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Stacking yard expansion planning in development country

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STACKING YARD EXPANSION PLANNING IN DEVELOPING COUNTRY

(Case Study in Tanjung Priok Multipurpose Terminal, Jakarta-Indonesia)

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 Dissertation: **Stacking Yard Expansion Planning in Developing Country (Case Study in Tanjung Priok Multipurpose Terminal, Jakarta-Indonesia)**

Degree: **Master of Science in International Transport and Logistics**

To accommodate the flow of ships and goods, the port is expected to have adequate facilities, both infrastructure and cargo handling equipment. The aims of this research are to observe possibility for Tanjung Priok Multipurpose Terminal to expand their container stacking yard in the limitation of port area to overcome the threat of congestion and determine appropriate equipment handling for better port services with operational and financial view as basis of assessment.

This study is started from analyzing the current condition of port facilities and previous annual container throughput, predict the future container throughput by time series forecasting method, then observe what options port has in order to expand stacking yard capacity. The next steps are creating general engineering cost estimation for investment of infrastructure and container handling equipment with considering financial assessment.

The result of study indicates that port has an option to add their stacking yard capacity about 647,691 Teus/year to accommodate container yard demand in the next three years. To maintain port service quality, it is suggested to facilitate the yard with 5 units of RMGC and 1 unit of Reach Stacker. From the financial appraisal point of view, yard expansion plan project is feasible to be executed because it have NPV value about IDR.484,000,516,773.58, IRR and ROI about 27.02% and 20.05% and 4 years payback period.

Keywords: yard expansion, forecasting, handling equipment, financial assessment

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LIST OF ABBREVIATIONS

ACF	Auto Correlation Function
ARMA	Auto Regressive Moving Average
EBIT	Earning Before Interest and Tax
GDP	Gross Domestic Product
IPC	Indonesia Port Corporation
IRR	Internal Rate of Return
KPI	Key Performance Indicator
MSE	Mean Square Error
NPV	Net Present Value
OPEX	Operating Expenses
PACF	Partial Auto Correlation Function
QC	Quay Container Crane
RMGC	Rail Mounted Gantry Crane
RMSE	Root Mean Square Error
ROI	Return of Investment
RS	Reach Stacker
RTGC	Rubber Tire Gantry Crane
TEUs	Twenty Equivalent Units
UNCTAD	United Nations Conference on Trade and Development
YC	Yard Capacity
YOR	Yard Occupancy Ratio

CHAPTER I
INTRODUCTION

1.1. Background

Indonesia is an archipelago of which have thousand islands connected by sea. Moreover, the strategic position of Indonesia between east bond and west bond shipping routes give a lot of benefits for Indonesia merchant trade. Almost 90% of world merchant's trades transported by sea[1] and 85% of Indonesian's trades transported by sea. Therefore, port becomes necessary node in trade and distribution of goods. One of the government's efforts to support the seaborne trade is providing the adequate port to accommodate the growth of export and import activity in Indonesia.

The economic growth of Indonesia and acceleration of world cargoes throughput in the last decade make the ports must be able adapt to change. A Port as a service provider should afford to give the best services. Low performance port will affect the economy and industrial growth in Indonesia which can lead for declining competitiveness of Indonesian product abroad. The problems of cargo flow in port will boost the cost of product and it will be charged to consumers. One of indicator in good performance port measured from the regularity of flow of ships and goods in port so it does not cause ship delay and cargo congestion which can influence high cost economy in port.

Nowadays, Port of Tanjung Priok also face the dynamic process of increasing the traffic both ships and cargoes. The goods traffic unloaded and loaded in such port is increasing higher each year. In container throughput for example, the TEUs of containers were recorded at 3.8 million TEUs in 2009, 4.7 million TEUs in 2010 and

1. Review Maritime Transport 2011, UNCTAD

5.8 million TEUs in 2011 or growing by 20% on annual basis[2]. These containers totally are handled by Tanjung Priok Multipurpose Terminal, Jakarta International Container Terminal (JICT), Koja Container Terminal, and Multi Terminal Indonesia (MTI).

Source: Google Earth

Figure 1.1. General layout of Tanjung Priok Port

To accommodate the dynamic process in port, Tanjung Priok Multipurpose Terminal prepares to re-arrange the port. The improving services and facilities of infrastructure and supra-structure at port of Tanjung Priok have been driven in line with Tanjung Priok's vision to become a modern port capable of competing at global level. The synergy of all stakeholders at the port to improve the level of service and productivity has resulted in the trust given by international shipping operators to utilize the facilities of Tanjung Priok port. The Company continues maximizing its port service capacity by doing facility investment.

2. Annual Report 2011, Indonesia Port Corporation (IPC)

1.2. Research Problem

The area of Tanjung Priok Port consists of dedicated terminal. Many terminal operators in Tanjung Priok are Tanjung Priok Multipurpose Terminal, Jakarta International Container Terminal (JICT), Koja Terminal Container, and Multi Terminal Indonesia (MTI). These companies are subsidiaries of Indonesia Port Corporation (IPC), a state owned company in port operation.

As ports in developing country which have dynamic process, Tanjung Priok Multipurpose Terminal also face some problems that create low performance services such as congestion of goods, limitation of facility and infrastructure, administration, and cargo manifest. In case of congestion, this problem not only occur inside the port, but also outside the port that causing delays in delivery of goods, increasing ship waiting time in port, and postpone in cargo handling.

These conditions make the ship owner and cargo owner prefer to use services of competitors port in Singapore and Malaysia, and only use Tanjung Priok Port as a feeder port. One of the trigger in goods congestion in port is limitation of stacking yard. Enhancement of container throughput in Tanjung Priok Multipurpose Terminal raises the ratio of yard occupancy. To overcome the problem, port managements have to prepare expansion of stacking yard in port area.

1.3. Restrictions

Because of magnitude of the problem, the research considers to restrict the discussion for sharpening the analysis into:

a. Object of study is Tanjung Priok Multipurpose Terminal.
b. Tanjung Priok Multipurpose Terminal consists of 3 Terminals. All terminals handle multi cargoes, such as dry bulk, liquid bulk, and containerized cargoes. This research only focuses on container cargo.

c. Stacking yard expansion planning concern inside the line 1 of terminal (Line 1 is the area inside the port that have direct access to the berth and stevedoring activity)
d. Yard expansion planning research excluding container yard layout and arrangement
e. Sources of the primer data come from Tanjung Priok Multipurpose Terminal

1.4. Expected Contribution

The purpose of this research is to create alternative expansion of container stacking yard in the limitation of port area and determine appropriate equipment handling for better port services with operational and financial view as basis of assessment. This is important not only to reduce the threat of congestion especially inside the port, but also contribute new profit of port in the next few years. This research is expected to be a reference for plan arrangement of port by port company and stakeholders.

1.5. Structure of Thesis

To make a comprehensive report, the author divides the report into several chapters as follows:

CHAPTER 1: INTRODUCTION
This chapter will deliver to the main problem that will be observed, that are background, research problem, restrictions, expected contribution, and structure of research.

CHAPTER 2: LITERATURE REVIEW
This chapter discusses several literatures and findings related to this research. According to this review will then be developed a conceptual framework for the study.

CHAPTER 3: RESEARCH METHODOLOGY

This chapter leads to the stage of research to become a guide for approaching the problem. So that, the study will produce comprehensive observation and reasonable recommendation to solve the problem

CHAPTER 4: DATA COLLECTION AND ANALYSIS

This chapter concerns to the data acquisition, processing, and interpretation. The observation result in this chapter will be a suggestion to solve the problem

CHAPTER 5: CONCLUSION AND RECCOMENDATION

This chapter will conclude the result of the research and issue some related suggestion to be a reference for stakeholder to develop better port.

CHAPTER II
LITERATURE REVIEW

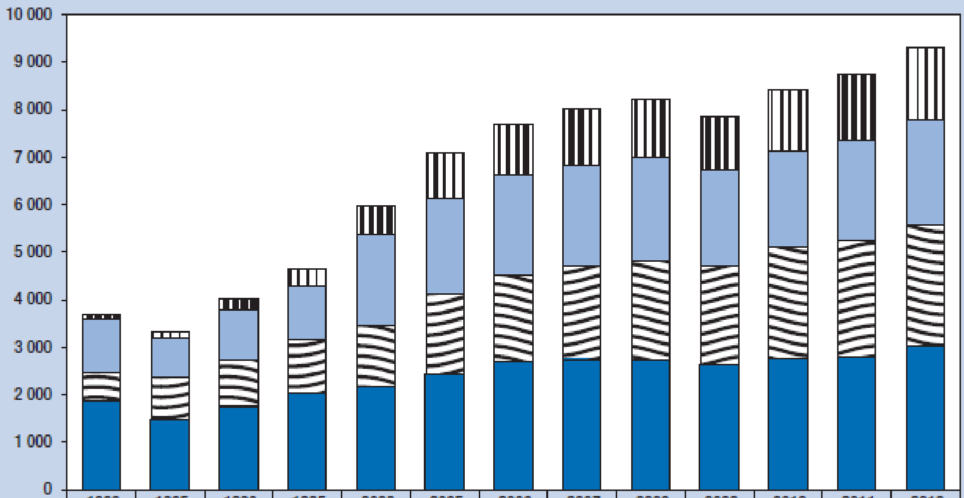
In this chapter, some literatures that support the decision making of this research project are provided in order to highlight the importance of previous findings in the field of multipurpose terminal operation and other important aspects, namely multipurpose terminal operation, zoning terminal layout, container stacking yard capacity, and equipments. Following, related findings in stacking yard expansion will be presented, as well as the operational consequences after implementation. In the end, The author will provide some financial analyses that should be carried out in making decision of investing in an expansion project.

2.1. Multipurpose Terminal Operation

Multipurpose Terminal is commercial port that serving the costumers with multi services activities, especially in handling of various cargoes, namely dry bulk cargo, liquid cargo, vehicle/automobile, container cargo, and including passenger terminal. Agos et.al (1991) in UNCTAD Monograph on Port Management defined as a complex infrastructure, equipment, and services that offer a combined and flexible response to the servicing demand of certain type of vessel and cargo, permitting the optimum utilization of man power and equipment. Other definition comes from Whitaker et.al (2000). He explained that Multipurpose Terminal generally refers to a facility handling commodities that range between container and bulk operations. Cargoes handled on such a terminal could include the full range of forest product, steel, project cargoes, break bulk general cargo, ro-ro cargo, and containerized cargo. On general cargo terminals, cargo is handled by differing methods. The cargo may be in the form of cartons, cases, drums, sacks, packages, bundled, pallets or units. The ship that engaged in such trades are relatively small freighters. The will be equipped with derricks or cranes with sufficient capacity to handle most of the cargo that they are required to carry. Bulk cargoes might be handled by fixed or portable pneumatic equipment. Warehouses on the terminals are mostly used for general cargo products that may perishif exposed to rain. In addition to the weather, protection is required from vandalism, pilferage and contamination from any source, including birds or animals.

In the evolution, package model of seaborne trade cargo changes to bigger unit to raise the efficiency of good delivery. The popular method of unitize cargo is container. Since their introduction in the 1960s, containers represent the standard unit load concept for international freight. As globally acting industrial companies have considerably increased their production capacities in Asian countries, the container traffic between Asia and the rest of the world has steadily increased (cf. Wang 2005). For instance, from 1990 to 1996, the total container traffic volume between Europe and Asia doubled, whereas in the same period the total container flow between Europe and the Americas went up by only 10%. The gradual shift from conventional package to containerization brought about a fundamental change in development of port as well as site selection. Containerized transportation has substantially changed port dynamics to give priority and provide more facilities for container cargo and container ship without ignoring the other various cargoes.

Containerization has numerous advantages. First, containerization offer safety by significantly reducing loss and damage, since the content of container cannot easily be modified unless at origin or destination. It is worth mentioning in this respect that safety level of the container is currently being significantly increased by electronic sealing and monitoring to address preoccupations with terrorist treat, illegal immigration, and smuggling. Second, due to standard structure, transfer operation at terminal is fast and performed with minimal amount of effort. This result reduced cargo handling, and thus a speed up operations not only at the terminal, but also through the whole transport chain. Third, containers are flexible enough to enable the transport of product of various type and dimension. Fourth, containerization enables a better management of transported goods. Due to the reasons, the use of container significantly decrease the transport cost (Bektas et al 2007).



	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Container	102	152	234	371	598	969	1 076	1 193	1 249	1 127	1 275	1 385	1 498
Other dry cargo	1 123	819	1 031	1 125	1 928	2 009	2 112	2 141	2 173	2 004	2 027	2 090	2 219
Five major bulks	608	900	988	1 105	1 295	1 709	1 814	1 953	2 065	2 085	2 335	2 477	2 547
Oil and gas	1 871	1 459	1 755	2 050	2 163	2 422	2 698	2 747	2 742	2 642	2 772	2 796	3 033

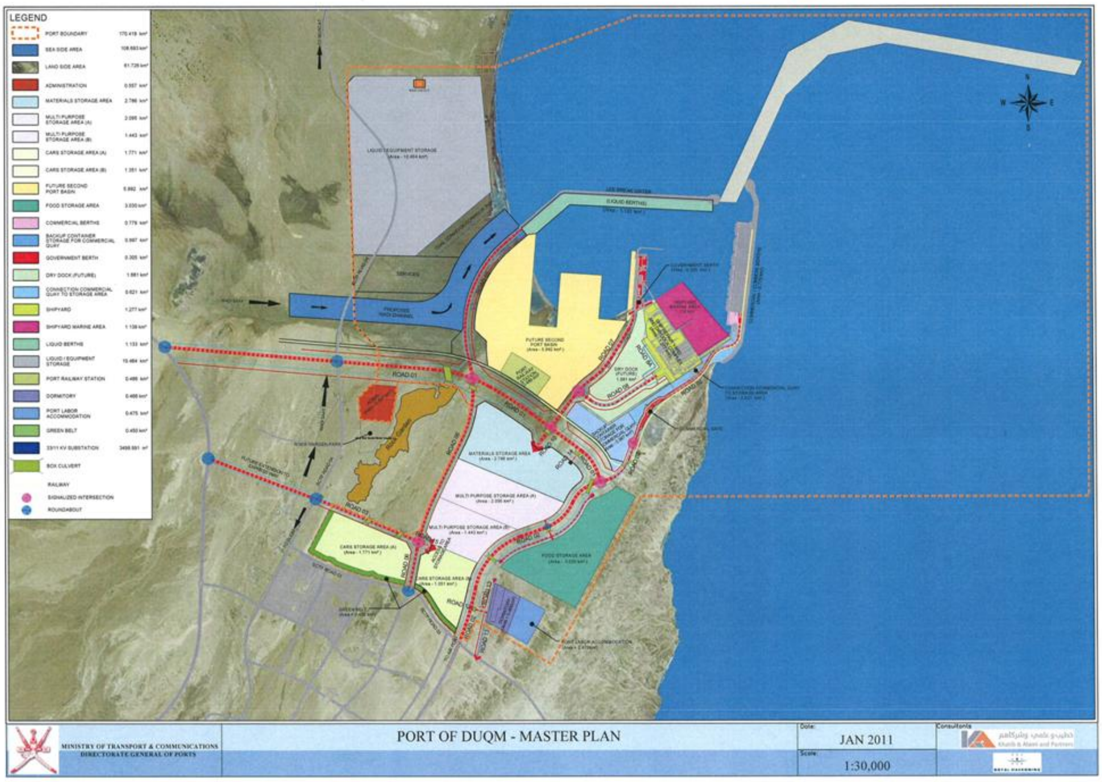
Source: Review maritime transport 2012 UNCTAD

Figure 2.1. International seaborne trade, selected years (millions of tons loaded)

2.2. Master planning and Port Zoning

Generally, the main principle of port planning is the long term commitment to serve and handle for increasing of cargo throughput possibility. So that, traffic of the ships and cargoes will not become problem in the future. According to Albanese (2012) in Speech to Ports Australia Biennial Conference – Adelaide, port master plans help clarify and communicate the port vision. They also provide a strategic framework for port authorities to consider a range of internal and external factors that may impact on current and/or future operation. In Regional Balkans Infrastructure Study Report (2003) stated that the land using of plan focuses principally on improvements of the efficiency of port operations and presents several staged layouts on the basis of development scenarios.

Almost every commercial port has zoning for land use plan and operation to accommodate many kinds of cargo flow to the port. Port need to divide the port area into specialized zones has resulted from the demand for increased productivity at each terminal. Where the volume of traffic is too small to justify a separate terminal for each kind. or where uncertainty as to the form of future traffic does not justify a specialized terminal, the answer can be a multipurpose terminal. In general terms the port will consist of the separate zones (Port Development Handbook UNCTAD, 1985).



Source: www.portduqm.com

Figure 2.2. Example zoning of Duqm Port, Oman

2.3. Container Stacking Yard

Storage area is one of the primary facilities that have to be owned by a port to support its function as transit point and distribution. This is a temporary storage of cargoes while documentary, administrative and other formalities are completed (Guler, 2002). There are two types of storage area in multipurpose port, namely close storage (warehouse/shed) and open storage (yard). Generally, warehouse/shed is used to keep small unitize cargo, pallet cargo, and others cargo which need to be protected from weather disturbances. In addition, yard is used to locate container and others cargo which have resistance over the weather. Warehouse and yard for transshipment usually located near from the quay, whilst for stacking located in inland area.

