010) explained container terminal capacity as the maximum throughput, which is depend on the capacities of the berths, equipment, stacks and transportation. Insufficient capacity will cause a major problem in a container terminal operation. Hence, Ng and Wong (2006) state that the container terminal capacity is crucial in planning and designing a container terminal.

Many research has been done to estimate the optimal terminal capacity and optimum number of terminal facilities. Imai (1997), Imai (2001) and Nishimura (2001) work on berth allocation for incoming ships by considering the optimal utilization of the berth. Murty *et al.* (2005) propose a decision support system for container terminal operation to optimize the use of resources and minimize vessels berthing time and waiting time. Kim and Kim (1998) propose an optimization model to determine the container yard space and the number of transfer cranes in a container terminal. Zhang *et al.* (2003) work on storage space allocation by considering all container terminal resources. Liu et al. (2002) develop a simulation model in order to evaluate an automated container terminal performance. Ding (2010), use a simulation model to estimate the throughput capacity in a container terminal by considering vessels arrival pattern which influence the utilization rates of the berth and quay cranes.

2.3. Container Terminal Performance

Almost the entire performance measurement affects the entire terminal port performance, especially in the port that consists of several terminals so that the measurement method varies depending on the purpose of the terminal. Thomas and Monie (2000) suggested that the container terminal can be measured by the level of business operations i.e. production, productivity, utilization, and service. The production measurement represents the container throughput in the ships, quay transfer, container yard and receipt/delivery; productivity measures refer to the ratio between input and output of the container terminal resources; utilization measures show the intensity of resources used for production and the service measures represent the customer satisfaction from the services that is offered by the container terminal.

The Ministry of transportation of Indonesia currently regulates the indicators of container terminal using measurement such as Waiting Time, Approach Time, Effective Time, Berth Time, Berth Occupancy Ratio (Quay utilization), Shed Occupancy Ratio (Shed Utilization), Yard Occupancy Ratio (Yard Utilization), Box/Crane/Hour productivity and Equipment Readiness (Indonesia-Government 2012).

The measurements suggested by Thomas and Monie (2000) and those used by the Ministry of transportation of Indonesia (Indonesia-Government, 2011) can be summarized as table follows:

Table 1 Container Terminal Performance Measurement

Author	Service Driven	Volume Driven	Profit Driven
(Thomas, 2000)	- Ship Productivity - Crane productivity - Quay Productivity - Terminal Area Productivity - Equipment Productivity - Labor Productivity - Ship TRT - Road Vehicle TRT - Rail Service Measure	- Ship Throughput - Quay Transfer Throughput - Container Yard Throughput - Receipt/Delivery Throughput - Quay Utilization - Storage Utilization - Gate Utilization - Equipment Utilization	Cost Effectiveness
(Indonesia-Government, 2011)	- Waiting Time - Approach Time - Effective Time - Berth Time - Productivity (Box/Crane/Hour) - Equipment Readiness	- Quay Utilization - Shed Utilization - Yard Utilization	No measurement

Source : Author

Based on the alternatives measurements of the performance above, to support the purpose of this study will use a combination of measurement volume driven and driven service to assess the capacity of container terminal.

2.4. Projection of Container Terminal Capacity

For planning and performing the anticipation actions, generally container terminal management forecasting the container terminal capacity. The first step in the proposed development project is to determine the demand of container throughput in order to predict future revenues where this projection is not only useful for port management but also for shipping lines to determine service network in the future (Syafi'i, Kuroda and Takebayashi, 2005). The causal relationship between port throughput and demography, socio-economic and industrial development has been studied to estimate port throughput in the future (Dorsser, Wolters and Wee, 2012).

2.5. Variables influencing the Demand of Container Terminal

2.5.1. Population

There are some references that use population as variables to do projection container throughput. Most of the container ports in developing countries, especially for the small container terminal using the population as variables to project container terminal throughput because the main function of the container terminal is as a means that serves the needs of the surrounding population. Syafi'i, Kuroda and Takebayashi (2005), Gosasang, Chandraprakaikul and Kiattisin (2010) concluded that population can be used as one of the factors that can affect the throughput of container terminals in an area.

2.5.2. Gross Domestic Product (GDP)

Jugovic, Hess, and Jugovic (2011), Gosasang, Chandraprakaikul, and Kiattisin (2010), Lubulwa et all, (2008), Syafi'i, Kuroda and Takebayashi (2005), Dorsser, Wolters and Wee (2012) and Australia AID (2012) are the various former researches that use GDP to predict container throughput. They investigated the effects of demand of container terminal on the throughput by using economic models that assume a stable relationship between the growth of port throughput and other variables such as GDP and trade growth.

The relationship between GDP, merchandise trade and sea borne trade represented in the Review of Maritime Transport 2011 by UNCTAD is shown in figure 2.

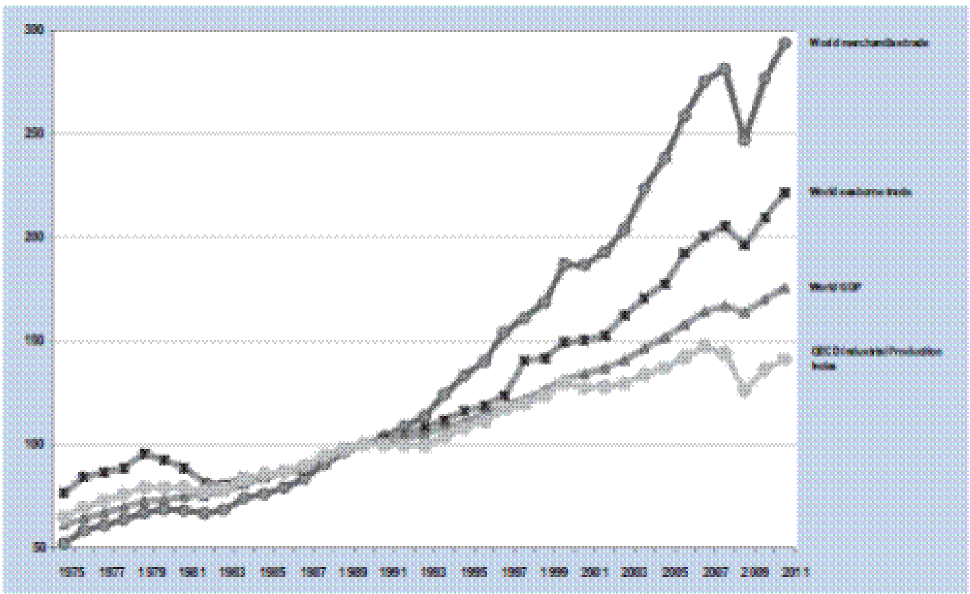


Figure 2 OECD Industrial Production Index, World GDP, World Sea Borne Trade and World Merchandise Trade (1975 - 2011)
Sources: Review of Maritime Transport 2011, UNCTAD

Chapter 3. RESEARCH METHODOLOGY

In this research will discuss about container terminal operation, performance and throughput projection including the forecasting techniques. Then, the historical data such as container throughput, container terminal performance, container ship call in the previous year will be analyzed to get more information about the changes in the throughput of container terminals. Furthermore, the socio-economic/hinterland also be analyzed where the GDP and population as variables that affect the throughput of container terminals.

The capacity of a container terminal at this time will be analized by using a suitable mathematical model in queuing theory to estimate the performance parameters in the queuing system. Furthermore, the result of this analysis will determine how the demand can be fulfilled by the existing container terminal capacity. Based on this assessment, it will be evaluated whether Boom Boom Palembang Container Terminal requires additional facilities and equipment to meet the demand in the future. Generally, description of the stages of problem solving can be seen in the figure 3:

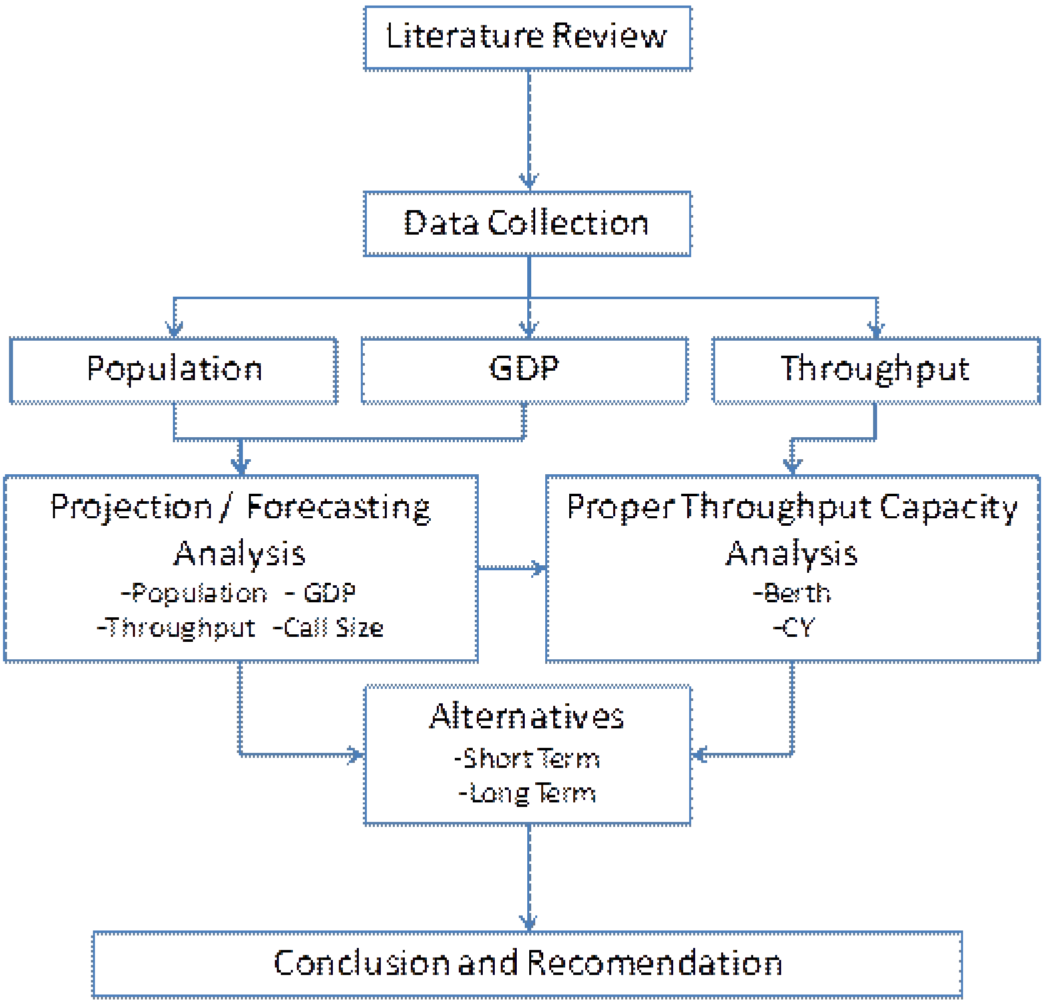


Figure 3 Research Methodology
Source : Author

3.1. Forecast Technique

The forecasting techniques related to port/container terminal industry in forecasting container throughput are relevant with shipping industries. There are four most popular forecasting techniques in the shipping industry (Stopford, 2003).

3.1.1. Opinion Survey

A survey conducted from the experts to look for information on future requests of the market. This technique is very useful for finding market research and expert opinion when investigating an important market issue.

3.1.2. Trend Analysis

This technique is used along with data from previous time period to identify certain trends and cycles. Trend analysis can be used for Trend Explanatory, Exponential Smoothing and Autoregressive Moving Average.

3.1.3. Regression Analysis

This model explains trends by quantifying the effect of independent variable(s) on the dependent variable(s) and can take the form of a Single Regression or a Multiple Regression. Regression analysis is a useful statistical technique and can be used for modeling relationships between the market and its variables.

3.1.3.1. Single Regression Analysis

Single regression analysis is used to find a relationship between the dependent variable and one independent variable. The equation can be shown as follow:

$$Y = a + bX1 + e1$$

This equation represents a straight line where 'a' and 'b' are parameters and 'e' is the error term. The parameter 'a' demonstrates the value of Y when X is zero whereas the parameter 'b' represents the slope of the line. The difference in the value between the actual and predicted is represented in 'e'. There are three basic test statistics that are used to analyze a regression equation in order to explain the significance of the equation in the overall model. The test statistics are the standard error, t-test and the correlation coefficient.

