# Optimization Container Yard Capacity Of Pantoloan Port in 2020 to Support Corridor Sulawesi Connectivity

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## Abstract

*The research aims to analyze the optimal utilization of container yard based on queuing model as well as the costs incurred by operators and users of port services. Optimization method is used to determine the level of utilization of container yard. Forecasting method using multiple regression analysis in which the flow of loading and unloading containers become dependent variable and socio-economic data condotions of Pantoloan Ports hinterland region became independent variable. Yard occupancy ratio optimization is calculated by comparing the cost of procurement of container yard and operational procurement costs of loading and unloading equipment (cost of the port operator) with cost of waiting due to unavailable facilities (cost of the port service users). The result show that the level of utilization of the container yard Pantoloan Port in 2020 is 70,20 % with a broad of optimum container yard is 45.000 $m^2$ with 219.000 TEUS per year capacity.*

## 1. Introduction

Central government programs that make Sulawesi as one of the corridors in the Master Plan for the Acceleration of Indonesian Economic Development (MP3EI) makes the entire infrastructure including ports in the island of Sulawesi continued accelerated development. Sulawesi's corridor which is 4$^{th}$ corridor in MP3EI has prepared a large investment to develop all ports in the main class of Sulawesi, including the Port Pantoloan in Palu. In the National Spatial Plan, Port Pantoloan has now become a major class port and prepared to become an international port with higher priority. Here is the data development of ship traffic in the Port of Pantoloan during the period 2007-2011:

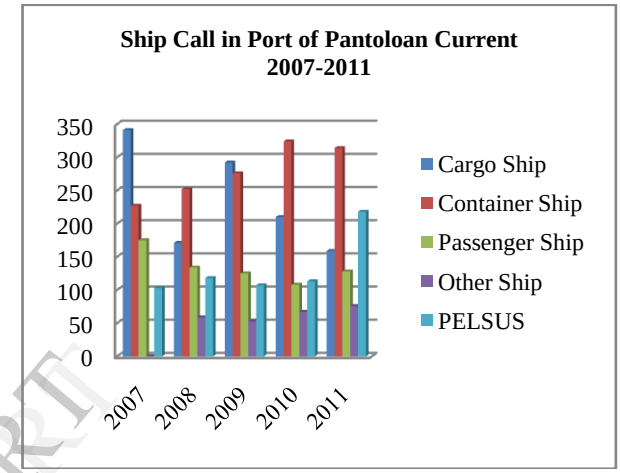


Figure 1. Ship Call in Port of Pantoloan

Here also presented data on the flow of loading and unloading containers at the Port of Pantoloan between the years 2007-2011:

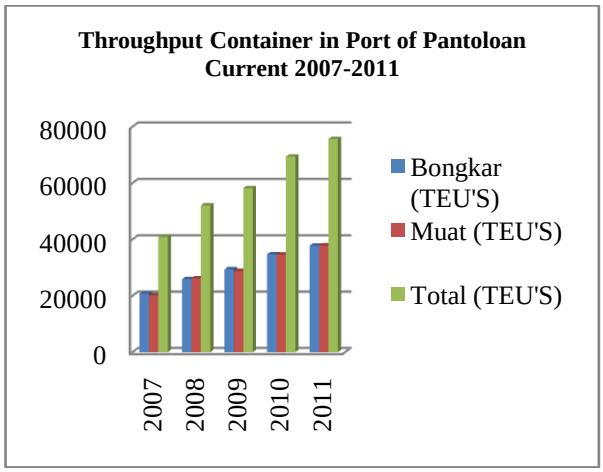


Figure 2. Throughput Container in Port of Pantoloan

Appropriate port development master plan Pantoloan , container yard will be expanded to cope the high flow of container in the future . Currently vast container port Pantoloan yard is 18 860 $m^2$ . In 2014 the planned container yard will be expanded to 34 705 $m^2$ . Container ships docks are now been expanded from 250 meters to 380 meters to prevent queuing incoming ships . Based on this background , it would require a study to look at the container yard capacity optimization of Pantoloan port in the future. This study aims to anticipate the flow of services to the container in the future. Optimization of the use of container stacking can be done in several ways, namely by applying queuing model approach to see how many containers are queued, then by knowing that there is a queue container, then calculated the cost of goods and cost of goods piled up waiting ship . The operators then calculated as how the cost of port operations . The lowest cost in terms of operator and service users which is the benchmark for optimum container yard . However YOR value remains to be seen . Based on the above explanation , the authors interested to research the topic with the title : " NEEDS OPTIMIZATION OF CONTAINER YARD CAPACITY OF PANTOLOAN PORT in 2020"

## 2. Literature Study

Based on Government Regulation no. 69 of 2001 About port, which is port is made up of land and water with certain limits as the activities of government and economic activity, which is used as a lean ship, docked, up and down passenger and cargo handling facilities are equipped with supporting the safety of shipping and port activities as well as the displacement of intra and inter-modal transport.