2.3.1. Stacking yard configuration

A very important issue when optimize port efficiency concerns storage and movement in the yard (Tranberg, 2005). Chen and Zhaohui Fu (2004) clarified that storage is an important constraining factor in logistics management for many ports. Factors that impact terminal storage capacity include stacking heights, net storage area available, storage density (containers per acre), and dwelling times. In storage yard, containers are stacked by yard cranes side by side and one on top of another to form rectangular shape heaps called blocks, each of which consists of a number of rows in width, a number of bays in length and a number of tiers in height (Chen et.al, 2005). There are two ways in handling container on the stacking yard. First, by putting on the chassis and second, by stacking on the ground. Chassis system could be accessed easily but this system needs more spacious area. On the other hand, stacking on the ground system could not be accessed directly and spacious area is not needed. Nowadays, stacking on the ground system are preferred because the area of the container yard is limited. (Iris F.A. Vis, Rene de Koster, 2002).

Using Analytical Hierarchy Process (AHP)[3], Golbabaie et.al (2010) designed stacking yard configuration of container become three alternative models. The first model locates the container at parallel direction with the berth.

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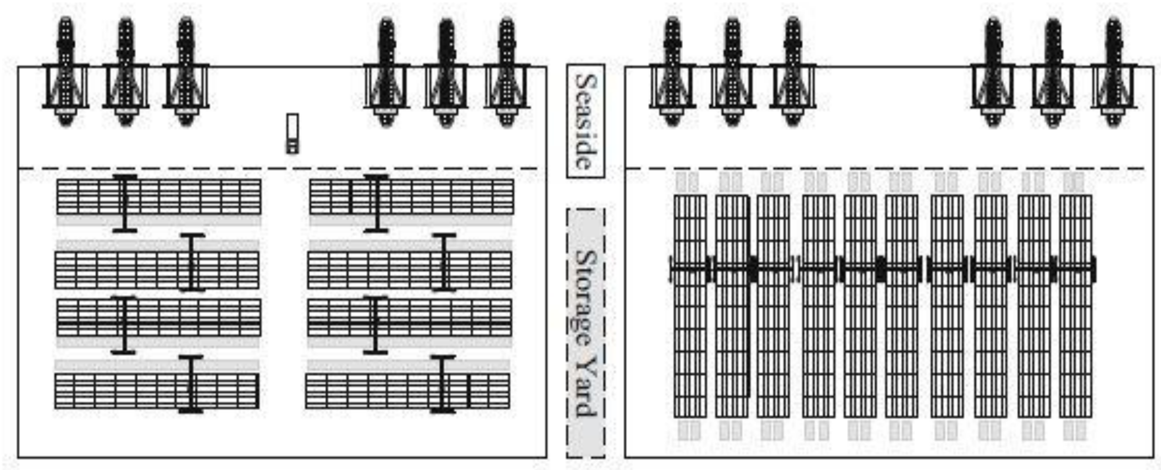
3. The output of this method is a prioritized ranking of the decision making alternatives based on the overall preferences expressed by the decision maker.

All horizontal roads of this layout are 2-lane ones and unidirectional except the berth one, which is bidirectional. All vertical roads are only used for the transit of vehicles not for loading and unloading. The second model configuration allows the container to stack in perpendicular layout. All vertical roads are bidirectional and used for loading and unloading of vehicles and are also used as transit roads. The roads in this layout provide a faster access to the mentioned cells. The third alternative is modification from perpendicular layout. In layout III the vehicles will not move into the vertical roads because roads can be eliminated or lessened in favor of more stacking capacity. They will be loaded or unloaded at the seaside tail of the stacks i.e. the stacking cranes have to travel along the stacks to load or unload.



Source: wiese et.al (2011)

Figure 2.3. Parallel layout with transfer lanes and perpendicular layout with transfer points

2.3.2. Stacking yard performance

The parameter is made to measure the utilization level of stacking yard facilities through Key Performance Indicator (KPI) such as Stacking Yard Capacity and Yard Occupancy Ratio. Stacking Yard Capacity is measured with analyzing a number of cargoes/containers that utilize stacking yard facility in a certain period of time (per month or per year) either they enter the ports through the sea (unloading) or they enter from the mainland (loading). Misliah et.al (2012) proposes the formula to calculate Yard Capacity (Teus/year) as follow:

$$yard\ capacity = \frac{effective\ \ area\ \ x\ number\ \ of\ \ stacking\ \ x\ number\ \ of\ \ day\ \ in\ a\ year}{container\ \ \ area\ \ x\ stacking\ \ duration} \qquad (2.1)$$

Effective area is total area of stacking yard minus broken stowage, a loss area of yard which used for other activities, such as access road and space between containers in stacking yard. The value of broken stowage is 25-50% depend on container handling method.

Storage Occupancy Ratio (SOR)/Yard Occupancy Ratio (YOR) is a ratio between stacking area utilization (ton day or m^3 day) and effective stacking capacity. Mapparanga et.al (2013) defined the formula to calculate Yard Occupancy Ratio as follow :

$$YOR = \frac{capacity\ \ used\ \ (\frac{TEUS}{year})}{capacity\ \ available\ \ (\frac{TEUS}{year})}\ x\ 100\% \qquad (2.2)$$

According Kim and Han (2007), large container terminals in Europe store a total of several 10,000 containers with average dwell times of 3-5 days and daily turnover of 10-20,000 containers. The storage area is separated into blocks, which are organized into bays, rows and tiers. Policies for assigning individual storage locations and stacking of containers are ruled by the objective to expedite the necessary storage and retrieval operations as far as possible and to avoid reshuffling of containers within the block. Specific issues include the reservation of dedicated storage areas for import and export containers and the planning of remarshalling operations for stacked containers. By J. A. Ottjes et al (2007), dwell time was defined as the total time a container spends in one or more terminal stacks. Several factors may influence container dwell times, such as time tables and availability of hinterland connections, the influence of custom regulations, and typical supply-chain related influences, such as the time the container owner decides to fetch his imported containers or to supply his containers for export.

2.4. Yard Container Handling Equipment

Escalation of container cargo flow requires appropriate handling method and equipment in container yard to acquire optimal services. In general terms, each part of terminal have seaside and landside that supported by different characteristics of container handling systems. This is described as open systems of material flow with two external interfaces. These interfaces are the quayside with loading and unloading of ships, and the landside where containers are loaded and unloaded on/off trucks and trains. Containers are stored in stacks thus facilitating the decoupling of quayside and landside operation (steenken et al, 2004). According to Brinkman (2011), the layout and choice of equipment for the above mentioned areas and their interfaces depend on, amongst others, the number of containers to be handled, available area and mode of hinterland transport. The combination of terminal equipment used is called operation system are at the vessel for transport tasks between quay and stacking yard (or vice versa), for container stacking, for transport from stacking yard to and from the landside operation area and for landside operation itself. Wiegmans (2003) categorized the following four forms of handling system:

1. mechanized systems, that use a wide range of manual handling equipments and, therefore, labor constitutes a high percentage of overall cost;
2. automated systems, which aims at minimizing labor as much as possible by substituting capital investment in handling equipment;
3. semi automated systems, which are systems that use automated equipments while the remainder of the handling is carried out mechanically (for example, a use of Automated Guided Vehicles (AGV) and Automated Stacking Crane (ASC) which are unmanned together with Quay Cranes (QC) which are manned;
4. information-directed systems, that use computers to maximize control over mechanized handling equipments

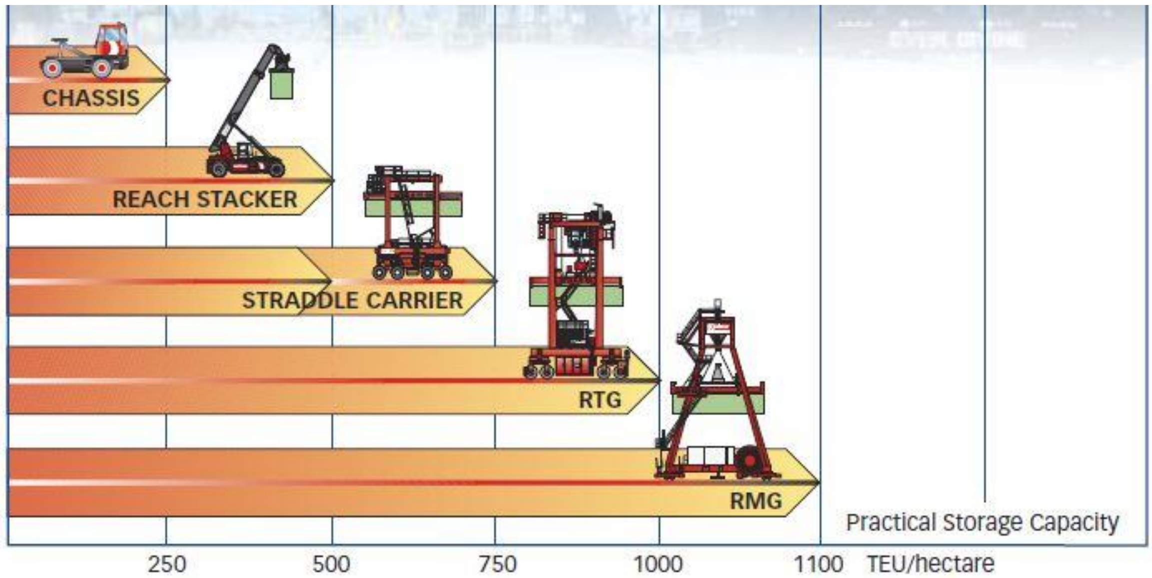
The popular equipment in stacking yard is gantry crane. Those are Rubber-Tyred Gantry cranes (RTG) and Rail-Mounted Gantry cranes (RMG). Carteni & Luca (2010) described that crane type usually consists of three separate movements for container transportation. The first movement is performed by the hoist, which raises and lowers the container. The second is the trolley gear, which allows the hoist to be positioned directly above the container for placement. The third is the gantry, which allows the entire crane to be moved along the working area. In addition, *A*utomated Rail-Mounted Gantry Cranes (RMGC) are newly used in container terminals. A survey of 114 terminals all over the world focused on large seaside container terminals published by Wiese et al (2009) shows that the most popular yard equipment is the RTG system used in 63.2% of the terminals.

Table 2.1. Terminal yard equipment statistics

Yard Equipment	Frequency	%	Main region	Frequency in region
RTG	72	63.2%	Asia	40
SC	23	20.2%	Europe	15
A-RMG	7	6.1%	Europe	6
Wheeled	2	1.8%	America	2
RTG / SC	2	1.8%	Asia	2
Reachstacker	2	1.8%	Europe	1
RTG / RMG	2	1.8%	Europe	1
automated SC	1	0.9%	Australia Pacific	1
RMG	1	0.9%	Asia	1
RTG / A-RMG	1	0.9%	Asia	1
OHBC	1	0.9%	Asia	1
Σ	114			

Source: wiese et al (2009).

To improve the stacking capacity of stacking yard, a use of Rail Mounted Gantry Crane (RMGC) is able to be good decision because such crane allows a much higher density of stacking. However, Compared to RTG (Rubber Tired Gantry), RMG is less flexible as RTG can switch from one stacking lane to another, however, changing from one stack lane to another is time consuming and, therefore, not done so often in practice (Meersmans and Dekker, 2001). In many cases, the other alternative, reach stackers, enable increased container storage, but increased storage density can affect the accessibility or selectivity of containers, which could then result in extra handling and reduced throughput of containers. Therefore, the key to making the right decision is to identify the specific application requirements and consider which equipment can best meet the demands of the operation. Kalmar[4] classified container handling equipment base on practical storage capacity as shown in figure below.



Source: Kalmar Container Handling System (complete range of product)

Figure 2.4. Practical storage capacity guide (TEU/ha)

2.5. Financial Review

Implementation of port development needs high investment cost. Therefore, there is an expectation to obtain the profits from port investment. Feasibility study is needed to describe about project worthiness from operational and financial point of views for minimizing useless cost in investment.

4. A Finn global supplier of heavy-duty material handling equipment and services in the container, trailer and heavy industrial sectors.

There are some investment criteria that can be implemented in a project, in order to ensure that the spending resources in investment will bring the best result in the future.

2.5.1. Net present value (NPV)

The net cash flows arising over time cannot be summed to calculate the return an investment will earn. This is because money has a time value. A sum of money held now usually worth more than an equal and certain sum to be paid in the future date because there is an opportunity to invest the money and obtain a return at the same time (Cariou, 2013). The net present value (NPV) is the sum of all net cash flows discounted using a specified discount rate. A project is accepted (rejected) if its NPV is positive (negative).

$$NPV = \sum_{i=0}^{n} \frac{A_i}{(1+r)^i} - C = 0 \qquad (2.3)$$

where:

n	project life
A_i	net cash flows at the end of year i
r	discount rate
C	initial capital expenditure

2.5.2. Internal rate of return (IRR)

An alternative approach to calculating the return on investment projects is the internal rate of return (IRR). Whereas the NPV method starts from a net cashflow in current terms and calculates the value today, IRR technique works out the discount rate which gives an NPV of zero (Stopford, 2009). IRR is an indicator for efficiency level of investment. Brealey et al (2004) argued that a project is recommended to be done if its rate of return exceed rate of return in different investment (eg : bank interest rate, obligation, etc). The relationship between IRR and NPV is formulated as follows:

$$NPV = \sum_{i=0}^{n} \frac{A_i}{(1+IRR)^i} - C = 0 \tag{2.4}$$

where:

n project life

A_i net cash flows at the end of year I

C initial capital expenditure

2.5.3. Return of investment

Besides NPV and IRR, some other criteria have their own advantages. The ROI (Return on Investment) method is often favorable in managerial decision as it is easy to understand. Understandably, a high ROI means a high return the company will get by investing in a project. The net income of the company, however, is not always a reliable measure of financial performance. Therefore, ROI might fail in determining the success of an investment (Niswari, 2004).

$$ROI = \frac{EBIT\ p.a}{Initial\ \ Capital\ \ Employed}\ x\ 100 \tag{2.5}$$

Where:

ROIt = Return on Investment on year -t

EBIT = Earning Before Interest and Tax

2.5.4. Payback period

Generally, payback period defines the length of time it takes to recover the cost of an investment. Simple payback period is the most widely used metric in capital budgeting. Determining the simple payback period can be useful if the main goal is quickly recapturing funds, or as a screening exercise to compare competing projects. Mills (1994) added that the payback period has an advantage over other methods because it is relatively simple to calculate, understand, and implement. Payback period is formulated:

$$Payback\ Period = \frac{Cost\ of\ Investment}{Annual\ \ Cashflow} \tag{2.6}$$

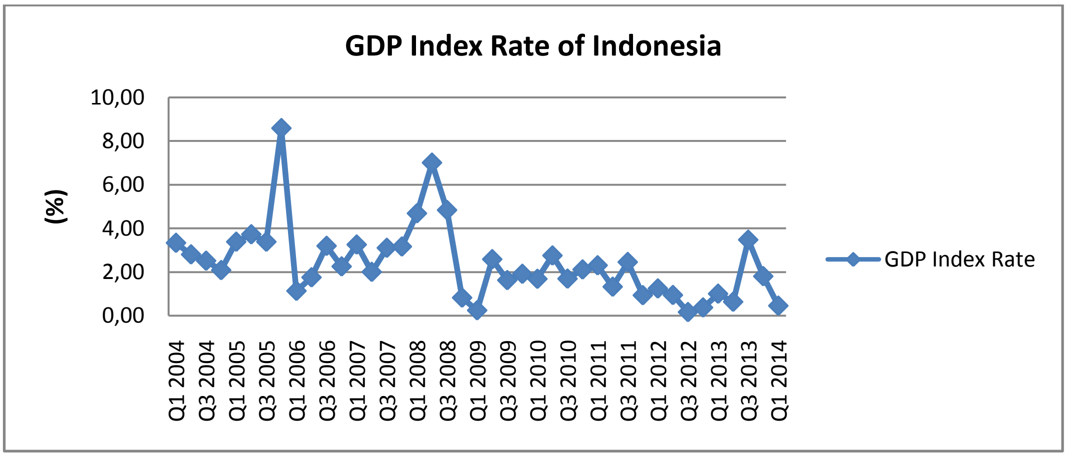
There is however some weaknesses in using the payback period as an assessment tool for an appropriate investment project. Firstly, the analysis does not consider any cash flows that arrive after payback period (Brealey et.al., 2004). Secondly, it does not consider the time value of the money (it gives equal weight to all cash flows). As a result of these weaknesses, payback period method could lead to a wrong investment decision. For example, a project with negative NPV can have the same (or shorter) payback period than a project with positive NPV.

2.5.5. Sensitivity analysis

Commonly, approximate calculation of project worthiness is different with expected result. This condition appears because of economic variables changeability which affecting the total cost or revenue prediction of investment. In the port sector, there are several independent variables of economic that give the direct impact to the port activities such as:

- Gross Domestic Product (GDP) of Indonesia

  Gross Domestic Product is defined as market value of goods and services which produced in a nation during certain period (often annually). GDP is the most noted economic statistics because it is considered as measurement of people's welfare. Consumption, investment, government purchasing, and export have positive correlation with GDP. Escalation of each component will increase GDP value. On the other hands, if import activity and its component have negative correlation with GDP. The changeability of GDP can affect trade capacity of a state which has direct impact to the port activity.