3.1.3.2. Multiple Regression Analysis

Multiple regression analysis is an extension of the single regression analysis using more than one independent variable. The equation can be shown as:

$$Y = a + b1X1t + b2X2t$$

Similar to the single regression analysis the parameter 'a' illustrates the value of Y when X1 and X2 is zero and b1 and b2 indicate the degree of contribution to Y for every change in X.

3.1.4. Probability Analysis

Probability analysis is also referred to as Monte Carlo and is used to foresee unpredictable events in the market. It involves using the sample data to calculate the number of times a particular event occurs.

Lubulwa et all, (2008), Gosasang, Chandraprakaikul and Kiattisin (2010), Jugovic, Hess, and Jugovic, (2010) used regression analysis to study the relationship of container throughput with other variables. Consequently, the regression analysis will be choosen as the forecasting technique for this study based on the data availability and the fact that the Container Port of Boom Baru Palembang is a relatively small container port serving economic activity in South Sumatra province.

3.2. Proper Capacity Calculation

Proper Container Throughput Capacity (PCTC) is handling capacity to cope with incoming cargoes with no congestion which leads to the port competitive edge. The higher the PCTC will lower the additional costs of container terminals. The higher the berth occupancy which has a direct impact on the ship's waiting that has consequences for lower service level container terminal. As far as PCTC is concerned, both the quay and the yard should be considered at the same time. In particular, the yard utilisation influence the performance of the terminal. (Moon, 2012).

The capacity of a container terminal is usually measured in terms of the number of containers that can be handled by the terminal per year (Guler, 2002). Another opinion stated that the capacity of a port terminal can be defined as the maximum traffic it can handle in a given scenario and there are various concepts of capacity (Soberon, 2012).

In this study, the calculation of the capacity of container terminal more focus to berth capacity and container yard capacity. It is related to the calculation of the Proper Container Throughput Capacity (PCTC) which compare between berth capacity with yard capacity. There are two ways to calculate proper throughput that is Traditional Method and Simulation Method (Moon, 2012). The following formulas have been used for berth throughput calculation :

$$BTP = C \times T \times CTR \times CE \times TF \times OF$$

Where,

BTP	=	Berth throughput
C	=	Number of Container Crane used for one berth
T	=	Work hours per year. This is the result of the multiplication of the number of working days in a year and the work day in a day.
CTR	=	Work hour ratio of crane. Berth occupancy ratio multiplied by the ship transfer multiplied crane operation ratio.
CE	=	Work efficiency of crane is crane design capacity (crane design capacity is the mechanical capacity of a crane per hour) multiplied by crane loss adjustment factor (the ratio between crane design capacity and actual loss adjustment which generally accepted ratio is 0.75) multiplied by interference factor. Interference factor is due to simultneous working with many cranes can cause interference in the other crane’s work (2 units 0.9, 3 units 0.83)
TF	=	Unit conversion factor is the ratio between 40ft container and 20ft container.
OF	=	Overstow factor is temporary stevedoring of containers. This handling volume is not to be included in the actual throughput.

Other formulas may also be used for calculating terminal throughput capacity focusing on berth capacity (Ding, 2010),

$$CC = \alpha_1 . \alpha_2 . \alpha_3 . N . Vq . Eq . t$$

Where,

CC	=	Throughput capacity of a container terminal in a year (TEUs/year);
α_1	=	Conversion coefficient of TEU per move;
α_2	=	Quay cranes rates in good condition;
α_3	=	Ratio of terminal operation time per day (hours/day);
N	=	Total number of the quay cranes at a container terminal;
Vq	=	Quay cranes utilization rates;
Eq	=	Average operation efficiency of quay cranes (moves/hour);
t	=	Total terminal operation hours in a year.

Furthermore, to calculate the throughput capacity of a container yard Dally (1983) as cited in (Moon, 2012) proposes a formula related to yard capacity as follows,

$$CC = \frac{Tgs \times H \times U \times K}{DT \times PF}$$

Where,

CC	=	Yard throughput in a year;
Tgs	=	Total ground slot is an area to stack the containers of 1 TEU
H	=	Average stacking height;
U	=	Land utilization ratio is the land occupied divided by the total land area. The recomended land utilisation of 0.75;
K	=	Service days of the yard (usually 365 days);
DT	=	Dwell time of containers or CY storage period is container's average storage period at the CY;
PF	=	Peaking factor is a buffer in response to the peak time.

After comparing an annual proper throughput per berth with CY throughput per berth, the lower numerical value of the two is a proper throughput.

Another way to calculate the PCTC is by simulation. Simulation is a broad collection of methods and applications to immitate the behavior of real system, usually on a computer with appropriate software (Kelton et al, 2007) as cited in (Moon, 2012). Instead of the traditional method for the calculation of proper throughput for both quay and CY, the simulation model can present a more practical way of calculating performance suggeting more diverse evaluation indicators and making it possible to check up the quality aspects of services of the container terminal. Calculation simulation method using PCTC takes quite a long time especially during the build and integrate logic with the computer system. Due to the limited time and resources using simulation PCTC calculation is not conducted in this study.

Chapter 4. PORT OF BOOM BARU PALEMBANG

4.1 Company Profile

Palembang is the second largest city on the island of Sumatra after Medan. As the capital of South Sumatra Province which is rich in potential in agriculture, forestry, mining and industry, Palembang show rapid economic growth. With a very promising economic potential, existence of the port as a logistic chain becomes very important. The Port of Boom Baru Palembang itself is one of the branches of the Indonesia Port Corporation (IPC) which as a single operator of ports in Indonesia, the IPC operates as a government agency in the port industry which operates 12 branches and five subsidiary companies covering an area of operations the following:

- Java Island : Port of Tanjung Priok (Jakarta), Port of Cirebon (West Java) and Port of Banten (Banten);
- Kalimatan Island: Port of Pontianak (West Kalimantan);
- Sumatra Island: Port of Panjang (Lampung), Port of Bengkulu (Bengkulu), Port of Teluk Bayur (West Sumatra) and the Port of Palembang (South Sumatera);
- Bangka Belitung Islands: Port of Pangkal Balam (Bangka) and Port Belitung (Belitung).

To anticipate an increase in the traffic of the commodity in the future, the management of IPC provides container terminal supported with modern equipment capable of ensuring a smooth service and ship goods. From year to year the performance of the Port of Palembang showed positive growth. This is apparent inter alia from the growth of 12 percent container service per year, while the average for cargo showed a growth of 10 percent.

The Port of Palembang is located on the Musi River in Palembang, South Sumatera province being approximately 180 kms from the River estuary with a geographical location 020 - 58' – 48' latitude and 1040 – 46' – 36 ET. It has an extremely strategic role in the South of Sumatra since it represents the main port for domestic and international trade; based on the origin and destination of the ships, it is the biggest trading port in domestic trades with Port of Tanjung Priok and has direct connections with the Port of Singapore as its only foreign port. Furthermore, the Port of Boom Baru Palembang also serves passenger ships whereby two ferry routes have regularly served the passengers to Batam and Bangka Island.

The weather conditions in the area are somewhat restricted with there being only two seasons i.e. the rainy season (from September to April) and the summer season for the remaining months hence keeping the terminal utilized for the entire year. Generally the land topography of the port is relatively flat when compared the river edge where the water front depth is up to 10 m LWS and the flow of the river is influenced by river and tidal flow.

The Port of Boom Baru Palembang was established under the joint decision of the Minister of Transport and Minister of Internal Affairs No. 85A 1990 and No. KP.27/AL-106/PHB-90 dated 9th October, 1990 and replaced Staatblad No. 543 1924. According to its establishment, the Port of Palembang has an operational area in Boom Baru, Sungai Lais and Tanjung Buyut with a total land area of 2.287.520 m2, water area of 593.446 m2 and navigation area of 10.526.576 m2. However, Sungai Lais is categorized with low traffic and small throughput and the Tanjung Buyut is an area commonly used for resting during Pilotage.

4.2 Facilities and Equipments

The port has four different types of terminal: conventional, container, bulk and passenger terminal (see Figure 4). The conventional terminal has 475 m quay with up to -7 m LWS depth, 84 m breasting dolphin with – 10 m LWS depth, 11.085 m^2 warehouse and 9.940 m^2 yards, container terminal has 266 m quay with depth up to –

9,2 m LWS, Container Freight Station and 46.100 m2 container yard, the bulk terminal has three-unit breast dolphins and the passenger terminal has two floating quay (see Table 2).

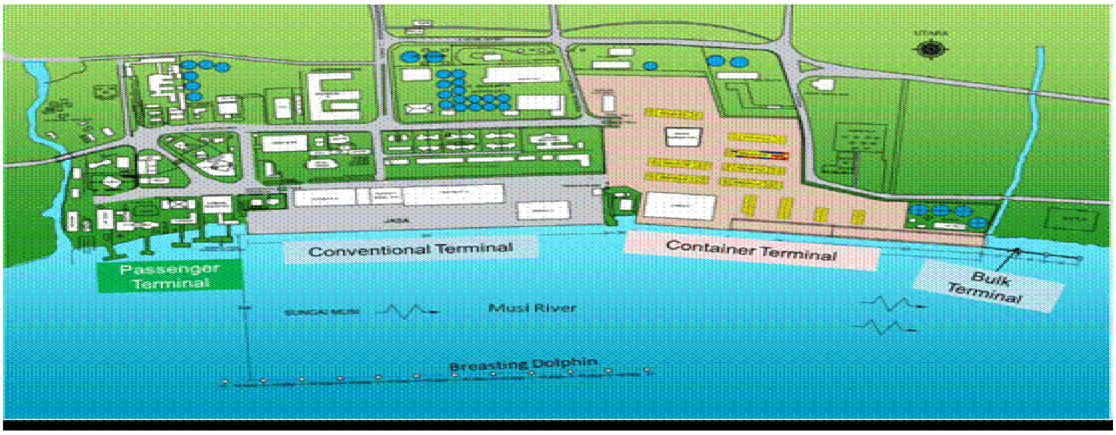


Figure 4 Layout of Berthing Facilities
Source : Port of Boom Baru Palembang

Table 2 Facilities and Equipments of Port of Boom Baru Palembang

	FACILITIES / EQUIPMENTS		*DESCRIPTION*
1	Quay		
	a	Conventional (depth -6 / -7 m LWS)	475 m' / 6,300 m2
	b	Container (depth -9 / -9.2 m LWS)	266 m' / 5320 m2
	c	Breasting Dolphin (depth -10 m LWS)	105 m' / 525 m2
2	Warehouse		8,085 m2
3	Yard		
	a	Conventional	8,940 m2
	b	Container	47,100 m2
4	Liquid Storage		21,500 tons
5	Workshop		1,152 m2
6	Passenger Terminal		418 m2
7	Office Area		7,759 m2
8	Quay Crane		2 units
9	RMGC		4 units
10	Forklift		20 units
11	Side Loader		3 units
12	Reach Stacker		2 units
13	Head Truck		10 units
14	Chassis		12 units
15	Fire Truck		1 units
16	Pilot Boat		4 units
17	Tugs Boat		3 units
18	Barge Water Supply		2 units

Source : Port of Boom Baru Palembang

4.3 Ship Calling and Cargo Throughput

Based on the 2012 annual report, overall calls reached 3.610 ship units with a total of 8 million gross tonnage (GT) and totaled container ship calls 244 units or 8,39% of total traffic of vessels in 2011.

As much as 7.68 million tons of cargo throughput via port with the majority are dry bulk cargo and containers. Based on historical data of ship calls since 2002 up to 2012 shows fluctuations. In comparison with domestic ship calls higher than ocean going ship calls. This is because the majority of the ships transporting commodities for daily needs of residents of South Sumatra. However, the average size of domestic ship smaller than the size of ocean going ships; then the ship's fluctuation does not significantly affect the number of loading/unloading.