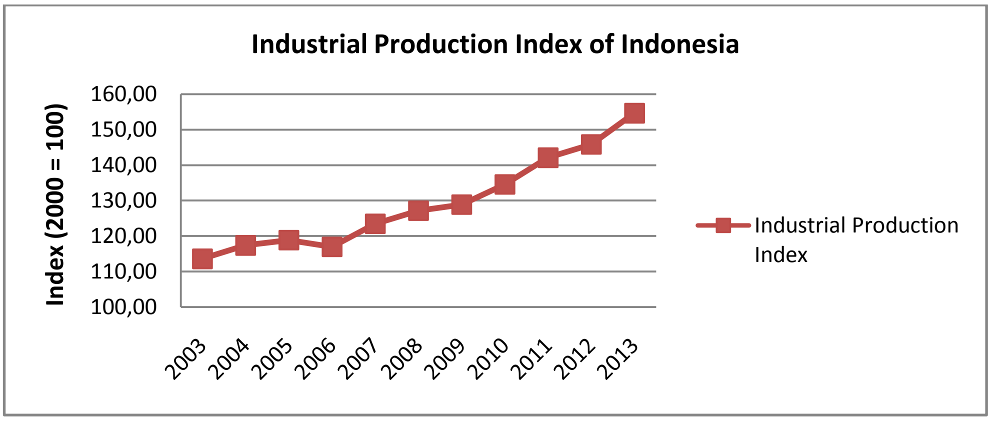


Source: Indonesia statistical bureau

Figure 2.5. GDP index rate of Indonesia (Quarter 1 2004 - Quarter 1 2014)

- Industrial Production Index of Indonesia

  Indonesia has developed industrial sector to fulfill domestic needs and export. Expanding industrial activities need huge import of raw material and industrial components. Beside that, Indonesia is the archipelago country whose port play important role in distribution of goods. About 4 big port in Indonesia listed in top 50 port in the world in term of container throughput.



Source: Indonesia statistical bureau

Figure 2.6. Industrial Production Index of Indonesia (2003 – 2013)

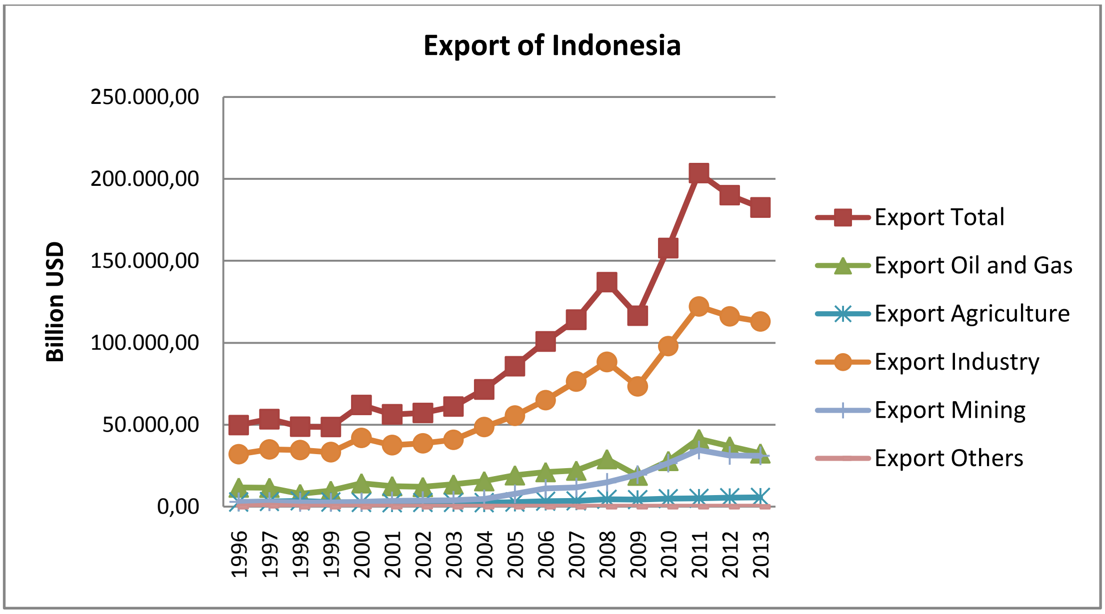
Figure 2.6 shows increasing trend of data gradually that represent industrial and production activities in Indonesia tend to rise so that it result good impact for domestic and international trade.

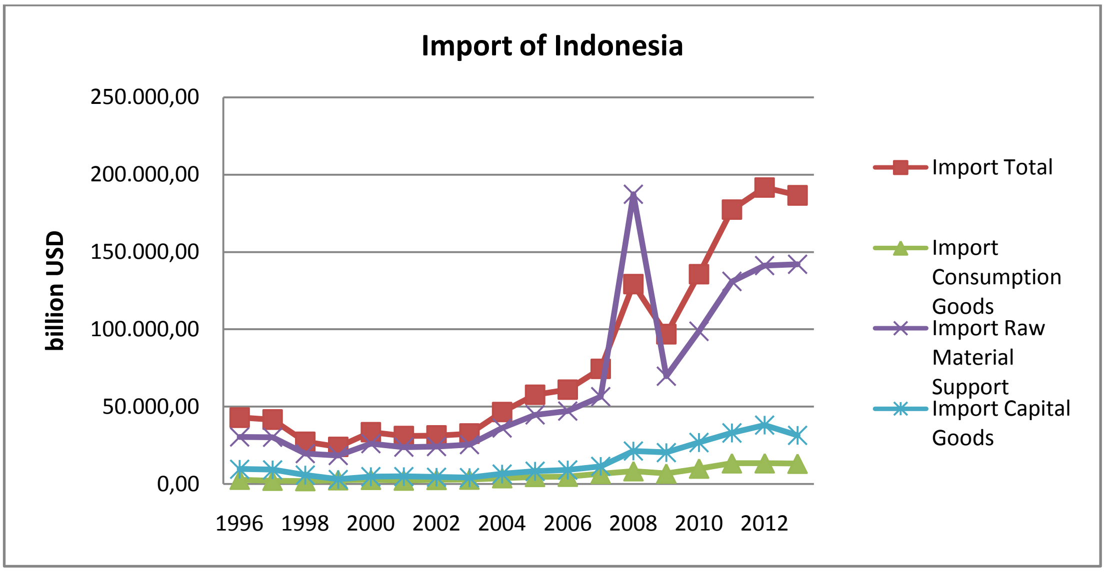
- Consumer Price Index of Indonesia (as an indicator of inflation)

  Consumer Price Index (CPI) is an index for measuring average price of goods and services which consumed by household. This index often used for surveying inflation level in a nation. Inflation cause continuous increasing of price related to market mechanism that created by strengthening purchasing power, excess liquidity in the market, including limitation of goods in the market. Inflation will make domestic price higher than the price of foreign products. This circumstance will increase import volume and reduce export volume, which further will lead to the deficit of reserve.

- Trade volume

  According to the Indonesian Trade Ministry, growth of Indonesian exports is likely to grow around 12% per year over last ten years (2004-2013) where export commodities are classified by oil and gas, agriculture, industry, mining, and other. Similarly, Indonesian import also increase about 21% per year over last ten years. This condition is predicted will keep the continuity of port activity.





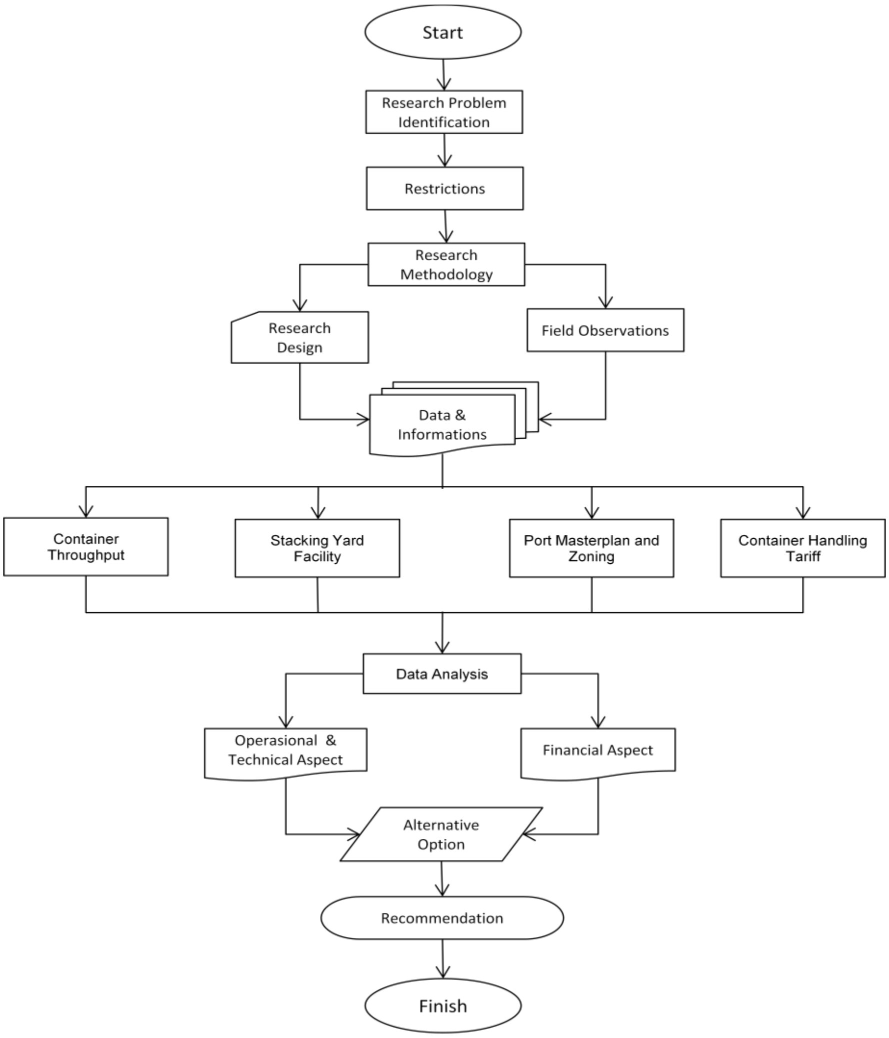
Source: Indonesian Ministry of Trade

Figure 2.7. Export and import trade of Indonesia (1996 – 2013)

Sensitivity analysis is used for investigating the effect of variable change in investment, identifying critical values, thresholds or break-even values where the optimal strategy changes. Sensitivity analysis procedure is extremely important to evaluate and appraise a project by identifying and simulating under real world scenario. Simulation will demonstrate many potential scenarios in project cash flow so that investor can design some strategies to reduce the risk, error, and uncertainty in investment (Makhani et al, 2010).

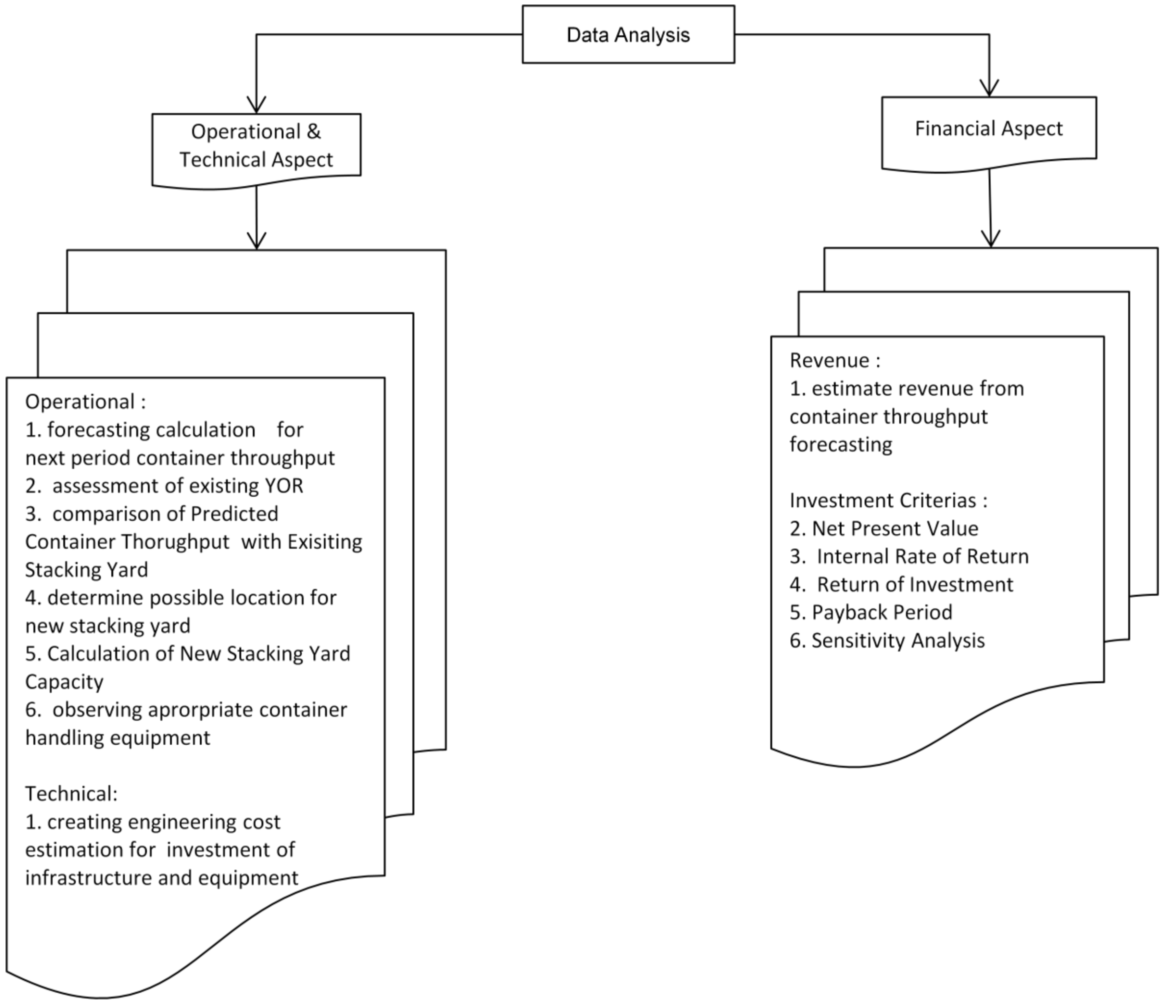
CHAPTER III
RESEARCH METHODOLOGY

The framework in the research will be started by reviewing some literature and main findings, concerning major elements that are of great importance in observing the requirements for expanding the stacking yard, both in terms of capacity of the storage yard as well as the productivity of the terminal equipments. The hypothetical case study is based on the real data provided by conventional container terminal in Tanjung Priok Multipurpose Terminal. Generally, stages of research methodology can be seen in flowchart in figure 3.1 and figure 3.2 below.



Source: Author

Figure 3.1. Research methodology



Source: Author

Figure 3.2. Reviewed aspect

3.1. Operational and Technical Aspect

3.1.1. Estimation of port container throughput

An analysis of current condition container cargo flow will be calculated and compared with future condition base on container throughput forecasting in time series data. Time series forecasting is the use of a model to predict future values based on previously observed values (Anderson et al, 2012). There are some methods to conduct forecasting based on time series data, such as Simple Unweighted

Average Method, Weighted Average Method, and Autoregressive Moving Average (ARMA) models.

3.1.1.1. simple unweighted average method

The simple moving averages method uses the average of the most recent n data values in the time series as the forecast for the next period. Mathematically, a moving average forecast of order n is as follows:

$$F_{t+1} = \frac{\Sigma(most\ \ recent\ \ k\ data\ \ value\ )}{n} = \frac{Y_t + Y_{t-1} + \ldots + Y_{t-k+1}}{n} \tag{3.1}$$

Where :
F_{t+1} = forecast of the times series for period t+1
Y_t = actual value of the time series in period t

3.1.1.2. weighted average method

Weighted moving averages involve selecting a different weight for each data value and then computing a weighted average of the most recent n values as the forecast. This method assigns weights to each observed data point and works out a weighted mean as the forecast value for the next time period. This can be shown as follows:

$$F_t = \Sigma(\text{weight x } Y_t \text{ value for most recent n periods}) \tag{3.2}$$

where:
Y_t = the actual value of the dependent variable for period t
n = the number of time periods included in the average

3.1.1.3. auto regressive and moving average (ARMA)

An ARMA model predicts a value in a response time series as a linear combination of its own past values, past errors, and current and past values of other time series. This methodology begins by determining if the time series under consideration is stationary. Intuitively, a time series is stationary if the statistical properties (for example, the mean and the variance) of the time series are essentially constant through time.

The basic theoretical of the model for autoregressive is:

$$y_t = \mu + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + ... + u_t \qquad (3.3)$$

where :

$y_t = Y_t - Y_{t-1}$

Whereas the basic theoretical of the model for moving average is:

$$y_t = u_t + \Theta_1 u_{t-1} + \Theta_2 u_{t-2} + ... \Theta_q u_{t-q} \qquad (3.4)$$

where :

$y_t = Y_t - Y_{t-1}$

3.1.1.4. mean square error (MSE)

The Mean Square Error measures forecast accuracy by averaging the squares of the forecast errors. The test is based on the following relation :

$$\mathrm{MSE} = \frac{\Sigma|e_t^2|}{n} \qquad (3.5)$$

where:

e_t is the forecast error for period t

n is the number of forecast errors

The reason why the forecast errors are squared is in order to remove all negative terms before the values are added up. Using the squares of the errors achieves the same outcome as using the absolute values of the errors, as the square of a number will always result in a non-negative value.