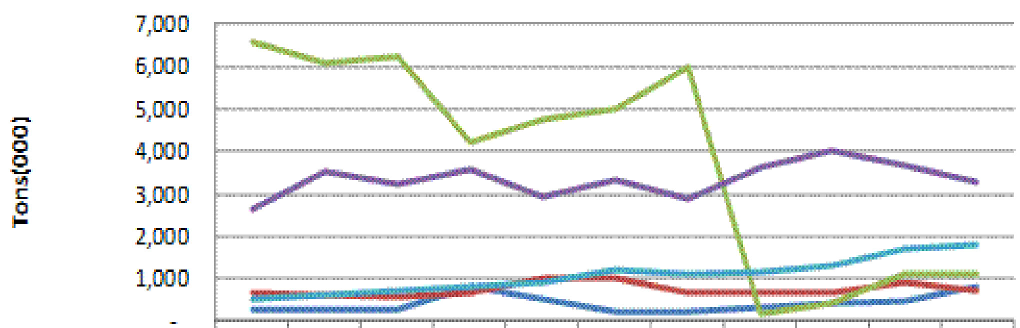
Table 3 : Port of Boom Baru Ship Calls 2002 – 2012

DESCRIPTION		***YEAR***										
		2002	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***
OCEAN GOING	UNIT	659	677	828	789	995	1,338	1,016	674	649	692	820
	GT (000)	3,077	3,274	4,005	3,639	5,189	6,384	3,889	1,997	2,238	2,184	2,782
DOMESTIC	UNIT	3,881	3,134	3,223	3,470	3,096	2,568	2,296	1,870	1,776	2,251	2,790
	GT (000)	9,959	8,482	7,782	7,670	5,976	4,317	4,182	3,476	4,183	4,817	5,280
TOTAL	UNIT	4,540	3,811	4,051	4,259	4,091	3,906	3,312	2,544	2,425	2,943	3,610
	GT (000)	13,036	11,756	11,787	11,309	11,165	10,701	8,071	5,473	6,421	7,001	8,062

Source : Port of Boom Baru Palembang

According to the company historical report (see Table 3), the largest cargo comes from the private berth in 2002 due to the natural resources such as coal, CPO, rubber and previously handled in the private berth. However, there was an increase in the public berth in 2012. This happened due to an increase in the services and the performance of Port of Boom Baru Palembang. Thus, this proves that the port has been able to increase market share during the last ten years. The image below shows a comparison of the distribution of the berth.

During the years 2002 – 2012, there has been a fluctuating composition of cargo flows by commodities, which are divided into five categories: general cargo, bag cargo, liquid cargo, dry cargo and container cargo where the last two commodities have been dominating for the last 12 years. There has been a remarkable increase is container cargo and the growth has significantly continued with an annual growth rate of 13%. On the other hand, the decline of Liquid bulk in 2008 is related to the implementation of new regulations in the port industry as shown in Figure 5.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
General Cargo	253	275	276	804	526	211	230	306	397	446	807
Bag Cargo	672	609	589	672	999	1,000	687	645	658	923	730
Liquid Bulk	6,562	6,097	6,239	4,196	4,772	5,008	5,986	178	436	1,110	1,092
Dry Bulk	2,646	3,522	3,199	3,585	2,907	3,339	2,897	3,617	4,034	3,684	3,271
Container	523	606	706	805	906	1,181	1,082	1,142	1,286	1,706	1,776

Figure 5 Port of Boom Baru Cargo Throughput 2002 – 2012
Source : Port of Boom Baru Palembang

4.4 Hinterland, Population and Gross Domestic Product (GDP)

4.4.1 Hinterland

In the 7th century, Palembang is recognized as the capital of Srivijaya in South Sumatera because it has rich natural resources. The Port of Palembang surrounded by Bangka - Belitung island in the East, Lampung Province in the South, Bengkulu Province in the West, and Jambi province in the North. Whole Ports in the Sumatra island are the port which can only captivate the market of the hinterland, this is because each province in Sumatra island have own ports that rely on natural resources resulting from their respective hinterland as the impact of the breadth of the area of each province so that it makes it expensive and inefficient to make transportation of commodities by other provinces.

Figure 6 South Sumatra Administrative Area
Source : The Government of South Sumatra Province

4.4.2 Population

The average growth of population in South Sumatra as shown in table 4 of 1.79% each year and an estimated will reach 8,875 Million in the year 2025 (Bappenas, 2008), as projected by the National Development Planning Agency of the Government of Republic of Indonesia. The increase of the population indicates that the economic of the South Sumatra could potentially increasing. Based on historical data, current economic conditions and predictions that will happen in the future, estimated the annual economic growth by 2013 will be in the range of 5.8-6.3%. International trade activity is expected to be way up began to improve following the expectations of improving China and India, coupled with household consumption and investment growing quite well (Bank Indonesia, 2012).

Table 4 Population of South Sumatra 2002 - 2012

Year	***Population (000)***	***Growth***
2001	6,343	
2002	6,430	1.37%
2003	6,519	1.38%
2004	6,625	1.63%
2005	6,756	1.98%
2006	6,900	2.13%
2007	7,020	1.74%
2008	7,122	1.45%
2009	7,223	1.42%
2010	7,446	3.09%
2011	7,576	1.75%
Average growth		***1.79%***

Source : South Sumatra Statistic Bureau

4.4.3 Gross Domestic Product

Growth in Gross Domestic Product (GDP) is the reflection of economic development in South Sumatera and it has been said that the GDP of the hinterland reflects the port throughput (Dorsser, Wolters ad Wee, 2012).

Based on current and constant price of year 2000, an increasing trend in the growth of GDP of South Sumatera is visible (Bank Indonesia, 2012). Average GDP growth based on constant prices is indicative of the actual economic growth which on average reached 4.75%. In the past three years, the growth can be seen to be substantially increasing.

Table 5 GDP of South Sumatra 2002 – 2012

Year	***GDP***	***Growth***
2001	42,693,467	
2002	43,810,324	2.62%
2003	45,247,398	3.28%
2004	47,344,396	4.63%
2005	49,633,536	4.84%
2006	52,214,848	5.20%
2007	55,262,114	5.84%
2008	58,065,455	5.07%
2009	60,446,546	4.10%
2010	63,735,999	5.44%
2011	67,878,839	6.50%
Average growth		***4.75%***

Source : South Sumatra Statistic Bureau

4.4.4 Development Planning

The planned developments of the South Sumatra Government relating to the study are:

a. Increased integration of the city transport system.

b. Increased integration of central economic activity via resources such as labor and raw material.

c. Increased accessibility between the central city and the city border.

d. Infrastructure developments such as enhanced road system between cities and the development of an integrated multimodal transportation system including rail, sea, river and container terminal transport.

4.5 Boom Baru Palembang Container Terminal (BCT)

4.5.1 Facilities and Equipments

BCT equipped with a 266 m long Berth, container yard covering 4.6 hectares and one workshop for heavy equipment operate manually ± 50.500 m2. With a depth of -9 to-9.2 m LWS this terminal has been able to handle container vessels first generation with a maximum capacity of 1000 TEUs (Ircha, 2012). Generally, the maximum capacity of the ship which visit to the terminal is only 400 TEUs because of limited draft of Musi River.

Table 6 BCT Facilities and Equipments

FACILITIES / EQUIPMENTS		***DESCRIPTION***	***PRODUCTIVITY***
1	Quay	266 m'	
2	Container Yard	46.100 m2	
3	Quay Crane	2 units	±20 - 24 B/C/H
4	RMGC	4 units	±15 B/C/H
5	Forklift 2 - 15 Tons	15 units	
6	Side Loader	3 units	
7	Reach Stacker	2 units	
8	Head Truck	10 units	
9	Chassis	12 units	

Source : Port of Boom Baru Palembang

Of the total area of CY 46,100 M2 only 35% or 16, 203.5 M2 can be used as a storage area (Net CY). Besides, there are some uniqueness in CY in BCT, where amid the CY there is a grave which is part of the historical site Kingdom of Srivijaya. Other uniqueness is a form of irregular CY as shown in the picture below:

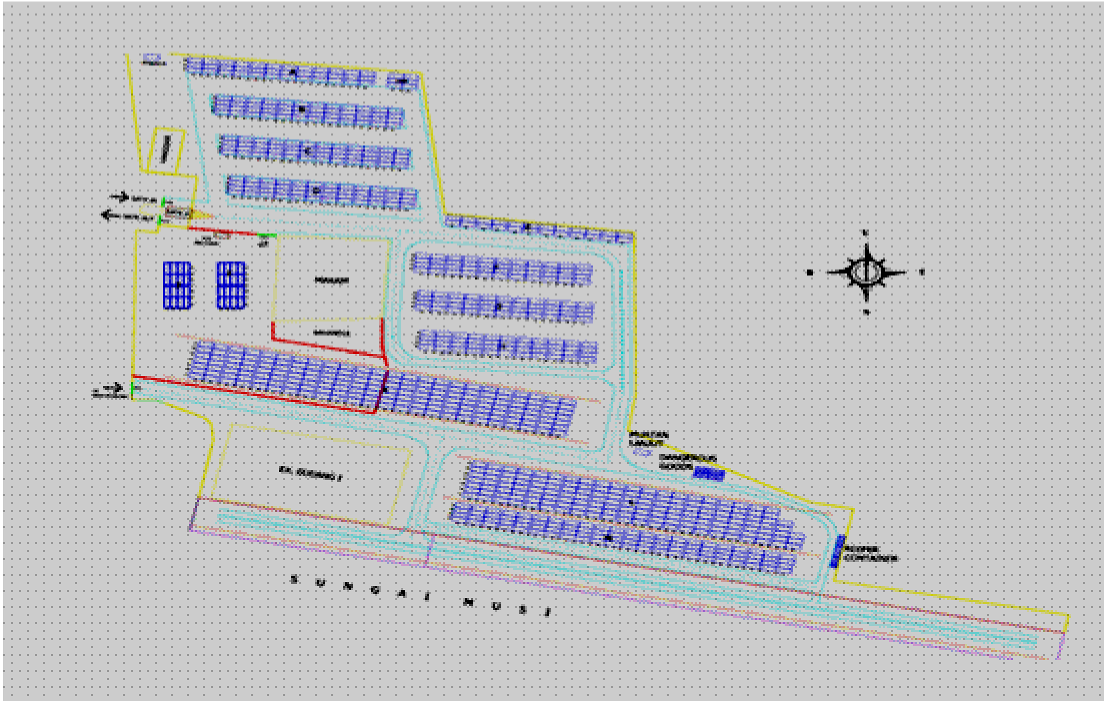


Figure 7 Container Terminal Layout
Source : Port of Boom Baru Palembang

4.5.2 Operational System

BCT constitutes of two quay cranes: one being a single lift with an average productivity of 18 boxes per hour and the second being a twin lift which can handle up to 40 boxes per hour. The Container Yard is consists of four Rail Mounted Gantry Crane (RMGC), two reach stackers, fifteen forklifts (with a capacity between 2 and 15 tons), three side loaders, twelve chassis and a truck for handling/stacking equipment in horizontal transportation modes. The stacking height capability allows the container to be stacked with five stacking height on the RMGC stacking area and four containers in the Reach Stacker stacking area. The Boom Baru Container Terminal requires a maximum of 10 days as dwelling time, based on data the actual dwelling time is an average of 7 days, whereby a container which requires more than 10 days is moved to the container depot outside. For the purpose of this study, the capacity calculation will be done using 7 days as the dwell time representing the acceptable day for the customer.

According to container flows, 80 % of the commodity loading is transported via barges as it can be either in container or non-container cargo. The cargoes come from hinterland transported via barges carrying commodities such as rubber, plywood and those in small packages. Containers are unloaded from the barge and transported to the yard awaiting the vessels whilst non-containers unload from the barges to the quay. Following this, the commodities transported to the yard to be stuffing in to the container and store in the container yard. Both of the container load by reach stacker / forklift / side loader and transported to the quay to load to the vessel by quay crane.

The remaining 20% of the commodities from the industrial area in Palembang are transported by truck; parts of which come from out of city areas such as Jambi and are similarly transported via containers and non-containers. However, there is no data available on the amount of commodities coming from Jambi or other provinces. The non-container commodities transported by truck to Container Freight Station for stuffing into the container are stored at the container yard. Meanwhile the commodities already in the container box are stores directly in the container yard and both of the containers will be transported to the quay side as soon as the vessel is ready to be loaded into the container.