3.1.1.5. root mean square error (RMSE)

The mean square error averages the squares of the forecast errors and thus fails to measure the accuracy of the forecasts under comparison in the same units as the original series. This problem can be eliminated if we take the square root of the MSE, creating a new statistic with most of the same attributes as the MSE. The new measure, known as the root mean square error, is given by the following relation :

$$\mathrm{RMSE} = \sqrt{\mathrm{MSE}} \qquad (3.6)$$

The advantages of the root mean square error over other tests of forecast accuracy are as follows :

- It is measured in the same units as the original series and can therefore be directly compared to it.
- By using squared error terms it gives more weight to the large forecast errors.
- It is very simple to use.

3.1.2. Stacking yard facility

To determine the need for stacking yard expansion planning, it suppose to be measured the current condition of performance indicator in stacking operation to optimize the development. Optimization used to identify a condition to achieve the best result and solve the practical problem in terminal operation. Escalation of annual container throughput has to be followed by availability of yard and efficient yard management to obtain high performance port. Some formula to calculate yard availability already provided in equations 2.1 to 2.3 above. By comparing current container throughput and forecasting condition with available stacking yard facility, the next stage in this research is analyzing the need for expansion of yard.

A field research will then be carried out to determine possible area to expand stacking yard capacity and then determine appropriate equipment handling in new stacking yard base on the operational point of view with comparing advantages and disadvantages of each option.

3.1.3. Engineering cost estimation

Hereafter, the research grows extensively to creating engineering cost estimation for investment of infrastructure and container handling equipment with considering financial assessment. Generally speaking, Estimation means an effort to assess or predict a value base on calculation analysis and experiences, such as bidding document, field condition, and work manager resources. Therefore, cost estimation will influence project feasibility, sustainable investment, and for obtaining economical value from project cash flow.

Engineering cost estimation in this research applies Unit Price Analysis method that already used in Indonesia Port Corporation (IPC). Unit Price Analysis describes basic principal for analysis basic unit of salaries, tools, and materials. This method also accommodates material conversion factor, weight of material, density of materials, including mixture of materials. General estimation in this research refers to similar work contracts in Indonesia Port Corporation year 2012.

3.2. Financial Aspect

The study in financial aspect including whether the project meet the criteria to be executed, by comparing the investment cost and profit achievement in the future from the revenues. Future revenue can be predicted base on container throughput forecast in container terminal for several years. With an assumption that project totally will be financed by company, this research is going to try to observe the financial assessment. Financial assessments in this research are limited to Net Present Value (NPV), Internal Rate of Return (IRR), Return of Investment (ROI), and Payback Periods. Some formula to calculate it already provided in equations 2.4 to 2.7 above. The next process is considering for sensitivity analysis to demonstrate possible change and error for many key variables.

3.3. Data Requirement

Data required to analyze the research problem and support the optimal decision is explained as follow:

1. Container throughput in Tanjung Priok Multipurpose Terminal . This can be accessed in Costumer Services Department Port of Tanjung Priok
2. Container Storage Yard in current conditions that will be analyzed, collected from Terminal Operation Division Port of Tanjung Priok
3. Technical Drawing of Port land use map and Zoning. This data acquired from Technical Division Port of Tanjung Priok and will be used to observe alternative location for expansion yard planning inside the port
4. Container handling tariff. This data obtained from Terminal Operation Division Port of Tanjung Priok
5. Cost of civil works and container handling equipment prices. This data acquired from Technical Division and Procurement Bureau Port of Tanjung Priok base on previous work of investment and bidding document.
6. Supporting data are retrieved from Indonesia Statistical Bureau and Indonesian Ministry of Trade

CHAPTER IV
DATA PROCESSING AND ANALYSIS

4.1. Operational Aspect

4.1.1. Container throughput forecast

Design for port terminal expansion begins with forecast/determination of the container flow. Since the market is flexible and the economy is ever/changing, actual developments will always be different from the forecast. Therefore, the design should be robust and be profitable within a certain range of circumstances. The container flow will be considered in great detail in this chapter as a basic consideration to create solution. A time series data is provided by Tanjung Priok Multipurpose Terminal for annual container throughput from 1996 to 2013. This data will be used to forecast future values of the series. The data shows as follows:

Tabel 4.1. Annual container throughput in Tanjung Priok Multipurpose Terminal

Year	Throughput (Teus)	Year	Throughput (Teus)
1996	163,313	2005	990,645
1997	214,094	2006	994,289
1998	170,531	2007	1,030,611
1999	231,613	2008	1,108,405
2000	284,383	2009	1,345,278
2001	680,052	2010	1,626,742
2002	436,632	2011	2,014,049
2003	707,660	2012	2,370,191
2004	715,862	2013	2,796,825

Source: Costumer services department, port of Tanjung Priok

= will be simulated for forecasting

4.1.1.1. simple unweighted average method

Using this model, with a span of 3 years to forecast container throughput and compute forecast accuracy of RMSE, and the result is shown on Figure 4.1. below.

NORMSDIST | =AVERAGE(C4:C6)

	A	B	C	D	E	F
1	Container Throughput/Year in Tanjung Priok Multipurpose Terminal					
2						
3	No	Year	Y (Actual Throughput)	Ŷ (Forecasting)		
4	1	1996	163,313			
5	2	1997	214,094			
6	3	1998	170,531			
7	4	1999		=AVERAGE(C4:C6)		
8	5	2000	284,383	AVERAGE(number1; [number2]; ...)		
9	6	2001	680,052	228,842		
10	7	2002	436,632	398,683		
11	8	2003	707,660	467,022		
12	9	2004	715,862	608,115		
13	10	2005	990,645	620,051		
14	11	2006	994,289	804,722		
15	12	2007	1,030,611	900,265		
16	13	2008	1,108,405	1,005,182		
17	14	2009	1,345,278	1,044,435		
18	15	2010	1,626,742	1,161,431		
19	16	2011	2,014,049	1,360,142		
20	17	2012	2,370,191	1,662,023		
21	18	2013	2,796,825	2,003,661		

Source: Author calculation

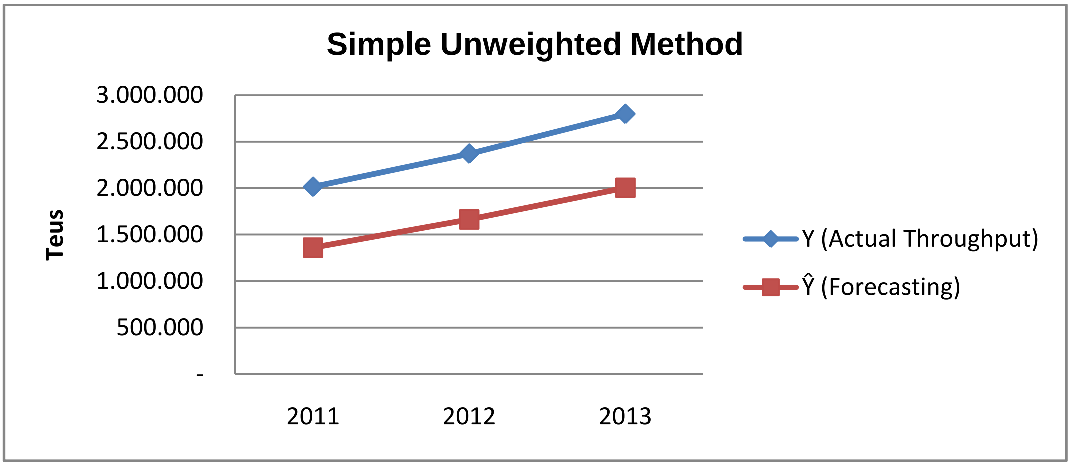
Figure 4.1. Simple unweighted method on Ms. Excel

Using Microsoft Excel can estimate for next 3 years throughput as follows:

Table 4.2. Forecast result for simple unweighted method

No	Year	Y (Actual Throughput)	Ŷ (Forecasting)
16	2011	2,014,049	1,360,142
17	2012	2,370,191	1,662,023
18	2013	2,796,825	2,003,661
	MSE	5.19402E+11	
	RMSE	720,696	

Source: Author calculation

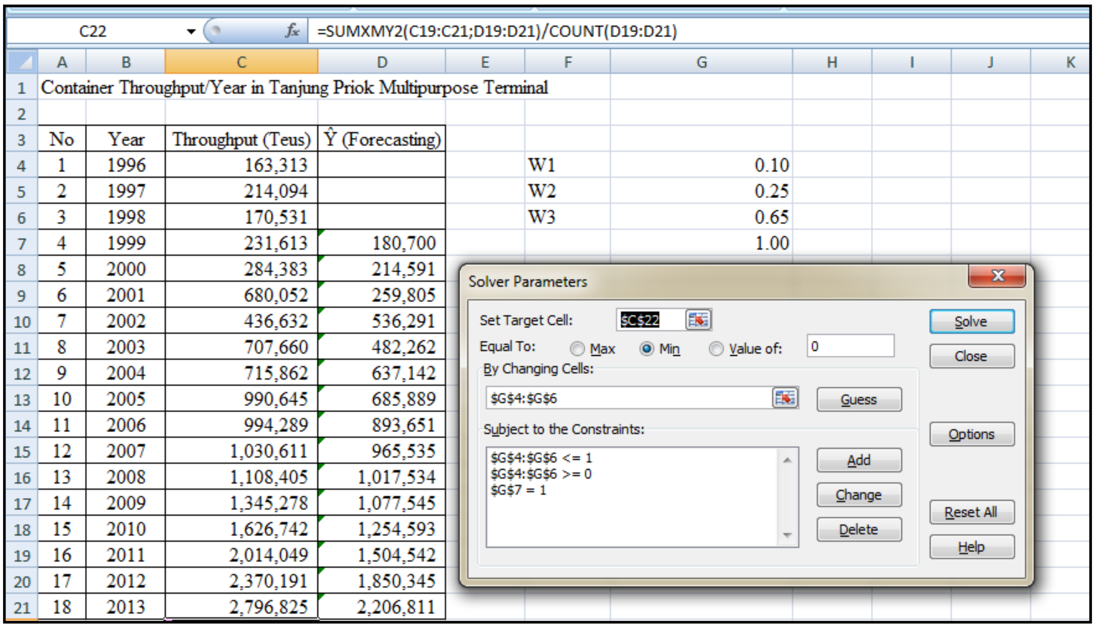


Source: Author calculation

Figure 4.2. Graph for comparison of forecasting result in simple unweighted method

4.1.1.2. weighted moving average method

Using this model, with a span of 3 years to forecast container throughput and compute forecast accuracy of RMSE, and the result is shown on Figure 4.3. below. The combination of weight is optimized by using Solver Parameter on Ms. Excel.



C22 =SUMXMY2(C19:C21;D19:D21)/COUNT(D19:D21)

Container Throughput/Year in Tanjung Priok Multipurpose Terminal

No	Year	Throughput (Teus)	Ŷ (Forecasting)		
1	1996	163,313		W1	0.10
2	1997	214,094		W2	0.25
3	1998	170,531		W3	0.65
4	1999	231,613	180,700		1.00
5	2000	284,383	214,591		
6	2001	680,052	259,805		
7	2002	436,632	536,291		
8	2003	707,660	482,262		
9	2004	715,862	637,142		
10	2005	990,645	685,889		
11	2006	994,289	893,651		
12	2007	1,030,611	965,535		
13	2008	1,108,405	1,017,534		
14	2009	1,345,278	1,077,545		
15	2010	1,626,742	1,254,593		
16	2011	2,014,049	1,504,542		
17	2012	2,370,191	1,850,345		
18	2013	2,796,825	2,206,811		

Source: Author calculation

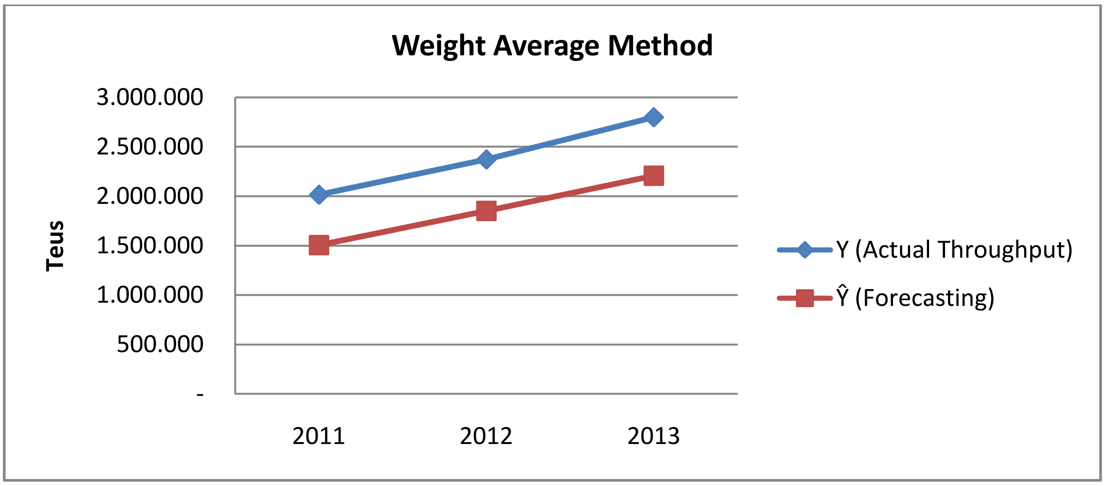
Figure 4.3. Solver parameter to optimize weight

Using weighted moving average can estimate for next 3 years throughput as follows:

Table 4.3. Forecast result for weighted method

No	Year	Throughput (Teus)	Ŷ (Forecasting)
16	2011	2,014,049	1,504,542
17	2012	2,370,191	1,850,345
18	2013	2,796,825	2,206,811
	MSE	2.92651E+11	
	RMSE	540,973	

Source: Author calculation



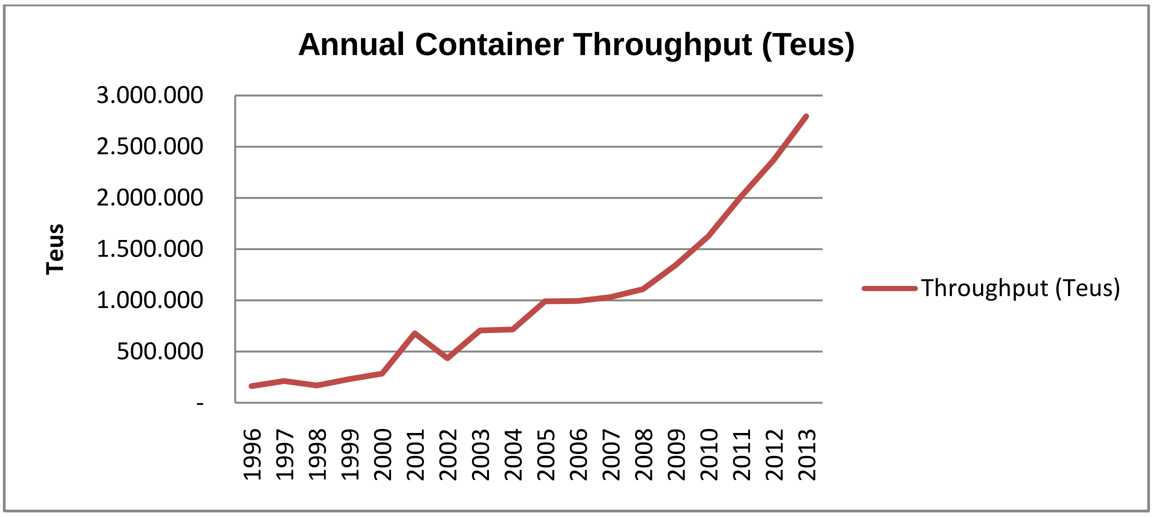
Source: Author calculation

Figure 4.4. Graph for comparison of forecasting result in weight average method

4.1.1.3. ARMA models

A. Identification of Y time series data

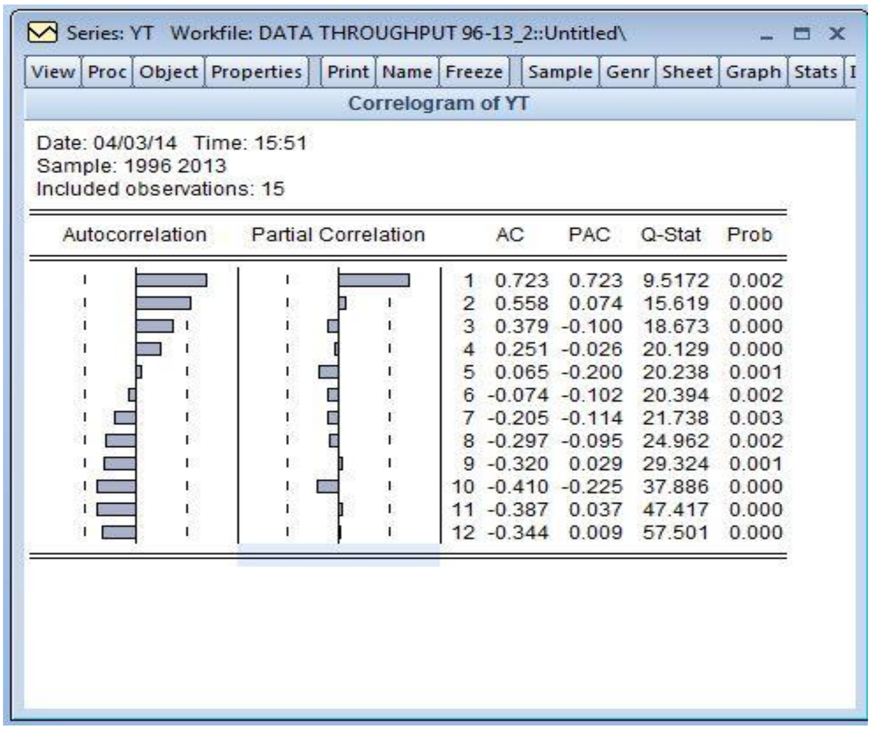
The original data of annual container throughput in Tanjung Priok Multipurpose Terminal plotted in the graph as follows:



Source: Costumer services department, port of Tanjung Priok

Figure 4.5. The Graphic of original annual container throughput

The plot clearly shows that the data are trending upward; consequently, the mean of the data will change over time. As defined above, this time series is not stationary.