4.5.3 Container Throughput

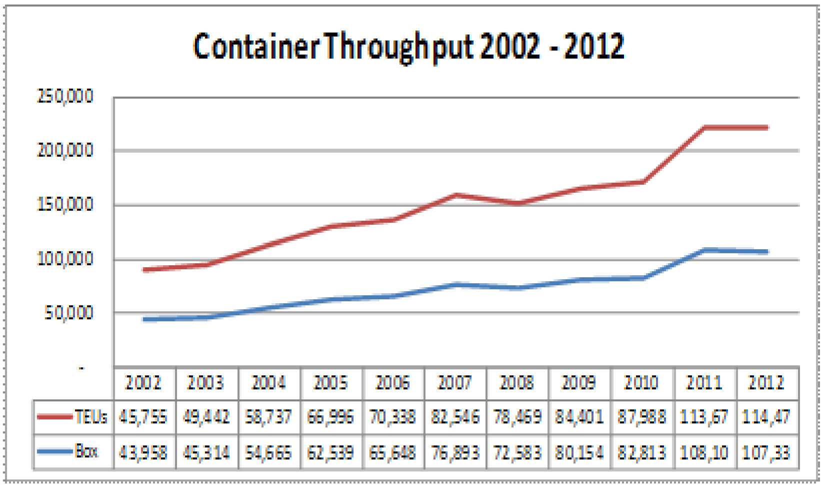


Figure 8 Container Throughput 2002 – 2012
Source : Port of Boom Baru Palembang

Based on data of container throughput as shown in figure 8, an increasing trend for the growth of the container throughput is exhibited over the last 10 years, with the exception of the year 2008, owing to the economic crisis that surfaced Asian countries the growth in throughput declined by 6% and rose to 10% in the year after. On average, the growth of the container terminal throughput has almost doubled compared to the growth of the GDP of South Sumatra with an average growth of container throughput of 13,82% in boxes and 13,63% in TEUs between 2001 and 2011

4.5.4 Container Terminal Performance

The existing performance measurement of the BCT shown in Table 7 below. However it should be noted that there is limited data available only 2007 - 2012. In 2011, the terminal start using RMGC to decrease Yard Occupancy that has exceeded 70% in 2010.

Table 7 : Performance of BCT

PERFORMANCE	***UNIT***	***YEAR***					
		2007	***2008***	***2009***	***2010***	***2011***	***2012***
Turn Round Time	Hour	64.49	68.31	65.22	68.07	64.52	47.02
Waiting Time	Hour	0.15	0.61	0.10	0.00	1.14	0.10
Approach Time	Hour	17.42	16.90	15.98	15.37	16.27	6.32
Effective Time	Hour	19.04	20.76	20.76	39.14	39.12	21.76
Berthing Time	Hour	46.92	50.80	49.15	52.70	47.11	40.60
Quay Crane Productivities	B/C/H	24	24	25	24	22	27
Berth Occupancy Ratio (BOR)	%	35.06	34.70	31.99	54.23	62.16	43.43
Yard Occupancy Ratio (YOR)	%	55.83	60.70	48.72	76.22	70.95	63.78

Source : Port of Boom Baru Palembang

Increased Quay Crane Productivity after the addition of one unit of gantry crane, which began operating in 2011. Normally the productivity of BCT is at the range of 22-24/B/C/H. Thus generally terminal has been doing anticipated in the face of economic growth in South Sumatera. Furthermore, this study will discuss about the capacity of the terminal and steps that need to be taken as the top priority in providing service to customer of BCT.

Chapter 5. BOOM BARU PALEMBANG CONTAINER TERMINAL CAPACITY ANALYSIS

5.1 Forecasting

One of the steps to achieve the objective of this paper is to predict and forecast from data that has been retrieved and inter-related. The most suitable forecasting method in doing the calculation at this study is quantitative forecasting method. Quantitative forecasting method consists of a regression method and time series analysis, where the study was more likely to use the regression method.

5.1.1. Population Forecasting

Population data is used as one of the factors to represent the hinterland of BCT as it is generally serves the people of South Sumatra.

Table 8 Correlation Coeficient between Container Throughput and Population

	Container Throughput	*Population*
Container Throughput	1	
Population	0.974306255	1

Source : Author

There is a strong relationship between population and container throughput, this can be seen from the correlation coeficient 0.974306255 or close to 1.

To predict South Sumatra Province population, forecasting methods which is used in this study is Polynomial Regression. Polynomial regression was chosen because it has R^2 the closest to 1 i.e. 0.9974 and has smalest Mean Square Error (MSE). The principle of choosing the best forecasting method is a method that has a forecasting error (MSE) as small as possible. Furthermore, to get the number of predictions the population in the province of South Sumatrea in 2013-2030 using the following formula:

$$y = 2.8869x^2 + 95.329x + 6325.9$$

Table 9 : South Sumatra Population Prediction 2013 – 2030

Year	*Actual Population (000)*	*Year*	*Population Prediction (000)*
2002	6,430	2013	7,886
2003	6,519	2014	8,053
2004	6,625	2015	8,226
2005	6,756	2016	8,405
2006	6,900	2017	8,590
2007	7,020	2018	8,781
2008	7,122	2019	8,977
2009	7,223	2020	9,179
2010	7,446	2021	9,387
2011	7,576	2022	9,601
2012	7,720	2023	9,820
		2024	10,046
		2025	10,277
		2026	10,513
		2027	10,756
		2028	11,004
		2029	11,258
		2030	11,518

Source : Author

5.1.2. GDP Forecasting

As already mentioned in the previous chapter that the Gross Domestic Product (GDP) can also be a factor affecting the growth of the container throughput in South Sumatra. How strong the correlation between GDP and container throughput can be seen in the following table:

Table 10 Correlation between Container Throughput and GDP

	Container Throughput	*GDP*
Container Throughput	1	
GDP	0.976168594	1

Source : Author

Cumulatively, in 2012 South Sumatra's economic grew by 6.0% per year, or slowed down as compared the previous year that amounted to 6.5%. Despite these achievements, however, slowed down the good enough conditions of uncertainty of the global economy in 2012. The growth rate in 2012 is at the range of projections of the Bank Indonesia on the previous report, i.e. 5.9-6.4%. When taken into account the overall performance of the year, the leading sectors of South Sumatra is still the main contributor to economic growth. The demand, investment and household consumption is the main sustainer of the economy in 2012 (Bank Indonesia, 2012). In predicting GDP the coming year, Linear Regression method has been chosen with the results as follows:

R Square (R^2)	0.986028767
Intercept (coefficient)	-5561510247
GDP (coefficient)	2798940.243

Single linear regression formula $y = a + bx$, then the formula for GDP forecasts to 2030 as shown in table 11:

$$y = -5561510247 + 279840.243x$$

Table 11 GDP Prediction 2013 - 2030

Year	*Actual GDP*	*Year*	*GDP Prediction*
2002	43,810,324	2013	72,756,462
2003	45,247,398	2014	75,555,402
2004	47,344,396	2015	78,354,342
2005	49,633,536	2016	81,153,283
2006	52,214,848	2017	83,952,223
2007	55,262,114	2018	86,751,163
2008	58,065,455	2019	89,550,103
2009	60,446,546	2020	92,349,044
2010	63,735,999	2021	95,147,984
2011	67,878,839	2022	97,946,924
2012	71,951,569	2023	100,745,864
		2024	103,544,805
		2025	106,343,745
		2026	109,142,685
		2027	111,941,625
		2028	114,740,565
		2029	117,539,506
		2030	120,338,446

Source : Author

5.1.3. Container Throughput Forecasting

In port planning and development, forecasting of container throughput demand is a necessary step in predicting future revenues for a proposed development project. Hence, analysis of container throughput demand is very important for port management. The container throughput growth in Indonesia increases 11,69%. In order to provide better quality services for shippers and liner shipping companies and to face the huge potential demand of container throughput, Container Terminal management shoud have best strategies to be implemented (Syafi'i, Kuroda, & Takebayashi, 2006).

On the calculation of prediction of container throughput in this study, needs to conduct data analysis calculation using microsoft excel.

Table 12 : Container Throughput, Population and GDP 2002 - 2012

Year	*Actual Container Throughput*	*Population(000)*	*GDP (000)*
2002	45,755	6,430	43,810
2003	49,442	6,519	45,247
2004	58,737	6,625	47,344
2005	66,996	6,756	49,634
2006	70,338	6,900	52,215
2007	82,546	7,020	55,262
2008	78,469	7,122	58,065
2009	84,401	7,223	60,447
2010	87,988	7,446	63,736
2011	113,678	7,576	67,879
2012	114,479	7,720	71,952

Source : Author

The results of the relationship between GDP and population with throughput can be summarized in table 13 :

Table 13 : Correlation Coefficient between Container Throughput, Population and GDP

	Container Throughput	*Population(000)*	*GDP (000)*
Container Throughput	1		
Population(000)	0.974306255	1	
GDP (000)	0.976168594	0.99723366	1

Source : Author

Furthermore, data analysis was done using excel to choose the most suitable method of forecasting is used in the calculation of the forecast container throughput.

Table 14 : Linear Regression Data Analysis Result

Summary Output	*Container Throughput*
Intercept (Y)	-13264604.69
X variable 1	6647.8
R Square	0.940466965
Standard Error	5847.365908

Source : Author

Or using following formula:

$$y = 6647.8x + 37643$$

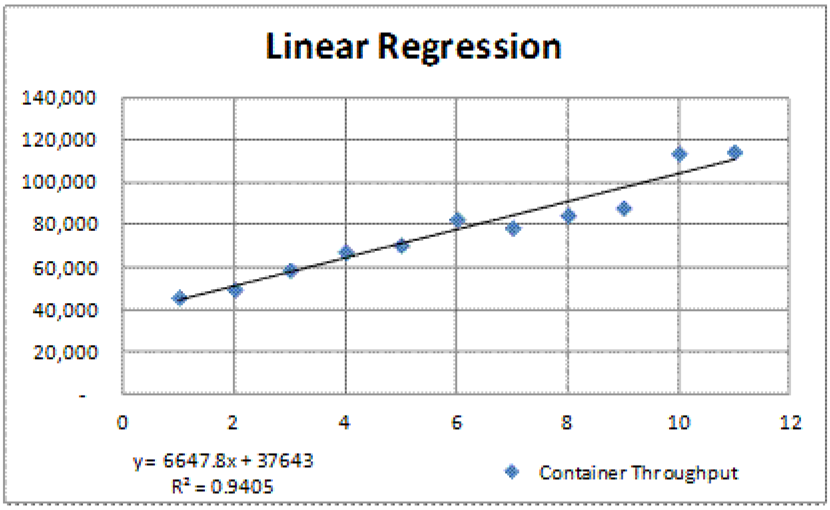


Figure 9 Linear Regression Chart and Trendline
Source : Author

Another regression calculations are applied to determine the throughput of container forecasting using polynomial regression method like the following results:

$y = 189.28x^2 + 4376.5x + 42564$

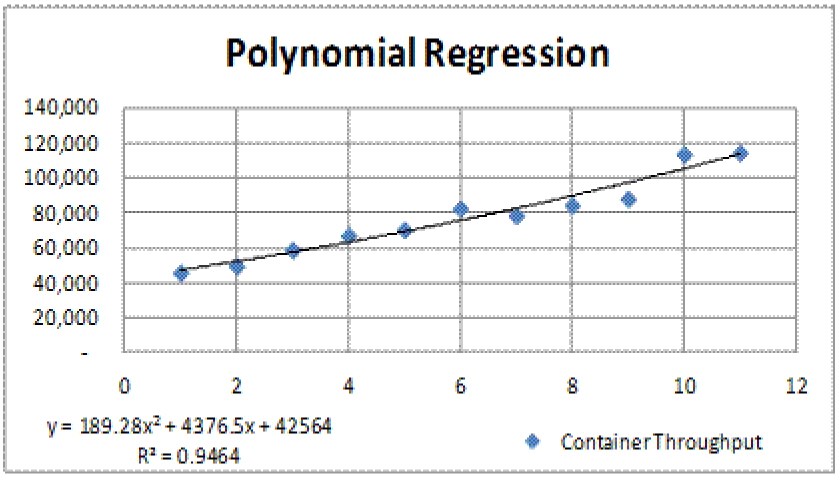


Figure 10 Polynomial Regression Chart and Trendline
Source : Author

The last method used to determine the container throughput forecasting is multiple regression forecasting method which combined the factors that affect container throughput to get the best forecasting approach. On the calculation method using multiple regression, the dependent variable (Y) is the Container Throughput while independent variables consisted of population (X_1) and GDP (X_2). Using data analysis in excel is found the result as shown in table 15:

Table 15 : Multiple Regression Data Analysis Result of Relationship between Container Throughput, Population and GDP

Summary Output	***Container Throughput***
Intercept (y)	-90805.06942
Population (x_1)	7.974561935
GDP (x_2)	2.006130724
R Square	0.953032249
Standard Error	5508.805072

Source : Author

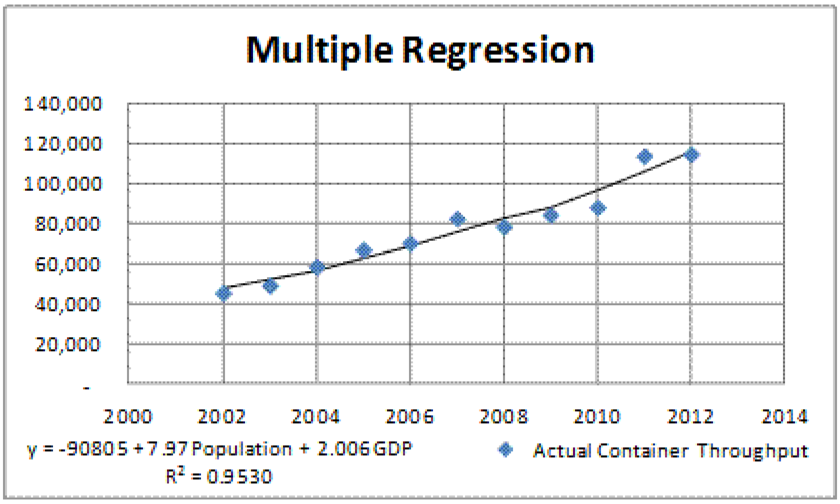


Figure 11 Multiple Regression Chart and Trendline
Source : Author

Overall results of data analysis using the method of regression can be seen in the table 16:

Table 16 : Data Analysis Result using Regression

Year	***Actual Container Throughput***	***Linear Regression***		***Polynomial Regression***		***Multiple Regression***	
2002	45,755		44,291		47,130		48,361
2003	49,442		50,939		52,074		51,953
2004	58,737		57,587		57,397		57,005
2005	66,996		64,234		63,098		62,642
2006	70,338		70,882		69,179		68,969
2007	82,546		77,530		75,637		76,039
2008	78,469		84,178		82,474		82,477
2009	84,401		90,826		89,690		88,059
2010	87,988		97,473		97,284		96,436
2011	113,678		104,121		105,257		105,784
2012	114,479		110,769		113,608		115,103
		R^2	**0.9405**	**R^2**	**0.9464**	**R^2**	**0.9530**
		MSE	**27,975,018**	**MSE**	**25,180,595**	**MSE**	**22,070,497**

Source : Author

Based on table 16 above, all the results of these three methods of data analysis has almost approached. The value of R^2 from all methods over 90%, but to define container throughput forecast for the next few years will be selected a method that has the highest value of R^2 and has the smallest MSE. The Multiple Regression is a method that is most suitable to be used in determining the results of the forecast of container throughput up to 2030 and it is chosen since it shows the strongest representation that GDP and population influence the container throughput. All the predictions of Container Throughput, population and GDP by 2013 to 2030 can be seen in the table 17:

Table 17 : Container Throughput, Population and GDP 2013 - 2030

Year	*Population (000)*	*GDP (000)*	*Throughput*
2013	7,886	72,756	118,038
2014	8,053	75,555	124,989
2015	8,226	78,354	131,985
2016	8,405	81,153	139,028
2017	8,590	83,952	146,117
2018	8,781	86,751	153,252
2019	8,977	89,550	160,433
2020	9,179	92,349	167,660
2021	9,387	95,148	174,933
2022	9,601	97,947	182,252
2023	9,820	100,746	189,618
2024	10,046	103,545	197,029
2025	10,277	106,344	204,486
2026	10,513	109,143	211,989
2027	10,756	111,942	219,539
2028	11,004	114,741	227,134
2029	11,258	117,540	234,776
2030	11,518	120,338	242,463

Source : Author

5.2 Ship Call

Container throughput can also determined by ship call, hence the berthing capacity in line with the number of ships visiting the terminal. In this study, data ship visiting the BCT in 2012 is used to compute ship call predictions as shown in the table 18:

Table 18 : Ship Calling BCT 2012

GT	***Ship Call / year***	***Total Load/Unload (box)***	***TEUs***	***Container/ ship***
1,962	1	160	160	160
1,988	1	252	252	252
2,123	50	8,647	8,813	173
2,509	34	7,330	8,196	216
2,714	16	4,276	4,863	267
2,993	14	4,229	4,246	302
3,127	5	1,743	1,746	349
3,288	2	480	484	240
3,401	46	12,461	12,491	271
3,431	3	690	705	230
4,129	33	10,789	10,923	327
4,225	8	3,164	3,170	396
4,967	44	17,804	18,446	405
5,250	61	23,485	28,080	385
6,245	2	684	715	342
6,603	5	2,998	2,998	600
6,888	16	8,147	8,190	509
65,843	***341***	***107,339***	***114,478***	***319***

Source : Port of Boom Baru Palembang

An estimate of the ship calls for the year 2013 to 2030 can be found by dividing the container throughput with the average loading/unloading of containers per ship in 2012 (370 TEUs), which means this is only a reflection of the average number of containers that can be carried by the ship in 2012.

According to Bottema (2012), to calculate the estimated call size can use the following formula:

$$Cs = (S / t) \times L \times M \times 2$$

Assuming the following:

Cs = Call size estimate in TEU

S = Ship size in TEU

t = TEU factor; comparison between the container 20 ' and 40 ' in this terminal is 1.1

L = Average load factor of the vessel in percentage; 60%

M = Port market share in percentage; Since this terminal only serves Port of Tanjung Priok for domestic trade and Port of Singapore for international trade, the market share of this container terminal is 100%.

2 = The activities of the vessel in the terminal, load and unloading

Based on the data history of 2012 the call size estimation calculation can be shown as follows:

Call Size in TEU = (319 / 1.1) x 60% x 100% x 2

= 348 Boxes

Furthermore, from the container throughput forecast to 2030 and call size estimates, the number of ships that will visit the container terminal can be defined by dividing the projected container throughput to size call, as shown in table 19 :

Table 19 : Ship Call Estimation

Year	*Container Throughput*	*Call Size*	*Ship Call*
2013	118,038	348	339
2014	124,989	348	359
2015	131,985	348	379
2016	139,028	348	400
2017	146,117	348	420
2018	153,252	348	440
2019	160,433	348	461
2020	167,660	348	482
2021	174,933	348	503
2022	182,252	348	524

2023	189,618	348	545
2024	197,029	348	566
2025	204,486	348	588
2026	211,989	348	609
2027	219,539	348	631
2028	227,134	348	653
2029	234,776	348	675
2030	242,463	348	697

Source : Author

5.3 Terminal Capacity Analysis

The existing facilities capacity of the container terminal will be assessed to learn whether the existing berth and container yard will be sufficient to meet the demand for container throughput in the next year. The study will observe from the year 2013 up to 2030. Moreover, the assumptions used are discussed with the management of BCT, based on data history and the characteristic of container terminal.

5.3.1 Berth Capacity

As mentioned in data facilities that BCT has a berth along the 266 M. Generally 1 unit along the berth is ± 300 M but in BCT, the berth enabled into 2 berth unit due to the length of the ship berthing in the BCT has an average length of 100 M-120 M.

The following indicators will be used to assess the berth capacity:

1) Labor force for service of the ship: divided into 3 shifts per day with each shift being 7 hours. Therefore the labor works a total of 21 hours per day, 7 days per week and 52 weeks per year.
2) Effective Time: the number of load (or) unload containers per ship/ quay crane productivity (B/C/H) per berth.
3) Non Operating Time: load/unload preparation (0,5 hour), shift change (0,5 hour), break (1 hour).
4) Idle time is considered as 1 hour.
5) Berth Operating Ratio: assumed as 50%, to be certain that berth will always be available for ships to berth.

6) Load factor of the ship: taken as 60%, based on the average historical load factor.

7) Quay Cranes: Two quay cranes are operated with the first one being an old crane (1978) with low productivity ± 18 box/hour and the second one being a twin lift with 30 B/C/H.

8) Working hour for quay crane: Currently it is 6 hour per shift, Hence the maximum working hours for 3 shifts is 6.552 hour/year.

9) Average LOA of visit is 106 m. Berthing space : for each ship is LOA + (10% x LOA) = 106 + 10,6 = 116,6 m

Table 20 : Berth Capacity Analysis

Description	***Formula***	***Unit***	***2013***	***2020***	***2027***	***2030***
Container Throughput	A	TEUs/year	118,038	167,660	219,539	242,463
Load/Unload per ship (Cs)	B	box/ship	348	348	348	348
Ship Call per year (Sc)	C=A/B	ship call	339	482	631	697
Average Quay Crane Prod.	D	B/C/H	24	24	24	24
Number of QCC	E	Unit	2	2	2	2
TEU factor	F		1.1	1.1	1.1	1.1
Total QC Productivity	G=DxE	Box	48	48	48	48
Max Working hour	H=(5x3x7x52)	Hour	5,460	5,460	5,460	5,460
QC capacity/berth capacity	*I=GxH*	*box/year*	*262,080*	*262,080*	*262,080*	*262,080*
		teus/year	*288,288*	*288,288*	*288,288*	*288,288*
<u>Berth Required</u>						
QC Productivity per Ship (Qp)	J=G/2	Box	24	24	24	24
Effective Time	K=B/J	Hour	15	15	15	15
Non Operating Time	L=(M+N+O)	Hour	2	2	2	2
-Load/Unload preparation	M	Hour	0.5	0.5	0.5	0.5
-Shift change	N	Hour	0.5	0.5	0.5	0.5
-Break	O	Hour	1	1	1	1
Idle Time	P	Hour	1	1	1	1
Berthing Time per ship	Q=K+L+P	Hour	18	18	18	18
Berthing Time all ship a year	R=QxC	Hour	5,936	8,431	11,040	12,193
Berthing Time in day a year	S=R/24	Day	247	351	460	508
Working day a year	T	Day	360	360	360	360
BOR	U	%	0.5	0.5	0.5	0.5
Berth Required	V=S/(T*U)	Unit	1	2	3	3
Lenght of each berth	W=LOA + 10%	M'	117	117	117	117
Lenght of Berth Required	*X= V x W*	*M'*	*117*	*233*	*350*	*350*
Lenght of Berth Available	*Y*	*M'*	*266*	*266*	*266*	*266*
Lack of Berth	***Z=Y-X***	***M'***	***149***	***33***	***(84)***	***(84)***

Source : Author

Berth capacity obtained from the results of the multiplication of the total productivity and QC maximum working hour. As was mentioned earlier that BCT has 2 units of QC with different productivity from each other, so that the average productivity of QC is 24 box/crane/hour. Total QC productivity is the result of the average QC productivity is multiplied with number of QC operating in the terminal and the result is 48 box/crane/hour.

Maximum working hour is affected by the number of hours worked per shift, the number of shifts worked per day, number of days of the week and number of weeks in a year. In this study the assumptions used for the business hours of each shift is 8 hours of reduced rest periods for 1 hour, turn shift 0.5 hours and preparation work 0.5 hours. Aside from the time of non regular operation, there is additional time for not work that idle time average for 1 hour each shift arrows. So the total time to work is effective for 5 hours multiplied 3 working shifts per day multiplied by 7 days a week and 52 weeks a year. The maximum working hours result is 5.460 hours per year.

From the above calculation, the result of a berth capacity to BCT is as in the following formula:

Berth Capacity	=	Total QC Productivity x Maximum Working Hour
	=	48 B/C/H x 5.460 Hours
	=	262,080 Box or 288,288 TEUs

Next to determine the need for a berth is calculated the berthing time of the vessels that visited the terminal in a year divided by the result of the multiplication between the expected berth occupation ratio (BOR) and working day in a year where applicable in Indonesia is 363 days or there are 2 days public holiday which are not required to work. It is clear that berth facility in BCT is still sufficient to accommodate the throughput until the year 2026. In the year 2027 management of BCT should investing extra berth in the meeting in future demands.