Series: YT Workfile: DATA THROUGHPUT 96-13_2::Untitled\

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats

Correlogram of YT

Date: 04/03/14 Time: 15:51
Sample: 1996 2013
Included observations: 15

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.723	0.723	9.5172	0.002
		2	0.558	0.074	15.619	0.000
		3	0.379	-0.100	18.673	0.000
		4	0.251	-0.026	20.129	0.000
		5	0.065	-0.200	20.238	0.001
		6	-0.074	-0.102	20.394	0.002
		7	-0.205	-0.114	21.738	0.003
		8	-0.297	-0.095	24.962	0.002
		9	-0.320	0.029	29.324	0.001
		10	-0.410	-0.225	37.886	0.000
		11	-0.387	0.037	47.417	0.000
		12	-0.344	0.009	57.501	0.000

Source: Author calculation using Eview 8

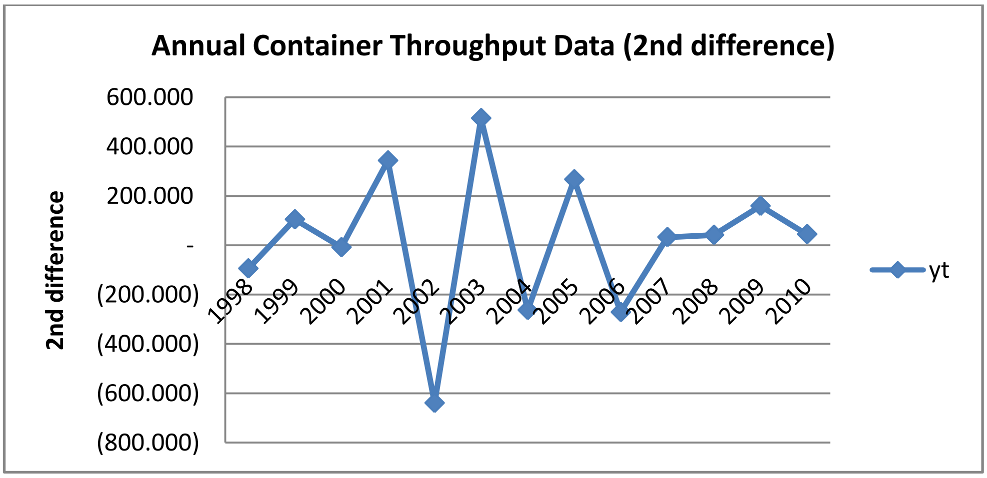
Figure 4.6. The correlogram of original Y time series data (tested by Software Eview 8)

To cure the data to be stationary, the data is transformed to the second difference model. The second difference data shows:

Table 4.4. Transformed data to second difference model

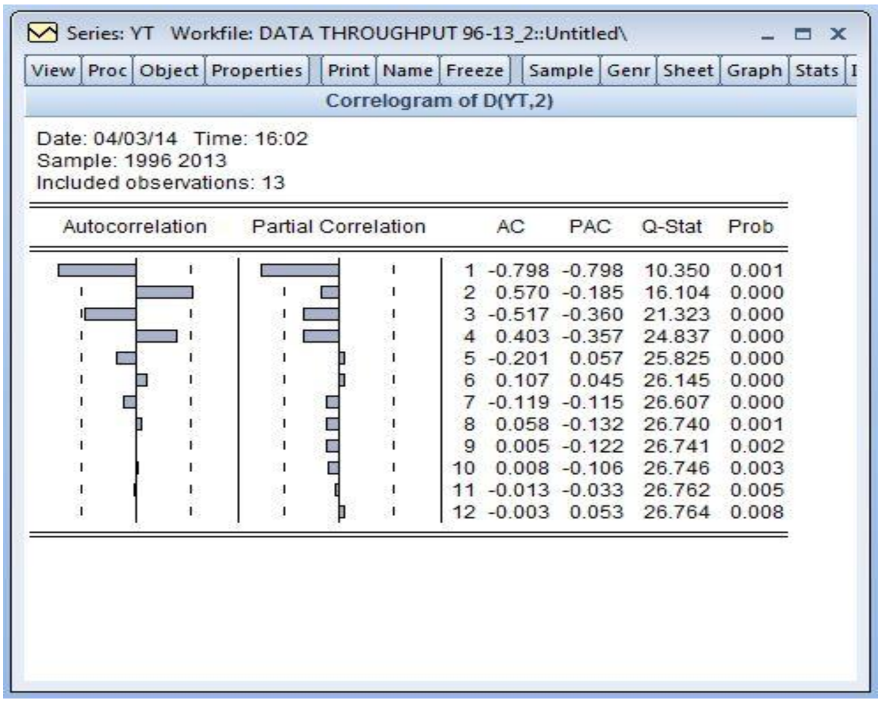
No	Year	Annual Throughput	lag 1	1st difference	lag 1 of 1st difference	2nd difference	lag 1 of 2nd difference
		Yt	Yt-1	yt	yt-1	2nd yt	2nd yt-1
1	1996	163,313	-	-	-	-	-
2	1997	214,094	163,313	50,781	-	-	-
3	1998	170,531	214,094	(43,563)	50,781	(94,344)	-
4	1999	231,613	170,531	61,082	(43,563)	104,645	(94,344)
5	2000	284,383	231,613	52,770	61,082	(8,312)	104,645
6	2001	680,052	284,383	395,669	52,770	342,899	(8,312)
7	2002	436,632	680,052	(243,420)	395,669	(639,089)	342,899
8	2003	707,660	436,632	271,028	(243,420)	514,448	(639,089)
9	2004	715,862	707,660	8,202	271,028	(262,826)	514,448
10	2005	990,645	715,862	274,783	8,202	266,581	(262,826)
11	2006	994,289	990,645	3,644	274,783	(271,139)	266,581
12	2007	1,030,611	994,289	36,322	3,644	32,678	(271,139)
13	2008	1,108,405	1,030,611	77,794	36,322	41,472	32,678
14	2009	1,345,278	1,108,405	236,873	77,794	159,079	41,472
15	2010	1,626,742	1,345,278	281,464	236,873	44,591	159,079

Source: Author calculation



Source: Author calculation

Figure 4.7. The Graphic of 2nd difference Y time series data



	AC	PAC	Q-Stat	Prob
1	-0.798	-0.798	10.350	0.001
2	0.570	-0.185	16.104	0.000
3	-0.517	-0.360	21.323	0.000
4	0.403	-0.357	24.837	0.000
5	-0.201	0.057	25.825	0.000
6	0.107	0.045	26.145	0.000
7	-0.119	-0.115	26.607	0.000
8	0.058	-0.132	26.740	0.001
9	0.005	-0.122	26.741	0.002
10	0.008	-0.106	26.746	0.003
11	-0.013	-0.033	26.762	0.005
12	-0.003	0.053	26.764	0.008

Source: Author calculation using Eview 8

Figure 4.8. The correlogram of 2nd difference Y time series data (tested by Software Eview 8)

After differencing, the series become stationary. Figure 4.7 shows that second differencing has eliminated the trend from the data, and the mean of the data will not change over time.

B. Model Estimation

The tools for identifying a good model for a stationary time series are its ACF and PACF. From figure 4.8 above, correlogram have large spike at lag 1 for ACF and PACF, and lag 2 & lag 3 for ACF. When diagnostic checking shows the first order of model already adequate, any extra model would be insignificant (Visvikis, 2013).

1. AR(1) model

   The basic theoretical of the model for autoregressive shown in equation (3.3) is:

   $y_t = \mu + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + ... + u_t$

   where:

   $y_t = Y_t - Y_{t-1}$

We regress 2nd y_t and 2nd y_{t-1} using Excel add-ins regression, the result is:

Table 4.5. Summary Output of Regression 2nd y_t toward 2nd y_{t-1} for AR(1)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.803359607
R Square	0.645386659
Adjusted R Square	0.609925325
Standard Error	191729.6107
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6.69026E+11	6.69E+11	18.19973	0.001647064
Residual	10	3.67602E+11	3.68E+10		
Total	11	1.03663E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	39467.4283	55423.61762	0.712105	0.492679	-84024.08692	162958.9435	-84024.08692	162958.9435
X Variable 1	-0.798433783	0.187157161	-4.26611	0.001647	-1.215445922	-0.381421644	-1.215445922	-0.381421644

Source: Author calculation

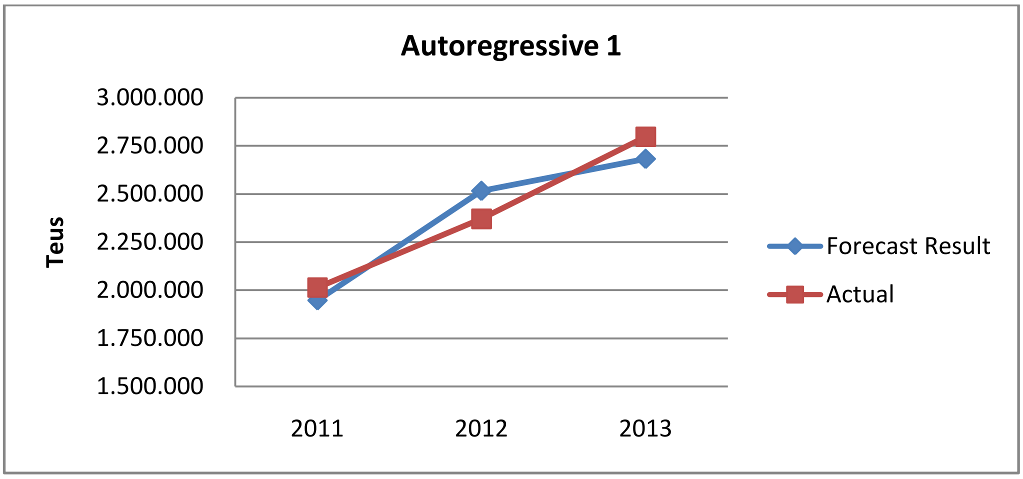
From the basic model of AR(1), we can obtain :

$y_t = 39467.43 – 0.798y_{t-1} + u_t$ (4.1)

Table 4.6. Forecast result for AR(1) method

Periods	Forecast Formula	Forecast Result		Actual
		2nd yt	Yt Throughput	Yt Throughput
2011	$\hat{y}t_1 = \mu + \varphi * y_0 + u_1$	39467.4283	1,947,673	2,014,049
2012	$\hat{y}t_2 = \mu + \varphi * y_1 + u_2$	114,794.87	2,516,151	2,370,191
2013	$\hat{y}t_3 = \mu + \varphi * y_2 + u_3$	(44,084.67)	2,682,248	2,796,825
	MSE	1.29460.E+10		
	RMSE	113,780		

Source: Author calculation



Source: Author calculation

Figure 4.9. Graph for comparison of forecasting result in AR(1)

2. MA(1) model

   The basic theorical of the model for moving average shown in equation (3.4) is:

   $y_t = u_t + \Theta_1 u_{t-1} + \Theta_2 u_{t-2} + \ldots \Theta_q u_{t-q}$

   where:

   $y_t = Y_t - Y_{t-1}$

   We regress y_t and y_{t-1} using Excel add-ins regression without intercept, the result is:

Table 4.7. Summary Output of Regression 2nd y_t toward 2nd y_{t-1} for MA(1)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.794066789
R Square	0.630542065
Adjusted R Square	0.539632974
Standard Error	187384.7067
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*gnificance F*
Regression	1	6.59189E+11	6.59189E+11	18.77335	0.001483
Residual	11	3.86243E+11	35113028294		
Total	12	1.04543E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
X Variable 1	-0.791454538	0.182664898	-4.332822276	0.001189	-1.1935	-0.389411809	-1.193497267	-0.389411809

Source: Author calculation

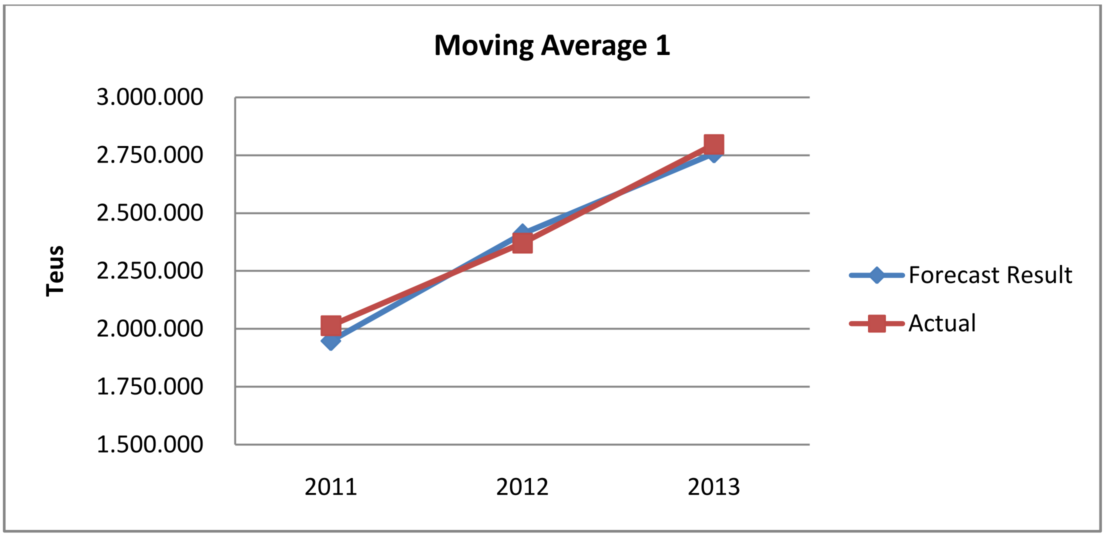
From the basic model of MA(1), we can obtain :

$$y_t = u_t - 0.791u_{t-1} \quad (4.2)$$

Table 4.8. Forecast result for MA(1) method

Periods	Forecast Formula	Forecast Result		Actual
		2^{nd} yt	Yt Throughput	Yt Throughput
	$\hat{y}t_1 = u_1 + (\Theta^* u_0)$	0		
2011	$\hat{y}t_2 = u_2 + (\Theta^* u_1)$	74,668.99	1,982,875	2,014,049
2012	$\hat{y}t_3 = u_3 + (\Theta^* u_2)$	(23,724.65)	2,377,631	2,370,191
2013	$\hat{y}t_4 = u_4 + (\Theta^* u_3)$	(12,198.41)	2,714,135	2,796,825
	MSE	2.62165.E+09		
	RMSE	51,202		

Source: Author calculation



Source: Author calculation

Figure 4.10. Graph for comparison of forecasting result in MA(1)

3. ARIMA(1,2,1) model

ARIMA stands for Autoregressive-Integrated-Moving Average. The letter "I" (Integrated) indicates that the modeling time series has been transformed into a stationary time series in second difference. The basic theoretical of the ARIMA model is a combination between Autoregressive and Moving average equation.

$y_t = \mu + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \ldots + u_t + \Theta_1 u_{t-1} + \Theta_2 u_{t-2} + \ldots \Theta_q u_{t-q}$

where :

$y_t = Y_t - Y_{t-1}$

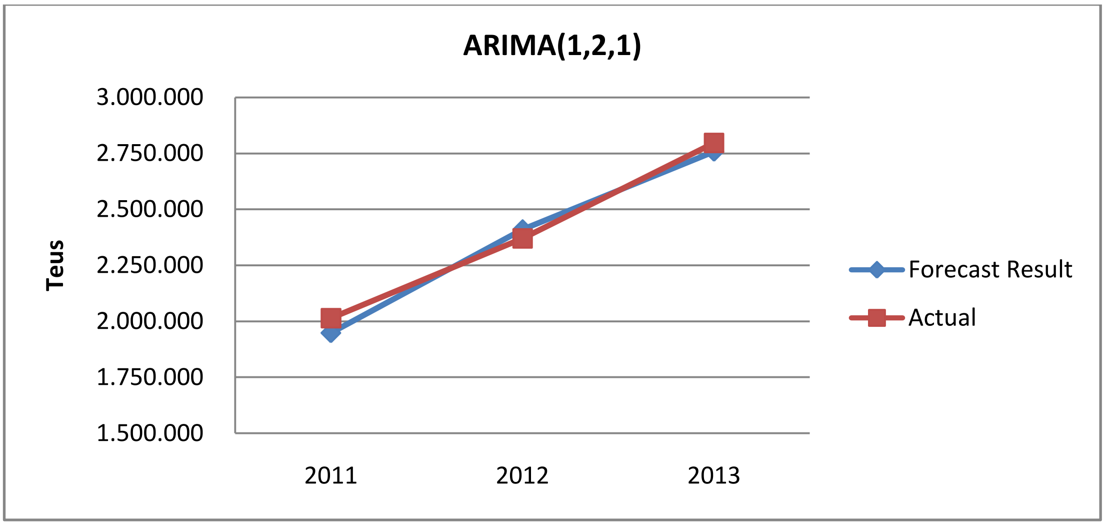
From the basic model of ARIMA(1,2,1), we can obtain:

$$\hat{y}_t = 39467.43 - 0.798 y_{t-1} + u_t - 0.791 u_{t-1} \quad (4.3)$$

Table 4.9. Forecast result for ARIMA(1,2,1) method

Periods	Forecast Formula	Forecast Result		Actual
		2^{nd} yt	Yt Throughput	Yt Throughput
2011	$\hat{y}t_1 = \mu + \varphi_1 y_0 + u_t + (\Theta^* u_0)$	39,467.43	1,947,673	2,014,049
2012	$\hat{y}t_2 = \mu + \varphi_1 y_1 + u_t + (\Theta^* u_{t1})$	8,909.10	2,410,265	2,370,191
2013	$\hat{y}t_3 = \mu + \varphi_1 y_2 + u_t + (\Theta^* u_{t2})$	31,687.82	2,758,021	2,796,825
	MSE	2.50581.E+09		
	RMSE	50,058		

Source: Author calculation



Source: Author calculation

Figure 4.11. Graph for comparison of forecasting result in ARIMA(1,2,1)

C. Diagnostic Checking

Regardless what estimation procedure is used in modeling, the criteria for testing the goodness of fit are the same. we use the t-statistics to test the significance of the coefficients and the standard error to measure how closely the model fits the data.