5.3.2 Yard Capacity

The analysis situation of the container terminal on BCT is based on the previous data and information about the condition of BCT. This section presents an analysis of container yard capacity based on throughput. By using Dally's formula as mention in previous chapter, the result can be seen in table 21:

Table 21 : Yard Capacity Analysis

Description	***Formula***	***Unit***	***2013***	***2014***	***2023***	***2028***	***2030***
Container throughput/year	A	TEUs	118,038	124,989	189,618	227,134	242,463
Operating Days of CY	B	Days	365	365	365	365	365
Dwelling Time	C	Days	7	7	7	7	7
Ground slot existing	D	TEUs	1,080	1,080	1,080	1,080	1,080
Average Stacking Height	F	Tier	4	4	4	4	4
Land Utilisation	G	%	70	70	70	70	70
Peaking Factor	H		1.3	1.3	1.3	1.3	1.3
Annual CY Capacity	*I = (DxFxGxB)/(CxH)*	*TEUs*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*

Source : Author

The Total Ground Slots (Tgs) available in BCT is currently 35% of the total area that has function as Container Yard. Where from 4.6 ha total area CY only 1.6 ha that can be occupied by the container storage area. This is due to the existence of uniqueness in the BCT as explained in the previous chapter. There are 2 types of stacking equipment operating in CY : RMGC with stacking height 1 over 5 (4.5 tiers) and Reach Stacker with stacking height 1 over 4 (3.5 tiers), so the average stacking heigth is 4 tiers. From the data obtained from the management, Land Utilisation and BCT Peaking Factor respectively is 70% and 30%

Thus the capacity of CY is still accommodating throughput up to 2013. Starting in 2014, BCT should start to do the expansion of CY. Still based on the Dally's formula, the requirement of storage area for the next few years at BCT can be seen in the table 22:

Table 22 : Storage Area Requirement

Description	*Unit*	*2013*	*2014*	*2020*	*2030*
Annual Container Throughput	TEU	118,038	124,989	167,660	242,463
Average dwell time	days	7	7	7	7
Required Tgs	TEU	1,051	1,113	1,493	2,159
Required area	M^2	15,765	16,694	22,393	32,384
Shortage (or Surplus) of area	M^2	439	(490)	(6,189)	(16,180)
Ratio of area shortage (or surplus)	%	2.8%	-2.9%	-27.6%	-50.0%

Source : Author

In 2014, the demands of storage area will grow 2.9% or 490 M^2 due to in 2014 the CY is expected to require 1,113 TGS. This condition will continue until next year as shown in the table. In 2030 demand increased storage area 50% or 32.384 M^2. As explained earlier that the effective area is used as a stacking location only 35% of the total land area of the entire CY. It means that there are other strategies besides expanding storage areas such as increasing the effective storage area of more than 35%.

5.4 Possible Alternatives to Increase Capacity

Overall, the capacity of the facilities owned by the BCT requires an increase in demand in the future. Berth capacity can still serve demands until 2024, if assume increasing demand upon the ship calls. However, based on the results of calculation, proper berth throughput capacity is 288.288 TEUs while the throughput forecasting results by 2030 is 242.463 TEUs. In conclusion, by mathematical calculation berth capacity can still serve demands over the year 2030.

On the other hand, capacity of storage area requires attention starting in 2014 to confront the increasing future demands. As was mentioned earlier that CY owned BCT has some uniqueness that is has irregular layout and the cemetery in the central part of CY that can also be considered a weakness that needs to be changed to be opportunities in the future.

For short-term alternatives, in order to fulfill the demand of storage area in the face of increasing the throughput, the management of BCT should be able to reduce the dwelling time to lighten the load of storage area. If the average dwelling time of 7 days reduced to 5 days, storage area in the BCT will be able to serve demand until the year 2020, as shown in the table 23:

Table 23 : Storage Area Required (Dwell Time 5 days)

Description	*Unit*	*2013*	*2014*	*2020*	*2021*	*2030*
Annual Container Throughput	TEU	118,038	124,989	167,660	174,933	242,463
Average dwell time	days	***5***	***5***	***5***	***5***	***5***
Required Tgs	TEU	751	795	1,066	1,113	1,542
Required area	M^2	11,261	11,924	15,995	16,689	23,131
Shortage (or Surplus) of area	M^2	4,943	4,280	209	(485)	(6,927)
Ratio of area shortage (or surplus)	%	43.9%	35.9%	1.3%	-2.9%	-29.9%

Source : Author

However, the strategy of reducing dwelling time is only a temporary solution because the shipping line as customer who enable the container as a means of transport as well as the warehouse will be hard to accept this solution.

The other strategy is a long-term alternative which requires extra attention and power in the run it because it is not easy to do and it will takes many time. If we look at the layout of the terminal where the BCT still has land that is currently occupied by 1) PT Smart, PT. 2), Tania, 3) Navy and 4) Cemetery "Kambang Koci" as in the figure 12:

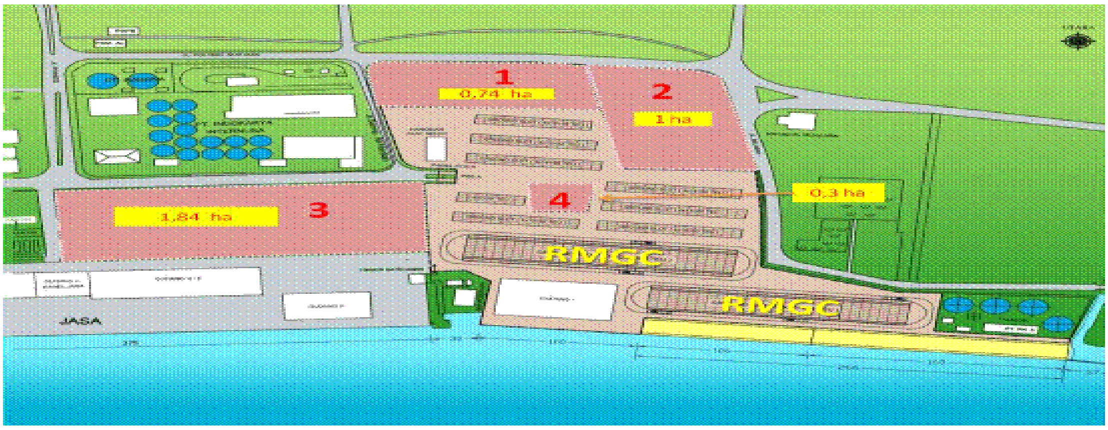


Figure 12: BCT Alternative Layout
Source : Port of Boom Baru Palembang and Own elaboration

1. The land belong to Port of Bom Baru Palembang which is still rented by PT Smart with an area of 0.74 ha, the contract will be completed by 2014.
2. The site is still occupied by PT. Tania Selatan has an area of 1 ha, expected to be completed by the end of 2013.
3. The land belonging to the Navy and Customs with an area of 1.84 ha.
4. Cemetery "Kambang Koci" with 0.3 ha, even though only small piece of total CY area, if it can be moved to a location outside of the container terminal will greatly help provide space in the storage area and safety in CY operation.

By utilizing additional area as in the previous discussion, CY capacity at BCT is expected to grow as much as 3.8 ha. Total storage area become 8.45 ha with some assumption of overall CY utilization percentage which can be used to stack the container , the calculation of the CY capacity as in the table 24:

Table 24 : Long-term Alternative Storage Area

Land Utilisation	*M^2*	*Tgs*	*Annual Throughput (TEUs)*		
			Before	*After*	*Surplus*
50%	42,250	2,817	121,292	316,371	195,079
60%	50,700	3,380	121,292	379,600	258,308
70%	59,150	3,943	121,292	442,829	321,537

Source : Author

Utilization of the existing land that is purely used as a storage area only 35% of this is due to the presence of cemetery in the central part of CY. When the cemetery be moved out of the CY, the utilization of CY it is possible to be 50% (4.2 ha / 2,817 Tgs / 316,371 TEUs) or 60% (5.1 ha / 3,380 Tgs / 379,600 TEUs) even 70% (5.9 ha / 3.943 Tgs / 442,829 TEUs).

5.5 The Possibility Of Unconventional

5.5.1 Change of Manufacturing Industry and Its Effects on Shipping Business

As it has been experienced by China, the change of manufacturing industry greatly influences the growth of shipping business. The feature of the change is that, Asia, notably East Asia, has overwhelmingly become the powerhouse of world shipping business as the largest importer of raw materials and the largest exporter of manufactured goods. In shipping, the volume rather than value matters, the region has consumed more raw materials and produced more manufactured products than either of them (Jiafu, 2004).

Another possibility that could happen is the possibility of an increase in standard of living and economy of people or the growing industry in South Sumatra Province which led to the increasing demand of the capacity of the terminal. If it is assumed South Sumatra Province as China, economic growth being experienced in China is the increase in international trade and indirectly impact upon increasing the GDP to 9.4% for the past 25 years (Jiafu, 2004).

As does China, manufacturing changes greatly affect international trade. It will also change the pattern of trade which was originally dominant domestic trade will develop into its dominating international trade. If the manufacturing industry increased, the need for raw materials will increase convey especially if raw materials required are not available in the country it will be done. Not just a change of pattern of trade is changing, the pattern of transport will also experience a change toward more advanced. However, in this study would not discuss about international trade.

Economic growth as the impact of the changes in the manufacturing industry will deliver the impact of changes to political policies in a region. This is normal due to the changing industry in a region requires a change of raw materials production and also changes in the workforce to support the industry.

The economic growth in this study can be measured by the GDP of South Sumatra Province. If the assumed GDP increased by 2 times of normal growth as in the average GDP growth 4.75% that has been discussed before, so the GDP growth the people in South Sumatra become 9.5% and probability can be seen in table 25:

Table 25 : Throughput Probability based on Growth of GDP 9.5%

Year	*GDP (000)*		*Throughput*		
	4.75%	*9.50%*	*Before*	*After*	*%*
2013	72,756	79,668	118,038	131,904	11.75%
2014	75,555	82,733	124,989	139,388	11.52%
2015	78,354	85,798	131,985	146,918	11.31%
2016	81,153	88,863	139,028	154,495	11.12%
2017	83,952	91,928	146,117	162,117	10.95%
2018	86,751	94,993	153,252	169,785	10.79%
2019	89,550	98,057	160,433	177,500	10.64%
2020	92,349	101,122	167,660	185,260	10.50%
2021	95,148	104,187	174,933	193,067	10.37%
2022	97,947	107,252	182,252	200,919	10.24%
2023	100,746	110,317	189,618	208,818	10.13%
2024	103,545	113,382	197,029	216,763	10.02%
2025	106,344	116,446	204,486	224,753	9.91%
2026	109,143	119,511	211,989	232,790	9.81%
2027	111,942	122,576	219,539	240,873	9.72%
2028	114,741	125,641	227,134	249,002	9.63%
2029	117,540	128,706	234,776	257,177	9.54%
2030	120,338	131,771	242,463	265,398	9.46%
			Average Growth of Throughput		10.41%

Source : Author

As shown in table 25, average throughput growth in GDP growth condition 9.5% per year is of 10.41% each year. Based on those predictions in table 25 and increased container throughput will occur as a result of the change in the pattern of trade.With throughput quantities as in table 25, the capacity of the BCT would change as in table 26, 27 and 28:

Table 26 : Berth Requirement based on GDP Growth 9.5%

Description	***Formula***	***Unit***	***2013***	***2023***	***2024***	***2030***
Container Throughput	A	TEUs/year	131,904	208,818	216,763	265,398
Load/Unload per ship (Cs)	B	box/ship	348	348	348	348
Ship Call per year (Sc)	C=A/B	ship call	379	600	623	763
Average Quay Crane Productivity	D	B/C/H	24	24	24	24
Number of QCC	E	Unit	2	2	2	2
TEU factor	F		1.1	1.1	1.1	1.1
Total QC Productivity	G=DxE	Box	48	48	48	48
Max Working hour	H=(5x3x7x52)	Hour	5,460	5,460	5,460	5,460
QC capacity/berth capacity	*I=GxH*	*box/year*	*262,080*	*262,080*	*262,080*	*262,080*
		teus/year	*288,288*	*288,288*	*288,288*	*288,288*
Berth Required						
QC Productivity per Ship (Qp)	J=G/2	Box	24	24	24	24
Effective Time	K=B/J	Hour	15	15	15	15
Non Operating Time	L=(M+N+O)	Hour	2	3	3	3
-Load/Unload preparation	M	Hour	0.5	0.5	0.5	0.5
-Shift change	N	Hour	0.5	0.5	0.5	0.5
-Break	O	Hour	1	1	1	1
Idle Time	P	Hour	1	1	1	1
Berthing Time per ship	Q=K+L+P	Hour	18	18	18	18
Berthing Time all ship a year	R=QxC	Hour	6,633	10,501	10,900	13,346
Berthing Time in day a year	S=R/24	Day	276	438	454	556
Working day a year	T	Day	360	360	360	360
BOR	U	%	0.5	0.5	0.5	0.5
Berth Required	V=S/(T*U)	Unit	2	2	3	3
Lenght of each berth	W=LOA + 10%	M'	117	117	117	117
Lenght of Berth Required	*X= V x W*	*M'*	*233*	*233*	*350*	*350*
Lenght of Berth Available	*Y*	*M'*	*266*	*266*	*266*	*266*
Lack of Berth	***Z=Y-X***	***M'***	***33***	***33***	***(84)***	***(84)***

Source : Author

As in the previous discussion that the need for additional berth in the BCT will take place in the year 2027, but with an increase in GDP, hence the need for an additional berth will advance to year 2024. On the other hand, berth capacity remain fulfilled until 2030 although there are changes in the economy of the South Sumatra which assumed by doubled from normal conditions.