Table 4.10. T test for coefficient significance

No	Method	P-Value	Significant Level	Hypothesis	Result
1	AR(1)	0.00165	0.05	Ho = φ = 0	Reject HO
2	MA(1)	0.00119		Ho = Ɵ = 0	Reject HO

Source: Author calculation

Table 4.10 above gives information that the coefficient of variable in AR(1) and MA(1) model are significant. We also need to check the adequate of model with Ljung Box-Pierce test from the Qstat value in figure 4.8.

Table 4.11. Ljung Box-Pierce test for adequate model

No	Method	Qstat	$\chi^2_{12;0.05}$	Hypothesis	Result
1	AR(1)	10.350	21.026	Ho = model Adequate	Accept HO
2	MA(1)	10.350			Accept HO

Source: Author calculation

Table 4.11 above gives information that the model in AR(1) and MA(1) model are adequate

D. Forecasting Results

The resume of all the models used in forecasting are shown by table below:

Table 4.12. RMSE value for various models

No	Model	RMSE value	Remarks
1	Simple Unweighted Method	720,696	The smallest value of RMSE show the best model of forecasting
2	Weighted Average Method	540,973	
3	AR(1)	113,780	
4	MA(1)	51,202	
5	ARIMA(1,2,1)	50,058	

Source: Author calculation

Table 4.12 gives information that ARIMA(1,2,1) has the smallest RMSE value, so that the forecasting result from this model is the most accurate prediction. Hereafter, the equation (4.3) of ARIMA model is used for estimating annual throughput of container in the next 3 years. The final forecast throughput of container for 2014 to 2016 shown in table 4.13 below.

Table 4.13. Predicted demand of Terminal

Periods	Forecast Formula	Forecast Result	
		2^{nd} yt	Final Throughput
2014	$\hat{y}t_1 = \mu + \varphi_1 y_0 + u_t + (\Theta^* u_0)$	39,467.43	3,262,927
2015	$\hat{y}t_2 = \mu + \varphi_1 y_1 + u_t + (\Theta^* ut_1)$	8,909.10	3,737,938
2016	$\hat{y}t_3 = \mu + \varphi_1 y_2 + u_t + (\Theta^* ut_2)$	31,687.82	4,244,637

Source: Author calculation

4.1.2. Assessment of yard performance

As a multipurpose port, Tanjung Priok Multipurpose Terminal serves many types of cargoes, so that not all of their stacking area used for container yard. Obviously, each terminal operates container yard for stacking need.

Green area : Domestic container
Blue area : International container

Source: Technical Division, Port of Tanjung Priok

Figure 4.12. Port zone for container stacking

The data of stacking yard is shown by Table 4.14 below.

Table 4.14. Data of container stacking yard in Line 1

No	Name and Location	specification		Operated by
		Area (m2)	Construction	
1	Front of Shed 005, 006, 007	60,010.00	Paving block	Terminal 1
2	South of Shed 005.	7,935.73	Concrete	Terminal 1
3	North Side Yard of Pulau Payung Street.	1,546.00	Concrete	Terminal 1
4	Yard Between Shed 101 - 102	650.00	Concrete	Terminal 2
5	Yard Between Shed 102 - 103	1,600.00	Concrete	Terminal 2
6	Yard Between Shed 103 - 104	3,161.73	Concrete	Terminal 2
7	Yard Between Shed 104 - 105	3,161.73	Concrete	Terminal 2
8	Yard Ex Shed 102X North and South	8,230.50	Concrete	Terminal 2
9	Yard Ex Shed 102	5,291.33	Concrete	Terminal 2
10	Yard Ex Shed 103	5,291.33	Concrete	Terminal 2
11	Yard Ex Shed 105	5,291.33	Concrete	Terminal 2
12	Yard arround shed 207X	33,578.18	Concrete	Terminal 3
13	Yard Between Shed 208 - 209	1,560.00	Concrete	Terminal 3
14	Yard Between Shed 209 - 210	6,300.00	Concrete	Terminal 3
15	Yard Ex Shed 211	5,800.00	Concrete	Terminal 3
16	Yard Ex Metal Scrap Terminal	12,534.50	Concrete	Terminal 3
17	Yard Ex Shed 108	2,925.00	Concrete	Terminal 3
	- First Extension Yard 108	1,310.84	Concrete	Terminal 3
	- Second Extension Yard 108	453.60	Concrete	Terminal 3
18	Yard Ex Shed 111	8,723.20	Concrete	Terminal 3
19	Yard Ex Shed 210	4,969.44	Concrete	Terminal 3
20	Yard Ex Shed 301	5,589.23	Concrete	Terminal 3
21	Yard Ex Shed 302	5,618.05	Concrete	Terminal 3
22	Yard Ex Shed 213X	3,258.96	Concrete	Terminal 3
23	Yard Ex Shed 303	7,905.09	Concrete	Terminal 3
24	Yard Ex Shed 305	6,720.00	Concrete	Terminal 3
25	Yard arround shed 303 - 305	38,546.64	Concrete	Terminal 3
26	Yard Ex Shed 304	8,525.00	Concrete	Terminal 3
27	Yard of PT.MAL	45,151.50	Concrete	Terminal 3
	Total Area	**301,638.90**		

Source: Technical Division, Port of Tanjung Priok

The actual yard capacity per year can be calculated using equation (2.1):

$$yard\ capacity = \frac{effective\ \ area\ \ x\ number\ \ of\ \ stacking\ \ x\ number\ \ of\ \ day\ \ in\ a\ year}{container\ \ area\ \ x\ stacking\ \ duration}$$

$$= \frac{(301{,}638.90x60\%)x\ 4\ tier\ full\ container\ x\ 365\ day}{18.35\ m2\ x4\ day}$$

= 3,600,647 Teus/year

At the same time, performance indicators of yard occupancy ratio (YOR) in the last five years are able to be calculated using equation (2.2). YOR calculations from 2009 to 2013 are shown in Table 4.15.

Table 4.15. YOR(%) from 2009 to 2013

No	Period	Throughput (Teus/year)	Yard Capacity (Teus/year)	YOR (%)
1	2009	1,345,278	3,600,647	37.36
2	2010	1,626,742	3,600,647	45.18
3	2011	2,014,049	3,600,647	55.94
4	2012	2,370,191	3,600,647	65.83
5	2013	2,796,825	3,600,647	77.68

Source: Author calculation

Table 4.1 gives information that in 2013 the actual annual container throughput has reached 2,796,825 boxes per year. While from final throughput forecasting in Table 4.13 predicts that container flow will rise to 4,244,637 boxes in 2016. It means that port have to increase container yard facility for reducing cargo congestion. By modifying equation (2.1), yard requirement to accommodate container stacking until 2016 can be estimated as follow:

$$effective\ area = \frac{yard\ throughput\ capacity\ 2016\ x\ container\ area\ x\ stacking\ duration}{number\ of\ stacking\ x\ number\ of\ day\ in\ a\ year}$$

$$= \frac{4{,}244{,}637 \frac{Teus}{year} x\ 18.35 m2\ x\ 4\ day}{4\ tier\ x\ 365}$$

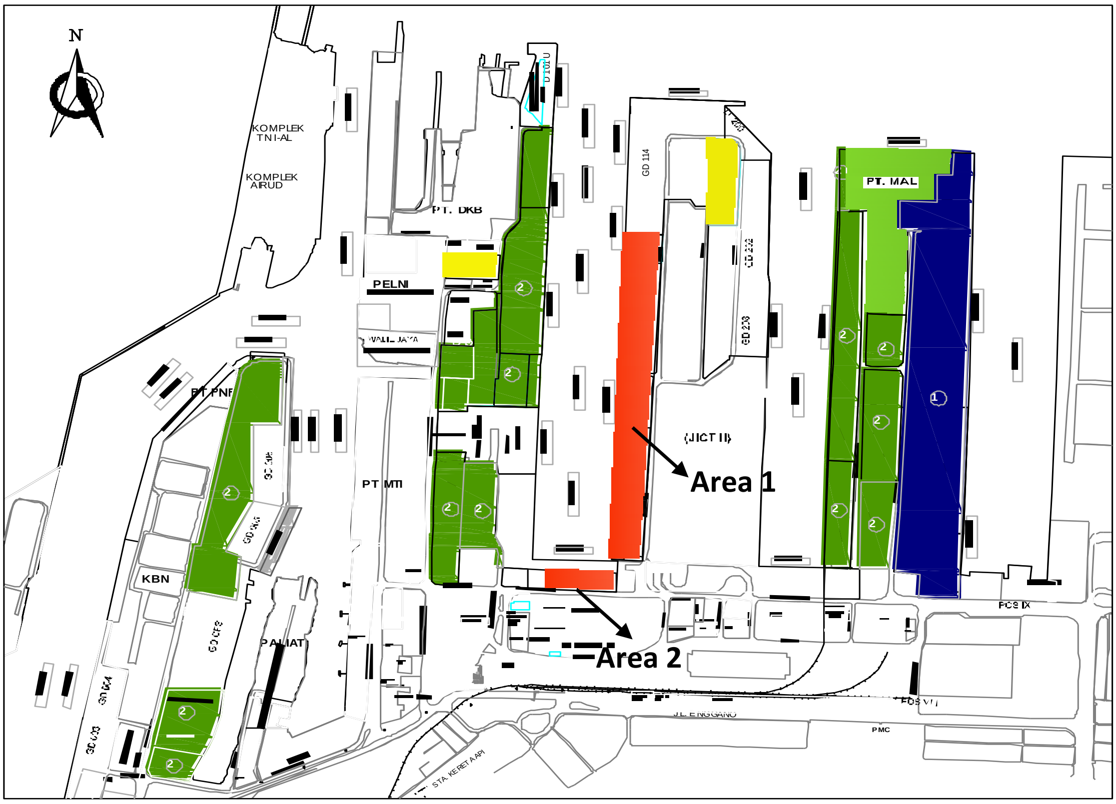
$= 213{,}394.76\ m^2$

If assumed that broken stowage is 40%, the requirement of total area in 2016 is about 355,657.94 m^2. At the present time, port has container yard area 301,638.90 m^2. It means that demand for new container stacking area for next three years is 54,019.04 m^2.

4.1.3. Reference for expanding area

The main principal in port planning is considering escalation of ship size and cargoes flow in the next several years so that it will be served well. Refer to master plan of

Tanjung Priok Multipurpose Terminal, this research will concentrate to propose an area in Terminal 2 to be developed become expansion area of container handling. Most of containers in Tanjung Priok Multipurpose Terminal are domestic and transhipment cargoes, whilst international containers are served by container dedicated terminal such as Jakarta International Container Terminal (JICT) and Koja Container Terminal.



Green area : Domestic container
Blue area : International container
Red area : stacking yard expansion planning
Yellow area : New warehouse plan

Source: Author planning

Figure 4.13. Research idea for stacking yard expanding

Figure 4.13 presents possible zone for stacking yard (red area). The first area is named 109 – 113 and the second area is named Ex-office block. These areas have been selected for several factors:

- Draft of port basin in Terminal 2 is between 8 – 12 LWS. This condition is appropriate for domestic shipping with small and medium ship size (100 – 2999 Teus capacity).
- Berth has sufficient size for gantry crane and head truck operation
- Easy access for container trailers and traffic management in the port area
- Availability of port utility, such as supply water pipe and wire cable installation for electrification of equipment

At the present time, there are four warehouses for general cargoes storage in area 109 – 113, while ex-office block is used for open storage of general cargoes. Cargo handling activity uses mobile harbor crane, head truck, and forklift. According to port master plan, general cargoes storage in these areas will be relocated to new warehouses of 12,600 m^2. Berth and yard will totally rebuild and reinforcement to accommodate container handling heavy equipment.

Yard capacity for new block 109 – 113 and ex-office can be calculated:

$$YC\ 109-113 = \frac{effective\ \ area\ \ x\ number\ \ of\ \ stacking\ \ x\ number\ \ of\ \ day\ \ in\ a\ year}{container\ \ area\ \ x\ stacking\ \ duration}$$

$$= \frac{(61.5x812x60\%)x\ 4\ tier\ full\ container\ x\ 365\ day}{18.35\ m2\ x4\ day}$$

= 595,776 Teus/year

$$YC\ ex-office = \frac{effective\ \ area\ \ x\ number\ \ of\ \ stacking\ \ x\ number\ \ of\ \ day\ \ in\ a\ year}{container\ \ area\ \ x\ stacking\ \ duration}$$

$$= \frac{(87x50x60\%)x\ 4\ tier\ full\ container\ x\ 365\ day}{18.35\ m2\ x4\ day}$$

= 51,915 Teus/year

Total yard capacity = current capacity + block 109-113 + block ex-office

= 3,600,647 + 595,776 + 51,915

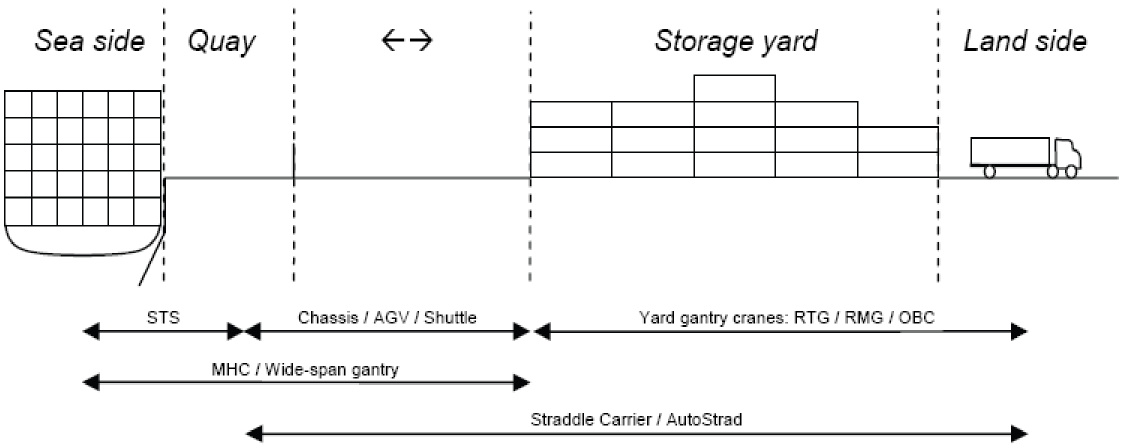
= 4,248,339 Teus/year

Total yard capacity > Container throughput forecast in 2016 (4,244,637 Teus/year)

From the calculation above, expanding block 109-113 and ex-office will increase container yard capacity up to 4,248,339 Teus/year. This will be able to handle containers flow until next three year in 2016.

4.1.4. Selection of container handling equipment

Container arrangement in stacking yard follows container handling equipment model. Each of equipment has own characteristic to arrange container box in the yard. Moreover, the size of equipment needs adequate pathway for operation activities. Handling process is started since container was on the ship board, stacking on yard, and delivery to the owner. Various types of equipments can be combined with each other to handle containers in a terminal. Generally, the whole process of container handling in port is presented by figure 4.14 below.



Source: W. Bose & Dr. Jurgen (2010)

Figure 4.14. Work area terminal equipment

Discussion in this research leads on yard of container storage equipment. There are three types of common equipment that used in storage side, namely reach stacker, rubber tyred gantry crane (RTGC) and rail mounted gantry crane (RMGC).

4.1.4.1. reach stacker

From the function point of view, reach stacker was developed to combine the job of lift truck and mobile crane equipment. It was designed for stacking, unstacking, lift on - lift off, and short moving of container in the container yard. Reach stacker is equipped with 360^o rotating spreader and telescopic boom to carry out the operation. Due to the flexibility, reach stacker can be the best alternative to handle container movement in small and medium terminal and multipurpose terminal.

Source: www.cargotec.com

Figure 4.15. Reach stacker operation.

4.1.4.2. rubber tired gantry crane (RTGC)

Rubber tired gantry crane is one of container handling utility in large size container yard. It is heavy equipment that can move in a long block container stacking to lift the container to the head truck chassis, shifting the container, and stacking it according to block, slot, row, and tier. It is necessary for container terminal to have heavy concrete structure of yard to accommodate RTGC movement as heavy equipment. RTGC is wheeled with rubber tire to make it move easily to other container block.