Furthermore, the chances of that happening against a capacity of CY can be seen in table 27:

Table 27 : CY Capacity based on GDP Growth 9.5%

Description	*Formula*	*Unit*	*2013*	*2014*	*2023*	*2028*	*2030*
Container throughput/year	A	TEUs	131,904	139,388	208,818	249,002	265,398
Operating Days of CY	B	Days	365	365	365	365	365
Dwelling Time	C	Days	7	7	7	7	7
Ground slot existing	D	TEUs	1,080	1,080	1,080	1,080	1,080
Average Stacking Height	F	Tier	4	4	4	4	4
Land Utilisation	G	%	70	70	70	70	70
Peaking Factor	H		1.3	1.3	1.3	1.3	1.3
Annual CY Capacity	I = (DxFxGxB)/(CxH)	TEUs	121,292	121,292	121,292	121,292	121,292

Source : Author

Table 27 indicates that the capacity of CY as much 121,292 TEUs in 2013 are already unable to cover estimates of the container throughput in 2013 assuming calculated based on factors of the economy people in South Sumatra which increased by two times the estimated normal.

Table 28 : Required Area based on GDP growth 9.5%

Description	*Unit*	*2013*	*2018*	*2019*	*2030*
Annual Container Throughput	TEU	131,904	169,785	177,500	265,398
Average dwell time	days	7	7	7	7
Required Tgs	TEU	1,174	1,512	1,580	2,363
Required area	M^2	17,617	22,677	23,707	35,447
Shortage (or Surplus) of area	M^2	(1,413)	(6,473)	(7,503)	(19,243)
Ratio of area shortage (or surplus)	%	-8.0%	-28.5%	-31.6%	-54.3%

Source : Author

Furthermore, the need for area will start in 2013 as shown in table 28, where the ratio shortage of storage area 8%. In the year 2030 if the expansion of area is not done for the storage, then the ratio of shortage area will 54.3% or 1.9 ha from existing area.

5.5.2 Increasing of Ship Size

The increasing throughput will impact the transportation patterns change. Based on the principle of economy of scale, where for the purpose of efficiency and make cheaper its transport freight, the shipping lines will increase the size of the ship, it will be equal to the increase in the economy, increasing the size of the carriers will also have an impact on capacity in a terminal.

If it is assumed the call size coming into BCT doubled from normal condition (see table 17), then the ship call declined by 32% due to Berthing Time per call will be increased by 68% or from 19 hours to 32 hours (assuming productivity and facilities that have not changed) assuming the average length of the ships (LOA) is 120 M[1]. This condition affects the increase in container throughput as in table 29 below.

Table 29 : Call Size Estimation (Doubled Version)

Year	*Call Size*	*Ship Call*	*Container Throughput*
2013	696	285	198,304
2014	696	302	209,981
2015	696	319	221,736
2016	696	336	233,568
2017	696	353	245,477
2018	696	370	257,464
2019	696	387	269,528
2020	696	405	281,669
2021	696	422	293,888
2022	696	440	306,184
2023	696	458	318,558
2024	696	476	331,009
2025	696	494	343,537
2026	696	512	356,142
2027	696	530	368,825
2028	696	548	381,586
2029	696	567	394,423
2030	696	585	407,338

Source : Author

As shown in table 29, where in 2013 container throughput in BCT predicted will reach 198,304 TEUs and continue to increase up to the year 2030 as much 407,338 TEUs assuming call size 696 TEUs per ship. Based on prediction of container throughput as in table 29, then the need of berth in BCT can be described in table 30:

Table 30 : Berth Requirement based on Double Call Size

Description	***Formula***	***Unit***	***2013***	***2020***	***2024***	***2030***
Container Throughput	A	TEUs/year	198,304	281,669	331,009	407,338
Load/Unload per ship (Cs)	B	box/ship	696	696	696	696
Ship Call per year (Sc)	C=A/B	ship call	285	405	476	585
Average Quay Crane Productivity	D	B/C/H	24	24	24	24
Number of QCC	E	Unit	2	2	2	2
TEU factor	F		1.1	1.1	1.1	1.1
Total QC Productivity	G=DxE	Box	48	48	48	48
Max Working hour	H=(5x3x7x52)	Hour	5,460	5,460	5,460	5,460
QC capacity/berth capacity	*I=GxH*	*box/year*	*262,080*	*62,080*	*262,080*	*262,080*
		teus/year	*288,288*	*288,288*	*288,288*	*288,288*
Berth Required						
QC Productivity per Ship	J=G/2	Box	24	24	24	24
Effective Time	K=B/J	Hour	29	29	29	29
Berthing Time per ship	Q=K+L+P	Hour	32	32	32	32
Berthing Time all ship a year	R=QxC	Hour	9,117	12,950	15,219	18,728
Berthing Time in day a year	S=R/24	Day	380	540	634	780
Working day a year	T	Day	360	360	360	360
BOR	U	%	0.5	0.5	0.5	0.5
Berth Required	V=S/(T*U)	Unit	2	3	4	4
Lenght of each berth	W=LOA + 10%	M'	132	132	132	132
Lenght of Berth Required	*X= V x W*	*M'*	*264*	*396*	*528*	*528*
Lenght of Berth Available	*Y*	*M'*	*266*	*266*	*266*	*266*
Lack of Berth	***Z=Y-X***	***M'***	***2***	***(130)***	***(262)***	***(262)***

Berth Capacity at BCT will only cover the container throughput up to the year 2020 but the number of berth by 2020 needs additional one more unit, this is due to the length of berth to be met by 2020 is all 396 M long berth while BCT is 266 M so less along the 130 M. Three units of berth will only last up to the year 2030 due in 2024 BCT must provide one additional unit more along the 132 M to cover the container throughput as much 331,009 TEUs and it predicts still be covered container throughput up to 2030.

As has been discussed previously that the PCTC in BCT is CY capacity then automatically the capacity of storage area in the BCT will experience shortage. Ratio of the shortage of storage area in BCT can be seen in table 31 below:

Table 31 : Storage Area Requirement based on Double Call Size

Description	*Unit*	*2013*	*2020*	*2025*	*2030*
Annual Container Throughput	TEU	198,304	281,669	343,537	407,338
Average dwell time	days	7	7	7	7
Required Tgs	TEU	1,766	2,508	3,059	3,627
Required area	M^2	26,486	37,620	45,883	54,405
Shortage (or Surplus) of area	M^2	10,282)	21,416)	29,679)	38,201)
Ratio of area shortage (or surplus)	%	-38.8%	-56.9%	-64.7%	-70.2%

Source : Author

Finally, the change in the manufacturing industry or changes the size of the ship that call to a terminal will increase the throughput will be even greater and also change the pattern of trade and political policy changes in the region.

Chapter 6. CONCLUSION AND RECOMENDATION

6.1. Conclusion

This study is conducted to predict the possibilities that will be faced by BCT as the only container terminal in South Sumatra Province to serve future demands relating to facilities and equipment. Thus investments in facilities and equipment should be made in accordance with the expected demand.

In forecasting future throughput, factors that influence are historical data from container terminals such as ship call, throughput, performance and other operational patterns using this assumption is based on the literature review and discussing with the container terminal management team. Other factors that are used in this study i.e., GDP and population as a parameter of the hinterland that have a strong correlation with container throughput.

The time period used in the forecasting of throughput on this study is beginning in 2013 to 2030 in order to make decision to select the suitable strategy. The forecasting methods used to predict different for each factor. Single regression method has been chosen to do the forecasting of the population and GDP, whereas for Throughput forecasting method of Multiple regression has been selected due to the independent variables are population and GDP.

There is no problem with a berth capacity if the determination of capacity based on productivity, however if the QC predestination based on ship call, Berth facility in BCT is still sufficient to accommodate the throughput until the year 2024. In the year 2025 management of BCT should investing extra berth in the meeting in future demands.

Another case with the capacity of storage area which requires attention starting in 2014 to meet the increasing future demands. Short term alternatives to increase the capacity of the storage area is to reduce the dwelling time from 7 days in existing to 5 days and the capacity of CY is expected will be sufficient up to the year 2020. As for long-term alternatives, BCT will do the hard work to get maximum results. By expanding the CY the estimated capacity of the BCT will be safe until more than 2030.

In conclusion, the comparison of results between berth throughput (288,288 TEUs) and CY throughput (121,292 TEUs), it is clear that the Proper Container Throughput Capacity (PCTC) is CY throughput. It means that BCT can still accommodate throughput through CY as much 121,292 TEUs and should do the anticipation if future demand will exceed the figure. In the event of a change in the manufacturing industry or changes the size of the ship that call to a terminal will change the pattern of trade and political policy changes also in the region and of course increase the throughput will be even greater.

6.2. Recomendation

BCT is expected to start thinking about the steps to be taken in anticipation of a surge in demand by doing short term strategies as well as long-term strategies. Both must run balanced so that there is no any party that will feel aggrieved at the moment running the improvement steps.

Focusing on storage area or CY capacity which is as the PCTC (PCTC is calculated by comparing berth capacity and yard capacity whichever is lower is considerd as PCTC) , the ability of BCT to anticipate future demand is getting bigger because if CY capacity can be addressed in a serious and proper ways is the likely occurrence of congestion at container terminal becomes very small. In addition, to doing the Setup layout is an alternative long term, short term alternatives to reduce the dwelling time in CY should still be executed primarily in improving the performance of container terminals. High Performace coupled with high service level would increase revenue for the container terminal.

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APPENDICES

Appendix 1 : Data Analysis Summary Output

Data Analysis of Population Forecasting

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.996791332
R Square	0.993592959
Adjusted R Square	0.992881066
Standard Error	36.48814668
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1858220.082	1858220.08	1395.70469	3.49848E-11
Residual	9	11982.46364	1331.38485		
Total	10	1870202.545			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-253824.6273	6982.378288	-36.352174	4.4672E-11	-269619.8643	-238029.39	-269619.864	-238029.39
Population	129.9727273	3.479008281	37.3591313	3.4985E-11	122.1026638	137.842791	122.1026638	137.8427908

Data Analysis of GDP Forecasting

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.992989812
R Square	0.986028767
Adjusted R Square	0.984476408
Standard Error	1164772.97
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	8.61747E+14	8.6175E+14	635.180813	1.17174E-09
Residual	9	1.22103E+13	1.3567E+12		
Total	10	8.73958E+14			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-5561510247	222891164.2	-24.951686	1.2808E-09	-6065725089	-5.057E+09	-6065725089	-5057295404
GDP	2798940.243	111056.7451	25.2027938	1.1717E-09	2547712.432	3050168.1	2547712.432	3050168.054

Data Analysis of Total Throughput BCT with Population and GDP

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.976233706
R Square	0.953032249
Adjusted R Square	0.941290311
Standard Error	5508.805072
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	4926206658	2463103329	81.1648183	4.8663E-06
Residual	8	242775466.6	30346933.32		
Total	10	5168982125			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-90805.06942	241337.0918	-0.37625824	0.716507451	-647329.4007	465719.2618	-647329.401	465719.2618
Population(000)	7.974561935	54.19333649	0.14715023	0.886654293	-116.995496	132.9446199	-116.995496	132.9446199
GDP (000)	2.006130724	2.506946325	0.80022883	0.446688174	-3.774897863	7.787159311	-3.77489786	7.787159311

Appendix 2 : Berth Capacity Analysis

CALCULATION OF BERTH CAPACITY
2013 - 2030

Description	Formula	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Container Throughput	A	TEUs/year	118,038	124,989	131,985	139,028	146,117	153,252	160,433	167,660	174,933	182,252	189,618	197,029	204,486	211,989	219,539	227,134	227,134	242,461
Load/Unload per ship (Cs)	B	box/ship	348	348	348	348	348	348	348	348	348	348	348	348	348	348	348	348	348	348
Ship Call per year (Sc)	C=A/B	ship call	339	359	379	400	420	440	461	482	503	524	545	566	588	609	631	653	653	697
Average Quay Crane Productivity	D	B/C/H	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Number of QCC	E	Unit	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
TEU factor	F		1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Total QC Productivity	G=DxE	Box	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
Max Working hour	H=(5x3x7x52)	Hour	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460
QC capacity/berth capacity	*I=GxH*	box/year	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080	262,080
		teus/year	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288	288,288
Berth Required																				
QC Productivity per Ship (Qp)	J=G/2	Box	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Effective Time	K=B/J	Hour	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Non Operating Time	L=(M+N+O+P)	Hour	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
-Load/Unload preparation	M	Hour	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
-Shift change	N	Hour	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
-Break	O	Hour	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Idle Time	P	Hour	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Berthing Time per ship	Q=K+L+P	Hour	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Berthing Time all ship a year	R=QxC	Hour	6,275	6,645	7,016	7,391	7,768	8,147	8,529	8,913	9,300	9,689	10,080	10,474	10,871	11,270	11,671	12,075	12,075	12,890
Berthing Time in day a year	S=R/24	Day	261	277	292	308	324	339	355	371	387	404	420	436	453	470	486	503	503	537
Working day a year	T	Day	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
BOR	U	%	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Berth Required	V=S/(T*U)	Unit	1	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
Lenght of each berth	W=LOA + 10%	M'	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
Lenght of Berth Required	*X= V x W*	*M'*	*117*	*233*	*233*	*233*	*233*	*233*	*233*	*233*	*233*	*233*	*233*	*233*	*350*	*350*	*350*	*350*	*350*	*350*
Lenght of Berth Available	*Y*	*M'*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*
Lack of Berth	*Z=Y-X*	*M'*	*149*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*(84)*	*(84)*	*(84)*	*(84)*	*(84)*	*(84)*

Appendix 3 : Yard Capacity Analysis

CALCULATION OF CY CAPACITY
(DWELLING TIME 7 DAYS)

Description	Formula	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Container throughput per year	A	TEUs	118,838	124,989	131,985	139,028	146,117	153,252	160,433	167,660	174,933	182,252	189,618	197,029	204,486	211,989	219,539	227,134	227,134	242,463
Operating Days of CY	B	Days	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
Dwelling Time	C	Days	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Ground slot existing	D	TEUs	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080
Average Stacking Height	F	Tier	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Land Utilisation	G	%	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Peaking Factor	H		1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Annual CY Capacity	*I = (DxFxGxB)/(CxH)*	*TEUs*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*	*121,292*

CALCULATION OF CY CAPACITY
(DWELLING TIME 5 DAYS)

Description	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Annual Container Throughput	TEU	118,838	124,989	131,985	139,028	146,117	153,252	160,433	167,660	174,933	182,252	189,618	197,029	204,486	211,989	219,539	227,134	227,134	242,463
Average dwell time	days	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Required Tgs	TEU	751	795	839	884	929	975	1,020	1,066	1,113	1,159	1,206	1,253	1,301	1,348	1,396	1,445	1,445	1,542
Required area	M^2	11,261	11,924	12,592	13,263	13,940	14,620	15,306	15,995	16,689	17,387	18,089	18,797	19,508	20,224	20,944	21,669	21,669	23,131
Shortage (or Surplus) of area	M^2	4,943	4,280	3,612	2,941	2,264	1,584	898	209	(485)	(1,183)	(1,886)	(2,593)	(3,304)	(4,020)	(4,740)	(5,465)	(5,465)	(6,927)
Ratio of area shortage (or surplus)	%	43.9%	35.9%	28.7%	22.2%	16.2%	10.8%	5.9%	1.3%	-2.9%	-6.8%	-10.4%	-13.8%	-16.9%	-19.9%	-22.6%	-25.2%	-25.2%	-29.9%

CALCULATION OF CY CAPACITY
(AREA REQUIREMENT)

Description	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Annual Container Throughput	TEU	118,838	124,989	131,985	139,028	146,117	153,252	160,433	167,660	174,933	182,252	189,618	197,029	204,486	211,989	219,539	227,134	227,134	242,463
Average dwell time	days	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Required Tgs	TEU	1,051	1,113	1,175	1,238	1,301	1,365	1,429	1,493	1,558	1,623	1,688	1,754	1,821	1,888	1,955	2,022	2,022	2,159
Required area	M^2	15,765	16,694	17,628	18,569	19,516	20,469	21,428	22,393	23,364	24,342	25,326	26,316	27,312	28,314	29,322	30,336	30,336	32,384
Shortage (or Surplus) of area	M^2	439	(490)	(1,424)	(2,365)	(3,312)	(4,265)	(5,224)	(6,189)	(7,160)	(8,138)	(9,122)	(10,112)	(11,108)	(12,110)	(13,118)	(14,132)	(14,132)	(16,180)
Ratio of area shortage (or surplus)	%	2.8%	-2.9%	-8.1%	-12.7%	-17.0%	-20.8%	-24.4%	-27.6%	-30.6%	-33.4%	-36.0%	-38.4%	-40.7%	-42.8%	-44.7%	-46.6%	-46.6%	-50.0%

average stacking height	4
utilisation factor	0.7
peaking factor	1.3
yard area for 20' equivalent GS	15
current CY area	16,204
working days	365

Annual CY throughput (Cc) = (Tgs x H x U x K) / (DT x PF)

Appendix 4 : Berth Capacity Analysis based on GDP 9.5%

CALCULATION OF BERTH CAPACITY 2013 – 2030
(BASED ON GDP GROWTH 9.5%)

Description	Formula	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Container Throughput	A	TEUs/year	131,904	139,388	146,918	154,495	162,117	169,785	177,500	185,260	193,067	200,919	208,818	216,763	224,753	232,790	240,873	249,002	249,002	265,398
Load/Unload per ship (Cs)	B	box/ship	348	348	348	348	348	348	348	348	348	348	348	348	348	348	348	348	348	348
Ship Call per year (Sc)	C=A/B	ship call	379	401	422	444	466	488	510	532	555	577	600	623	646	669	692	716	716	763
Average Quay Crane Productivity	D	B/C/H	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Number of QCC	E	Unit	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
TEU factor	F		1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Total QC Productivity	G=DxE	Box	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
Max Working hour	H=(5x3x7x52)	Hour	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460
QC capacity/berth capacity	*I=GxH*	*box/year*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*
		teus/year	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*
Berth Required																				
QC Productivity per Ship (Qp)	J=G/2	Box	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Effective Time	K=B/J	Hour	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Non Operating Time	L=(M+N+O)	Hour	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
-Load/Unload preparation	M	Hour	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
-Shift change	N	Hour	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
-Break	O	Hour	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Idle Time	P	Hour	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Berthing Time per ship	Q=K+L+P	Hour	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Berthing Time all ship a year	R=QxC	Hour	6,633	7,009	7,388	7,769	8,152	8,538	8,926	9,316	9,709	10,104	10,501	10,900	11,302	11,706	12,113	12,522	12,522	13,346
Berthing Time in day a year	S=R/24	Day	276	292	308	324	340	356	372	388	405	421	438	454	471	488	505	522	522	556
Working day a year	T	Day	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
BOR	U	%	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Berth Required	V=S/(T*U)	Unit	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
Lenght of each berth	W=LOA + 10%	M'	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
Lenght of Berth Required	*X= V x W*	*M'*	*233*	*233*	*233*	*233*	*233*	*233*	*233*	*233*	*233*	*233*	*233*	*350*	*350*	*350*	*350*	*350*	*350*	*350*
Lenght of Berth Available	*Y*	*M'*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*
Lack of Berth	***Z=Y-X***	***M'***	***33***	***33***	***33***	***33***	***33***	***33***	***33***	***33***	***33***	***33***	***33***	***(84)***	***(84)***	***(84)***	***(84)***	***(84)***	***(84)***	***(84)***

CALCULATION OF CONTAINER YARD CAPACITY 2013 – 2030
(BASED ON GDP GROWTH 9.5%)

Description	*Unit*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*2025*	*2026*	*2027*	*2028*	*2029*	*2030*
Annual Container Throughput	TEU	131,904	139,388	146,918	154,495	162,117	169,785	177,500	185,260	193,067	200,919	208,818	216,763	224,753	232,790	240,873	249,002	249,002	265,398
Average dwell time	days	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Required Tgs	TEU	1,174	1,241	1,308	1,376	1,444	1,512	1,580	1,650	1,719	1,789	1,859	1,930	2,001	2,073	2,145	2,217	2,217	2,363
Required area	M^2	17,617	18,617	19,623	20,635	21,653	22,677	23,707	24,744	25,786	26,835	27,890	28,951	30,018	31,092	32,171	33,257	33,257	35,447
Shortage (or Surplus) of area	M^2	(1,413)	(2,413)	(3,419)	(4,431)	(5,449)	(6,473)	(7,503)	(8,540)	(9,582)	(10,631)	(11,686)	(12,747)	(13,814)	(14,888)	(15,967)	(17,053)	(17,053)	(19,243)
Ratio of area shortage (or surplus)	%	-8.0%	-13.0%	-17.4%	-21.5%	-25.2%	-28.5%	-31.6%	-34.5%	-37.2%	-39.6%	-41.9%	-44.0%	-46.0%	-47.9%	-49.6%	-51.3%	-51.3%	-54.3%

Appendix 5 : Berth Capacity Analysis based on Bigger Call Size

CALCULATION OF BERTH CAPACITY 2013 – 2030
(BASED ON CALL SIZE)

Description	Formula	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Container Throughput	A	TEUs/year	198,304	209,981	221,736	233,568	245,477	257,464	269,528	281,669	293,888	306,184	318,558	331,009	343,537	356,142	368,825	381,586	394,423	407,338
Load/Unload per ship (Cs)	**B**	**box/ship**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**	**696**
Ship Call per year (Sc)	C=A/B	ship call	285	302	319	336	353	370	387	405	422	440	458	476	494	512	530	548	567	585
Average Quay Crane Productivity	D	B/C/H	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Number of QCC	E	Unit	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
TEU factor	F		1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Total QC Productivity	G=DxE	Box	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
Max Working hour	H=(5x3x7x52)	Hour	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460	5,460
QC capacity/berth capacity	*I=GxH*	*box/year*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*	*262,080*
		teus/year	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*	*288,288*
Berth Required																				
QC Productivity per Ship (Qp)	J=G/2	Box	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Effective Time	K=B/J	Hour	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Berthing Time per ship	Q=K+L+P	Hour	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Berthing Time all ship a year	R=QxC	Hour	9,117	9,654	10,195	10,739	11,286	11,837	12,392	12,950	13,512	14,077	14,646	15,219	15,795	16,374	16,957	17,544	18,134	18,728
Berthing Time in day a year	S=R/24	Day	380	402	425	447	470	493	516	540	563	587	610	634	658	682	707	731	756	780
Working day a year	T	Day	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
BOR	U	%	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Berth Required	V=S/(T*U)	Unit	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4
Lenght of each berth	W=LOA + 10%	M'	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132
Lenght of Berth Required	*X= V x W*	*M'*	*264*	*264*	*264*	*264*	*396*	*396*	*396*	*396*	*396*	*396*	*396*	*528*	*528*	*528*	*528*	*528*	*528*	*528*
Lenght of Berth Available	*Y*	*M'*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*	*266*
Lack of Berth	***Z=Y-X***	***M'***	***2***	***2***	***2***	***2***	***(130)***	***(130)***	***(130)***	***(130)***	***(130)***	***(130)***	***(130)***	***(262)***	***(262)***	***(262)***	***(262)***	***(262)***	***(262)***	***(262)***

CALCULATION OF CONTAINER YARD CAPACITY 2013 – 2030
(BASED ON CALL SIZE)

Description	*Unit*	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Annual Container Throughput	TEU	198,304	209,981	221,736	233,568	245,477	257,464	269,528	281,669	293,888	306,184	318,558	331,009	343,537	356,142	368,825	381,586	394,423	407,338
Average dwell time	days	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Required Tgs	TEU	1,766	1,870	1,974	2,080	2,186	2,292	2,400	2,508	2,617	2,726	2,836	2,947	3,059	3,171	3,284	3,398	3,512	3,627
Required area	M^2	26,486	28,045	29,615	31,196	32,786	34,387	35,999	37,620	39,252	40,894	42,547	44,210	45,883	47,567	49,261	50,965	52,680	54,405
Shortage (or Surplus) of area	M^2	(10,282)	(11,841)	(13,411)	(14,992)	(16,582)	(18,183)	(19,795)	(21,416)	(23,048)	(24,690)	(26,343)	(28,006)	(29,679)	(31,363)	(33,057)	(34,761)	(36,476)	(38,201)
Ratio of area shortage (or surplus)	%	-38.8%	-42.2%	-45.3%	-48.1%	-50.6%	-52.9%	-55.0%	-56.9%	-58.7%	-60.4%	-61.9%	-63.3%	-64.7%	-65.9%	-67.1%	-68.2%	-69.2%	-70.2%