Source: www.kalmarind.co.uk

Figure 4.16. Rubber tired gantry crane

4.1.4.3. rail mounted gantry crane (RMGC)

The main difference between RMGC and RTGC is drive system for gantry movement. If RTGC is wheeled by rubber tire, RMGC uses metal wheels that move on the fix rail with wider span. RMGC usually has bigger size and structure than RTGC with a cantilever outside the portal of crane. It makes RMGC has more rigid position and has more operation capacity than RTGC. Therefore, it works in the larger area of terminal. Although RMGC and RTGC have different characteristics, they have similar operational function to handle container operation in stacking yard.

Source: www.conecranes.com

Figure 4.17. Wide span of RMGC

The summary of the advantages and disadvantages of equipment is shown in table 4.16 below.

Table 4.16. Summary of advantages and disadvantages of equipment

Equipment	Advantages	Disadvantages
Reach Stacker	- flexibility in operation and easy to operate	- Low performance for large container terminal
	- good choice for small and medium container yard	- low level automation
	- fast working time for small and medium area	- disturbance of operation in yard by truck
	- can be used for short distance transportation of container	
	- relatively low investment cost	
	- low operating cost compared with others	
Rubber Tired Gantry Crane	- can be used in large terminal	- need expert operator because of high automation
	- system has high stacking density	- disturbance of operation in yard by truck
	- long distance travelling movement	- require strong concrete structure for movement base
	- can be allocated to other storage block if necessary	
	- medium investment cost per equipment	
Rail Mounted Gantry Crane	- can be used in large terminal	- high investment cost
	- higher stacking capacity and wider span	- rigid rail system is difficult to change terminal layout
	- more durable and reliable than RTGC	- high disturbance of terminal operation in case of crane failure
	- easier to automate than RTGs	

Source: Brinkmann (2011)

Brinkmann (2011) created an auxiliary table as a reference for the terminal planner to identify the requirement of container handling equipment. Table 4.17 below is refer to practical experience and averaged from a multitude of terminals operated in different countries around the world and does not include allowances for maintenance and repair. Furthermore, the author also considers figure 2.4 about practical storage capacity guide which published by Kalmar Container Handling System as a reference.

Table 4.17. Main data of operation system.

Operations System	Required equipment per Quay Crane(2+3)	Stacking Tiers [1-over-*n*-high]	Yard Capacity [TEU / ha]
Reachstacker & TTU	3–4 Reachstackers + 4–5 TTUs	3 4 5	350 500 950–1,000[4]
Pure SC	4–5	2 3	500 750
RTG & TTU	2–3 RTGs 4–5 TTUs	4–5[5]	1,000
RMG & TTU (blocks parallel to quay)	2 RMGs 4–5 TTUs	4–5	1,000[6] (or more)
RMG & ShC (blocks perpendicular to quay)	2 RMGs 2–3 ShCs	4–5	1,000[6] (or more)
RMG & AGV	5–6	4–5	1,000[6] (or more)

Source: Brinkmann (2011)

3. Only empty container
4. Max. 1-over-7-high (high costs for reshuffling of containers which decreases the productivity and increases the number of required RTGs).
5. Independent from space requirements of horizontal transport equipment.

From the field research known that the container yard capacity of block 109 – 113 has 61.5 m width and 812 m length. If effective area for container storage is assumed 60%, the storage capacity can be calculated as follow:

$$storage\ capacity\ 109-113 = \frac{effective\ \ area\ \ x\ number\ \ of\ stacking}{container\ \ area}$$

$$= \frac{(61.5\ m\ x\ 812\ m\ x\ 60\%) x\ 4\ tier}{18.35\ m2}$$

= 6,531 Teus/m^2 ≈ 6,531 Teus/hectare

While ex - office area has 50 m width and 87 m length. The storage capacity can be calculated as follow:

$$storage\ capacity\ ex-office = \frac{effective\ \ area\ \ x\ number\ \ of\ stacking}{container\ \ area}$$

$$= \frac{(87\ m\ x\ 50\ m\ x\ 60\%) x\ 4\ tier}{18.35\ m2}$$

= 568 Teus/m^2 ≈ 568 Teus/hectare

Refers to figure 2.4 and table 4.17, the author decides to use RMGC in block 109 – 113 and reach stacker in block ex – office.

4.1.4.4. Estimation number of equipment

There are some variables used to determine the capacity of material handling equipment such as:

- number of equipment : units
- working performance : box/crane/hour
- working time in a year : hour

It is assumed that working performance of RMGC is 20 box/crane/hour (refers to regulation from Indonesian Ministry of Transportation 2011) and working time in a day is 5,475 hours in a year (15 hours per day). From these variables can be calculated throughput capacity of an RMGC as follow:

Throughput capacity RMGC = working performance x working time in a year
= 20 x 5,475
= 109,500 Teus/year.

If yard capacity of block 109-113 is 595,776 Teus/year (obtained from calculation above), the requirement of RMGC is able to be estimated by:

$$Number\ of\ equipment = \frac{yard\ capacity\ per\ year}{throug\,hput\ capacity\ RMGC\ per\ year}$$

$$= \frac{595{,}776\ Teus/year}{109{,}500\ Teus/year}$$

= 5.44 units ≈ 5 units RMGC

4.2. Technical Aspect of Investment

A calculation for investment planning is needed for budget allocation and review of financial assessment to predict gained profit. It is necessary to create break down of work base on technical and engineering estimation to obtain conformity between item of work and cost required. This sub discussion concentrates to investment component to conduct container yard expansion planning in port including cost for civil work of container stacking yard and procurement of equipment. This data acquired from Technical Division and Procurement Bureau Port of Tanjung Priok base on previous work of investment and bidding document. Investment cost in this research is calculated by Indonesian currency rupiahs (IDR), whereupon it will be converted to US dollars (USD) for the total cost.

4.2.1. Civil works

Capital expenditure for yard expansion planning project in Tanjung Priok Multipurpose Terminal consist of direct cost and indirect cost. There are several works which classified in direct cost such as preparation work, demolition of old structure, excavation, concrete reinforcement, lighting tower, utilities ducting for electrical of container handling equipment, and rail installation for RMGC line. The next is indirect cost that includes design engineering consulting, supervision of work, and value added tax. Engineering estimation of project cost for this project described by Table 4.18 below.

Table 4.18. General engineering estimation of civil works

No	Scope of Work	Unit	Volume	Unit Price	Budget Plan	
					Total	
A	**BLOCK 109 - 113**				(IDR)	(USD)
1	Preparation work	ls	1.00	178,500.00	178,500.00	15.48
	- Mobilization and demobilization of equipment					
	- Repeated measurement of project scope					
	- Project office and safety equipment					
	- water and electricity for work					
	- project fences					
2	Demolishing, excavation, and compaction work of old structure	m^2	49,938.00	63,550.00	3,173,559,900.00	275,291.46

3	Demolishing for sheds 109, 110, 112, and 113	m^2	19,882.00	7,725.00	153,588,450.00	13,323.08
4	Piling work for RMGC line	m^2	49,938.00	156,100.00	7,795,321,800.00	676,207.65
	- Procurement of concrete pile					
	- Pile handling and installation					
	- Strength test					
5	Concrete work and reinforcement	m^2	49,938.00	552,500.00	27,590,745,000.00	2,393,367.89
	- Concrete steel reinforcement					
	- Concrete beam installation					
	- Yard concrete levelling					
	- Base coarse ramp slab					
6	Lighting tower and utilites	unit	5.00	422,425,450.00	2,112,127,250.00	183,217.15
7	Electrical ducting for RMGC	m	800.00	1,346,400.00	1,077,120,000.00	93,435.11
8	Cable manhole	unit	5.00	3,997,200.00	19,986,000.00	1,733.69
9	Installation of RMGC rail line	m	1,600.00	7,000,000.00	11,200,000,000.00	971,547.54
10	yard fences	m	812.00	1,918,500.00	1,557,822,000.00	135,133.76
	SUB TOTAL A				**54,680,448,900.00**	**4,743,272.81**
B	**BLOCK EX - OFFICE**					
1	Preparation work	ls	1.00	150,250,000.00	35,500,000.00	3,079.46
	- Mobilization and demobilization of equipment					
	- Repeated measurement of project scope					
	- Project office and safety equipment					
	- water and electricity for work					
	- project fences					
2	Demolishing, excavation, and compaction work of old structure	m^2	4,350.00	63,550.00	276,442,500.00	23,980.09
3	Concrete work and reinforcement	m^2	4,350.00	552,500.00	2,403,375,000.00	208,481.52
	- Concrete steel reinforcement					
	- Concrete beam installation					
	- Yard concrete levelling					
	- Base coarse ramp slab					
4	Lighting tower and utilites	unit	2.00	422,425,450.00	844,850,900.00	73,286.86
	SUB TOTAL B				**3,560,168,400.00**	**308,827.93**
	TOTAL (A+B)				**58,240,617,300.00**	**5,052,100.74**

1 USD = 11,528 Rupiahs (www.blomberg.com, retrieved May, 05th 2014)

Source: Summarized from Technical division and Procurement bureau, Port of Tanjung Priok

The calculation shows that direct investment cost for civil works are about IDR 58,240,617,300.00 rupiahs or USD 5,052,100.74.00

Some assumptions can be determined to calculate indirect cost. Cost for engineering design, consulting, and supervision work are about 2% from total direct cost. In addition, value added tax is determined 10% from total direct cost by Indonesian government. The amounts of indirect cost are:

- Engineering design consulting = 2% x IDR 58,240,617,300
  = IDR 1,164,812,346.00
- Supervision work = 2% x IDR 58,240,617,300
  = IDR 1,164,812,346.00
- Value added tax = 10% x IDR 58,240,617,300
  = IDR 5,824,061,730.00

Finally, the total cost for civil works are presented by Table 4.19 below.

Table 4.19. Total calculation of civil works

No	Scope of Work	Cost	
		IDR	USD
1	Civil work Block 109 - 113	54,680,448,900.00	4,743,272.81
2	Civil work Block ex - office	3,560,168,400.00	308,827.93
3	Engineering design & consulting	1,164,812,346.00	101,042.01
4	Supervisor work	1,164,812,346.00	101,042.01
5	Added value tax	5,824,061,730.00	505,210.07
	TOTAL CIVIL WORKS	66,394,303,722.00	5,759,394.84

Source: Author calculation

4.2.2. Procurement of material handling equipment

The next stage of technical aspect concerns to procurement of material handling equipment. From the discussion in section 4.1.4 above, selection of container handling equipment for new yard plan is decided to use rail mounted gantry crane (RMGC) and reach stacker (RS). The purchasing price of RMGC and reach stacker refers to previous procurement in Tanjung Priok Multipurpose Terminal with general specification as follows:

Table 4.20. General specification for RMGC and Reach Stacker

No	Item	Specification
A	**RMGC for block 109 - 113**	
1	Lifting capacity	SWL 45 ton under spreader
2	Width of span	35 m
3	Lifting high	1 over 5 high cup container
4	Hoist Lifting speed	30 m/min (rated load)
		60 m/min (empty load)
5	Trolley traveling speed	100 m/min
6	Gantry traveling speed	120 m/min
7	Spreader	Fully electric spreader 20' and 40'
8	Power supply	6.6 KV, 50 Hz, 5% Harmonic
9	Rail type	A100
B	**Reach Staacker for block ex-office**	
1	Total weight with load	max. 80,000 kg
2	Spreader turning radius 20'	max. 12,500 mm
3	Spreader turning radius 40'	max. 14,500 mm
4	Wheel dimension	18.00 x 25 or standard
5	Traveling speed	
	- unloaded (forward/reverse)	min. 24 kph / 24 kph
	- loaded (forward/reverse)	min. 20 kph / 20 kph
6	Lifting speed	
	- unloaded	min. 0,21 m/s
	- loaded	min. 0,40 m/s
7	Spreader	telescopic 20’and 40’
8	SWL under spreader	max. 45.000 kg

Source: Summarized from Technical division and Procurement bureau, Port of Tanjung Priok

While the price for equipment according to the procurement document is represented by Table 4.21 below.

Table 4.21. General estimation for procurement of RMGC and Reach Stacker

NO	Scope of Work	Volume	Unit	Unit Price (USD)	Total (USD)
1	Procurement of 5 units Rail Mounted Gantry Crane Double Cantilever Price including: -Transport and delivery to Port of Tanjung Priok - Loading - Unloading - Installation in Yard - Testing dan Commissioning - Insurance - Training - Waranty - Maintenance free for 1 year - Spare part	5	Unit	1,840,824.94	9,204,124.71
2	Procurement of 1 unit Reach Stacker Price including: -Transport and delivery to Port of Tanjung Priok - Loading - Unloading - Testing dan Commissioning - Insurance - Training - Waranty - Maintenance free for 1 year - Spare part	1	unit	498,785.57	498,785.57
	Amount Duties 5 % Added Value Tax 10 %				9,702,910.27 485,145.51 1,018,805.58
	TOTAL (USD)				**11,206,861.37**
	TOTAL (IDR)				**129,192,697,833.52**

1 USD = 11,528 Rupiahs (www.blomberg.com, retrieved May, 05th 2014)

Source: Summarized from Technical division and Procurement bureau, Port of Tanjung Priok

The calculation shows that investment cost for container handling equipments are about 129,192,697,833.52.00 rupiahs or USD 11,206,861.37.00

4.3. Financial Aspects of Investment

Indonesian economy will influence some variables to decide the feasibility of investment to be executed. Not only because of Indonesian economy connections with global economy but also fluctuation of global economy and market commodities are going to affect revenue and service lifespan of investment. Therefore, some assumptions are created in this research such as:

1. Project financing

   Company's financial position allows them to pay the investment using internal fund. It is assumed that total of investment will be incurred by company.

2. Service lifespan of investment

   The author assumes that performance of assets can run until next 20 years. Estimation of assets depreciation uses straight line depreciation method and assumes that assets do not have salvage value because assets have a long economic life. After economic lifespan period, assets performance will deteriorate and costly to restore the assets to their best performance.

3. Currency

   Calculation of investment refers to Indonesian currency. The volatility of exchange rate between Indonesian currency and US Dollar will affect the sustainability of project. It is decide to set exchange rate about IDR 11,528.00/USD[5].

4. Size of container

   Prediction of annual container throughput does not show the proportion number for 20 feet and 40 feet. However, it can be identified by TEU factor. TEU factor is an important variable to predict the exact number of container boxes that can be handled in the terminal. It represents the ratio between the container boxes and the number of TEU, span from 1 to 2. Ratio 1 means all containers are 20 feet size, while ratio 2 indicates that all containers are 40 feet size.

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5. *www.blomberg.com, retrieved May, 05th 2014*

The author assumes TEU factor ratio for yard capacity about 1.67 that means that number of 20 feet size is about 67% and 40 feet size is about 33% from total of boxes.

4.3.1. Expenses

Capital expenditure of investment has calculated in sub section 4.2 including civil works and procurement of equipments. Total of capital expenditure in yard expansion planning is shown in Table 4.22 below.

Table 4.22. Total of capital expenditure of investment

No	Scope of Work	Cost	
		IDR	USD
1	Civil works - block 109 - 113 - block ex - office	66,394,303,722.00	5,759,394.84
2	Procurement of equipment - 5 units of RMGC - 1 unit of Reach stacker	129,192,697,833.52	11,206,861.37
	TOTAL	195,587,001,555.52	16,966,256.21

Source: Author calculation

In addition, investment planning also calculates operational expenses for operation and maintenance of structure and equipment. For civil structure, Handbook for Planners in Developing Countries published by UNCTAD (1985) gives information about percentage of maintenance cost for surface of stacking yard. It is allocated about 1% of current new cost.

Maintenance cost/year = 1% x IDR. 66,394,303,722.00
= IDR. 663,943,037.22
= USD. 57,593.95

Table 4.23. Maintenance costs for structural elements: values adopted for estimating purposes

Class of structure and type	Annual average maintenance costs as a percentage of current new cost or replacement value
Quay structures	
Steel sheet piling	0.30
Steel piling with reinforced concrete deck	1.00
Reinforced concrete piles and deck	0.75
Rubber fendering ,,,,,,,,,..	1 .00
Embankments	
Rock-fill	0.75
Surfacing	
Concrete aprons or roads	1.00
Asphalt	1.50
Other surfaces (gravel, etc.)	7 50
Breakwater	2.00

Source: UNCTAD, (1985)

Container handling equipments need more components for operation expenses such as labor cost, fuel/electricity cost, maintenance, and spare part. According to Operation and Maintenance Features of Container Handling System issued by UNCTAD (1988), there are some proportions in percentage for operation expenses as shown in table below.

Table 4.24. Components of operation expenses for container handling equipment

Item	Type of Equipment	
	Rail Mounted Gantry Crane	Reach Stacker
Total Operating Expenses	14% from purchasing price	45% from purchasing price
consist of :		
- Labor cost	55% from total OPEX	73% from total OPEX
- Fuel and Eletricity	15% from total OPEX	10% from total OPEX
- Maintenance Cost	30% from OPEX	17% from OPEX
- labor	80% form Maintenance Cost	60% form Maintenance Cost
- spare part	18% form Maintenance Cost	35% form Maintenance Cost
- consumable part	2% form Maintenance Cost	5% form Maintenance Cost

Source: UNCTAD, (1988)

From Table 4.24 is produced calculation of operation expenses for container handling equipment.

Table 4.25. Operation expenses/year/unit equipment

No	Item	Type of Equipment			
		Rail Mounted Gantry Crane		Reach Stacker	
		IDR	USD	IDR	USD
1	Purchase price	21,221,029,908.32	1,840,824.94	5,750,000,050.96	498,785.57
2	Total Operating Expenses	2,970,944,187.16	257,715.49	2,587,500,022.93	224,453.51
	consist of :				
	- Labor cost	1,634,019,302.94	141,743.52	1,888,875,016.74	163,851.06
	- Fuel and Eletricity	445,641,628.07	38,657.32	258,750,002.29	22,445.35
	- Maintenance Cost				
	- labor	713,026,604.92	61,851.72	263,925,002.34	22,894.26
	- spare part	160,430,986.11	13,916.64	153,956,251.36	13,354.98
	- consumable part	17,825,665.12	1,546.29	21,993,750.19	1,907.85

Source: Author calculation

4.3.2. Revenue projection

Port service for stacking yard is incurred to container box that are stacking up in the yard, including container movement using container handling equipment facility in yard. There are several services of container stacking yard such as:

1. Container stacking

   Container stacking fee is classified base on type and size of container:

   - full and empty container for 20 feet and 40 feet
   - Over height / overweight / over length container
   - Refer container

   For stacking time period, Tanjung Priok Multipurpose Terminal applies discount of charge policy for the first 5 days. Time period for first 5 days only considered for a day. After that, stacking charge will be applied normally day by day.

2. Lift on / Lift off (Lo Lo)

   Lift on charge is incurred when container moves from truck chassis to the yard, while lift off charge is applied when container moves from stacking yard to truck chassis.

3. Shifting

   Shifting charge appears when container moves from a point of stacking to other place in a yard.

Table 4.26. Stacking yard services charge in Multipurpose Terminal

No	Port Services	Services Charge
1	Container stacking (average) - 20 feet - 40 feet	 IDR. 17,500/box/day IDR. 26,250/box/day
2	Lift on Lift off (average)	IDR. 140,600
3	Shifting (extra movement)	IDR. 110,000

Source: Operational Division, Port of Tanjung Priok

Base on data in Table 4.26 can be estimated the revenue per year from the new stacking yard by the calculation below.

1. yard capacity of block 109 – 113 = 595,776 Teus/year

- TEU factor = 1.67
- number of box = number of TEU/TEU factor = 595,776/1.67
  = 356,752 boxes
  - ✓ 20’ container = 67% x 356,752
    = 239,023 boxes
  - ✓ 40’ container = 33% x 356,752
    = 117,728 boxes
- average Dwelling time (applied discount charge) = 4 days ≈ 1 day
- revenue/year from stacking activity
  - ✓ 20’ container = IDR.17,500 x 239,023 boxes
    = IDR. 4,182,902,500.00
  - ✓ 40’ container = IDR.26,250 x 117,728 boxes

= IDR. 3,090,360,000.00

- revenue/year from Lift on Lift off = IDR. 140,600 x 356,752 boxes
  = IDR. 50,159,331,200.00
- revenue/year from shifting = IDR. 110,000 x 356,752 boxes x 30%
  (assumption 30% container) = IDR. 11,772,816,000.00
- Revenue/year = stacking (20' and 40') + Lo Lo + Shifting
  = 4,182,902,500.00 + 3,090,360,000.00 + 50,159,331,200.00
  + 11,772,816,000.00
  = IDR. 69,205,409,700.00 ≈ USD. 6,003,245.12

2. yard capacity of block ex - office = 51,915 Teus/year

- TEU factor = 1.67
- number of box = number of TEU/TEU factor = 51,915/1.67
  = 31,087 boxes
  - ✓ 20' container = 67% x 31,087
    = 20,828 boxes
  - ✓ 40' container = 33% x 31,087
    = 10,259 boxes
- average Dwelling time (applied discount charge) = 4 days ≈ 1 day
- revenue/year from stacking activity
  - ✓ 20' container = IDR.17,500 x 20,828 boxes
    = IDR. 364,493,038.92
  - ✓ 40' container = IDR.26,250 x 10,259 boxes
    = IDR. 269,289,633.23
- revenue/year from Lift on Lift off = IDR. 140,600 x 31,087 boxes
  = IDR. 4,370,807,784.93
- revenue/year from shifting = IDR. 110,000 x 31,087 boxes x 30%
  (assumption 30% container) = IDR. 1,025,865,269.46
- Revenue/year = stacking (20' and 40') + Lo Lo + Shifting

= 364,493,038.92.00 + 269,289,633.23 + 4,370,807,784.93 + 1,025,865,269.46

= IDR. 6,030,455,726.05 ≈ USD. 523,113.79

4.3.3. Cash flow analysis

Generally, cash flow analysis describes income and outcome of cash belong to investment. From the investment cash flow can be calculated indicator of project financing such as Net Present Value and Internal Rate of Return that give information about feasibility of investment. Table 4.26 shows information about cash flow analysis of stacking yard expansion project, where the reference formula refers to equation (2.3) until equation (2.6). The computation results Net Present Value (NPV) of IDR. 484,000,516,773.58 equal to USD. 41,984,778.65. Net Present Value gives positive and higher value than present value of cost to be incurred by company to finance the project. Appraisal of ROI about 20.05% is also considered as a measurement of an investment performance. It means that the project is feasible to be executed by company.

The next financial indicator is Internal Rate of Return (IRR). The calculation gives percentage value of IRR about 27.02%. This value is greater than rate of return from free risk investment (bank, government bond, etc). Cash flow analysis predicts the Payback Period of project will take place in the fourth year of assets operation. It means port operator begin to gain profit from the fourth year of assets operation until next 16 years with assumption of assets lifespan about 20 years. This indicator recommends port operator to invest in expanding yard project.

Table. 4.27. Project cash flow analysis

No	Stacking Yard & Equipment Investment (in million rupiahs)	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
1	Capital Expenditure	195,587.00																				0.00
2	Earnings p.a.*																					
	A. Yard Block 109 - 113																					
	1. Stacking service																					
	- 20 feet		4,182.90	4,182.90	4,182.90	4,182.90	4,182.90	4,392.05	4,392.05	4,392.05	4,392.05	4,392.05	4,611.65	4,611.65	4,611.65	4,611.65	4,611.65	4,842.23	4,842.23	4,842.23	4,842.23	4,842.23
	- 40 feet		3,090.36	3,090.36	3,090.36	3,090.36	3,090.36	3,244.88	3,244.88	3,244.88	3,244.88	3,244.88	3,407.12	3,407.12	3,407.12	3,407.12	3,407.12	3,577.48	3,577.48	3,577.48	3,577.48	3,577.48
	2. Lift on Lift off		50,159.33	50,159.33	50,159.33	50,159.33	50,159.33	52,667.30	52,667.30	52,667.30	52,667.30	52,667.30	55,300.66	55,300.66	55,300.66	55,300.66	55,300.66	58,065.70	58,065.70	58,065.70	58,065.70	58,065.70
	3. Shifting		11,772.82	11,772.82	11,772.82	11,772.82	11,772.82	12,361.46	12,361.46	12,361.46	12,361.46	12,361.46	12,979.53	12,979.53	12,979.53	12,979.53	12,979.53	13,628.51	13,628.51	13,628.51	13,628.51	13,628.51
	B. Yard Block Ex - Office																					
	1. Stacking service																					
	- 20 feet		364.49	364.49	364.49	364.49	364.49	382.72	382.72	382.72	382.72	382.72	401.85	401.85	401.85	401.85	401.85	421.95	421.95	421.95	421.95	421.95
	- 40 feet		269.29	269.29	269.29	269.29	269.29	282.75	282.75	282.75	282.75	282.75	296.89	296.89	296.89	296.89	296.89	311.74	311.74	311.74	311.74	311.74
	2. Lift on Lift off		4,370.81	4,370.81	4,370.81	4,370.81	4,370.81	4,589.35	4,589.35	4,589.35	4,589.35	4,589.35	4,818.82	4,818.82	4,818.82	4,818.82	4,818.82	5,059.76	5,059.76	5,059.76	5,059.76	5,059.76
	3. Shifting		1,025.87	1,025.87	1,025.87	1,025.87	1,025.87	1,077.16	1,077.16	1,077.16	1,077.16	1,077.16	1,131.02	1,131.02	1,131.02	1,131.02	1,131.02	1,187.57	1,187.57	1,187.57	1,187.57	1,187.57
3	Operating cost p.a.**																					
	1. Yard structure		1,955.87	2,053.66	2,156.35	2,264.16	2,377.37	2,496.24	2,621.05	2,752.11	2,889.71	3,034.20	3,185.91	3,345.20	3,512.46	3,688.08	3,872.49	4,066.11	4,269.42	4,482.89	4,707.03	4,942.39
	2. 5 units of RMGC		14,854.72	15,597.46	16,377.33	17,196.20	18,056.01	18,958.81	19,906.75	20,902.08	21,947.19	23,044.55	24,196.78	25,406.61	26,676.94	28,010.79	29,411.33	30,881.90	32,425.99	34,047.29	35,749.66	37,537.14
	3. 1 unit of Reach Stacker		2,587.50	2,716.88	2,852.72	2,995.35	3,145.12	3,302.38	3,467.50	3,640.87	3,822.92	4,014.06	4,214.76	4,425.50	4,646.78	4,879.12	5,123.07	5,379.23	5,648.19	5,930.60	6,227.13	6,538.48
4	Net Cashflows	-195,587.00	55,837.77	54,867.87	53,849.47	52,780.15	51,657.36	54,240.23	53,002.36	51,702.60	50,337.84	48,904.85	51,350.10	49,770.22	48,111.36	46,369.55	44,540.65	46,767.68	44,751.32	42,634.14	40,411.10	38,076.91
5	Cumulative cashflows	-195,587.00	-139,749.23	-84,881.36	-31,031.89	21,748.26	73,405.63	127,645.86	180,648.22	232,350.82	282,688.66	331,593.52	382,943.61	432,713.83	480,825.19	527,194.74	571,735.39	618,503.07	663,254.39	705,888.53	746,299.63	784,376.53
6	Payback	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
7	Discounted cash flows	-195,587.00	53,690.17	50,728.43	47,871.98	45,116.69	42,458.59	42,866.84	40,277.44	37,778.58	35,366.70	33,038.37	33,356.04	31,086.33	28,894.43	26,777.26	24,731.84	24,969.65	22,974.13	21,045.41	19,180.82	17,377.80
8	Discounted cumulative cash flows	-195,587.00	-141,896.83	-91,168.40	-43,296.42	1,820.27	44,278.86	87,145.70	127,423.14	165,201.72	200,568.43	233,606.79	266,962.83	298,049.17	326,943.60	353,720.86	378,452.70	403,422.35	426,396.48	447,441.89	466,622.71	484,000.52
9	NPV***	484,000.52	484,000.52																			
10	IRR	27.02%																				

* Stacking charge increase 5% of every 5 year

** increase 5% per year follow Indonesian inflation

*** Discount rate 4%

	Investment	TC p.a	Opex p.a.	EBIT	ROI
Yard Expansion Project	195,587.00	81,069.00	32,070.82	39,218.83	20.05%

Source: Author calculation

4.3.4. Sensitivity analysis

Sensitivity analysis is carried out to examine project capacity against possible change of cash flow and revenue in the future. This method is applied by creating some scenarios and observing how the circumstances will influence the investment. The key variables to be analyzed are increasing of investment cost due to inflation (5%, 10%, 12.5%, and 15%) and falling down of revenues (5%, 10%, 15%, 20%) due to reduction of seaborne trade volume. The simulations of many scenarios are presented by table below.

Table 4.28. Simulation summary of sensitivity analysis

Investment Indicator	Scenario for Change of Variables			
	Inflation per year			
	5%	10%	12.5%	15%
NPV (IDR)	472.158,40	197.512,65	-12.343,41	-294.295,15
IRR (%)	25,57%	20,03%	12,11%	-
ROI (%)	18,78%	6,60%	-2,24%	-13,80%
Payback Period (year)	4	5	5	5
	Reduction of Revenue per year			
	5%	10%	15%	20%
NPV (IDR)	429.562,90	375.125,29	320.687,67	266.250,06
IRR (%)	24,90%	22,75%	20,53%	18,24%
ROI (%)	17,98%	15,91%	13,83%	11,76%
Payback Period (year)	4	5	5	6

Source: Author calculation

Sensitivity analysis shows that the transformation of NPV still have positive value when total cost (investment cost, operating, and maintenance cost) rise due to inflation at 5% and 10% position. However, NPV value becomes negative when the inflation value is greater than or equal to 12.5%. It means that in this circumstance, investment is no longer reasonable. On the other side, revenue decreasing in certain percentage of simulation does not significantly affect the value of NPV. It means that revenue changeability under unexpected value still keep the investment is worth to be executed.

Tabel 4.29. Combination scenario for sensitivity analysis

Investment Indicator	Combination scenario															
	I 5%, R 5%	I 5%, R 10%	I 5%, R 15%	I 5%, R 20%	I 10%, R 5%	I 10%, R 10%	I 10%, R 15%	I 10%, R 20%	I 12.5%, R 5%	I 12.5%, R 10%	I 12.5%, R 15%	I 12.5%, R 20%	I 15%, R 5%	I 15%, R 10%	I 15%, R 15%	I 15%, R 20%
NPV (IDR)	417.720,79	363.283,17	308.845,56	-348.732,76	143.075,03	88.637,42	34199,80031	-348.732,76	-66.781,03	-121.218,64	- 175.656,26	-230.093,87	-348.732,76	-403.170,37	-457.607,99	-512.045,60
IRR (%)	23,53%	21,45%	19,32%	-	17,29%	14,12%	9,89%	-	-	-	-	-	-	-	-	-
ROI (%)	16,81%	14,83%	12,86%	-15,60%	4,72%	2,83%	0,95%	-15,60%	-4,08%	-5,92%	-7,77%	-9,61%	-15,60%	-17,40%	-19,21%	-21,01%
Payback Period (year)	5	5	5	6	6	5	6	7	5	6	6	7	-	-	-	-

I = Inflation rate per year

R = Reduction of Revenue per year

Source: Author calculation

Table 4.29 represents combination scenarios for sensitivity analysis. Table gives information that in the inflation rate 5% and 10%, decline in revenue to 15% per year just keep the project is safe to be continued. When the revenue go down to 20% under unexpected value causes the project become no longer acceptable. At the same time, hyper inflation (greater than or equal to 12.5%) clearly indicates that the project Become not feasible anymore designated by negative NPV value.

CHAPTER V
CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Stacking yard is a port facility for temporary container storage before loading to container vessel or after unloading from container vessel. It is needed to avoid delay time risk of ship that create a decrease in productivity of container handling and reduce effective time for ship and cargo in port. The increasing of cargo flows in the recent years force the port operator to expand their stacking yard. Annual container throughput rise from 163,313 Teus in 1996 to 2,796,825 Teus in 2013. It is predicted to increase until next few years. From container throughput forecasting calculated by Auto regression Moving average method (ARMA) model show that container throughput will reach 4,244,637 Teus in 2016.

However, limited land is a problems often faced by port, including Tanjung Priok Multipurpose Terminal. They have to own a comprehensive master plan to maximize allocated area and avoid congestion in port. In the recent time, Tanjung Priok Multipurpose Terminal has about 301,638.90 m^2 of container storage area with the capacity almost 3,600,647 Teus/year and Yard Occupancy Ratio (YOR) has reached 77.68% in 2013. It will not able to gather predicted container throughput in 2016. One of applied alternative is using Block 109 – 113 and Block Ex – Office to accommodate demand in stacking yard. They have yard capacity about 595,776 Teus/year and 51,915 Teus/year respectively. To maintain service quality, port operator has to provide appropriate container handling equipment in yard. Base on comparison of equipment and considering yard capacity, it is decided to operate 5 units Rail Mounted Gantry Crane (RMGC) in Block 109 – 113 and 1 unit Reach Stacker in Block Ex – Office.

To carry out the expansion planning, the port managements have to do project appraisal to examine feasibility of investment. From the calculation, port has to spend totally about IDR. 195,587,001,555.52 equal to USD. 16,966,256.21 to finance the investment. Refers to yard capacity and container handling charge in yard, it is predicted to obtain the revenue about IDR. 69,205,409,700.00 equal to USD. 6,003,245.12 per year from Block 109 – 113 and IDR. 6,030,455,726.05 equal to USD. 523,113.79 per year from Block Ex – Office. By considering operating expenses of assets during next 20 years, computation of investment indicators presents Payback Period is occurred in fourth year with NPV about IDR. 484,000,516,773.58 equal to USD. 41,984,778.65, whilst IRR and ROI give percentage value about 27.02% and 20.05% respectively. These indictors notify that stacking yard expansion project is reasonable to overcome increasing demand of stacking yard service in port. Furthermore, the sensitivity analysis exhibits that investment is still feasible on condition of inflation rate 5% and 10% with acceptable decreasing of revenue up to 15% under unexpected circumstances.

5.2. Recommendation

This research attempts to give an alternative to solve demand of container stacking yard in port which has limited area. However, problem solving is probably suitable to be applied in next few years. For long time period, port managements have to looking for new area to accommodate the increased flow of containers at the port by sea reclamation to expand the port or build a new port in strategic area. Provision of port facility to maintain service quality not only will increase costumer’s satisfaction but also provide many benefits to the port operator and government. Further analysis is needed with considering other parameters such as berth performance and water side equipment study (e.g. ship to shore crane or harbor mobile crane) to acquire complete observation and ensure that the result of study can be applied for problem solving in port.

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