### 2.1. Container Yard

To carry out activities unloading of containers at the port, the port must be equipped with various facilities, namely:

a. Container Ship Dock

Container terminal requires a large courtyard, which is usually more than 10 hectares for each of the moorings. For it must be of type wraft dock, pier or finger-shaped instead. Given the large container ships that dock should be long enough and have deep water.

b. Apron

Apron container terminal is greater than the terminal apron to another, usually measuring between 20 m to 50 m. Placed on the apron of container unloading equipment such as giant crane (gantry cranes), rail-to-rail, truck and trailer lines.

c. Marshailing Yard

Marshailing Yard is a yard used to place containers will be temporarily loaded into ships. This temporary yard is located near the apron.

d. Container Yard

Container yard in the port area is the area that used to contain and put the container empty container that will be shipped or transported out of the harbor. This field is located on the mainland and the surface should be hardened to be able to support the transport and lifting equipment or container loads. Stacking container must have both longitudinal aisles and transverse to the operation of container handling equipment.

e. Container Freight Station (CFS)

CFS is provided for handling warehouse stuffing and stripping stuff. In CFS at loading port, the goods of several shipping containers put together in a one containers. At the port of destination / unloading, containers are loaded LCL CFS and then transported to the charge removed and stored in warehouses and shipping companies concerned petikemasnya returned to the ship.

### 2.2. YOR Calculation

Yard Occupancy Ratio (YOR) is the ratio between the amount of usage stacking yard area with capacity available in a time unit.

$$YOR = \frac{\text{Capacity Used (TEUS/year)}}{\text{Capacity Available (TEUS/year)}} \text{ x } 100\ \%$$

Where the available capacity (AC) is calculated by the formula:

$$AC = \frac{\text{Effective Broad x Pericodic x Stack Height}}{\text{Container Broad x Dwelling Time}}$$

Formulation and use of standards for the usage of container yard (Minsitry of Interconnection Decree No. KM 53 of 2002):

a. Ready for operation time, is equal to the time available (possible time) to dock which is additional 24 hours multiplied by the number of calendar days in the period.

b. Effective area, is the overall floor area minus the floor area used for traffic equipment and people, offices and border security, effective area ± 60% of the total area.

c. Stacking capacity, is the maximum amount of goods in the warehouse / field both in units of weight (tons) or volume ($m^3$) of effective area multiplied by the number of calendar days.

d. The average time the goods are stacked (Dweling Time / DT), is the average number of days per ton or $m^3$ goods at capacity during a certain time unit.

### 2.3. Cost and Service Level Relations

Cost optimization model of the queue is used to obtain a level of service with optimal results in terms of both value and number of maid service. This is achieved by balancing the cost of existing services with waiting costs caused by existing services.

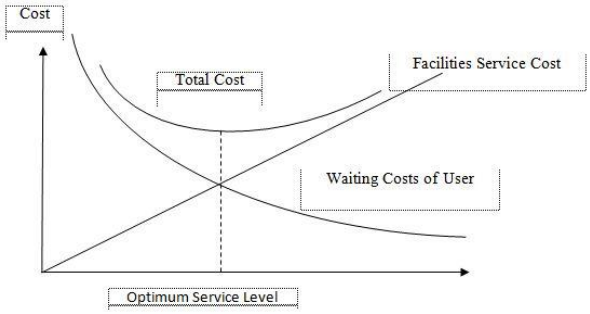


Figure 3. Optimum Service Level

## 3. Research Methodology

The methodology used in analyzing hinterland area based on hinterland accessibility level districts located in Central Sulawesi province to the mileage indicator and a road network that connects to the hinterland area with Pantoloan port. In determining the forecasting model of ship traffic and the flow of container using multiple regression models using stepwise modeling stages. The analysis of the level of utilization of container yard with find optimal YOR and minimum cost incurred for the operators and users of port services.

## 4. Result

### 4.1. Hinterland Area Analysis

Pantoloan port is a class I port, located in the province of Central Sulawesi, where in the province Pantoloan became the main port of many ports collection around it, such as in Donggala, Kolonodale, and Toli-toli. Discern accessibility to the Port Pantoloan, covering both road conditions and travel time to the Port Pantoloan faster compared to the Port of Bitung in North Sulawesi or the Port of Soekarno-Hatta in Makassar, the entire area in Central Sulawesi province can be Pantoloan Ports hinterland areas.

Socio-economic potential of the chosen as the independent variable of container flow forecasting is the number of population and GDP. GDP chosen because in it there are the values of other business sectors such as plantations, trade, industry, and others.

### 4.2. Container Flow Forecasting in Pantoloan Ports 2012-2020

To determine the current models of loading/unloading containers flow at the Port Pantoloan, its used multiple regression method. Forecasting results of socio-economic potential of hinterland areas used as independent variables (population x1, x2 GDP) and container flow is used as the dependent variable. The model is: $y$ = 46530.36684 + (0.01528077 x $X_1$) + (0.002295365 x $X_2$)

While the model for forecasting the flow of containers in the port of unloading Pantoloan are:

$y = 53208.12728 + (0.018811231 \times X_1) + (0.002148683 + X_2)$

From the forecasting model, forecasting the flow of loading and unloading containers at the Port Pantoloan year 2012-2020 as follows:

Table 1. Loading and Unloading Forecasting

| Year | Loading Forecasting (TEUS) | Unloading Forecasting (TEUS) | Total (TEUS) | Growth (%) |
|---|---|---|---|---|
| 2012 | 42,454 | 42,553 | 85,007 | - |
| 2013 | 46,703 | 46,894 | 93,597 | 10,11 |
| 2014 | 50,952 | 51,236 | 102,187 | 9,18 |
| 2015 | 55,201 | 55,577 | 110,778 | 8,41 |
| 2016 | 59,450 | 59,918 | 119,368 | 7,75 |
| 2017 | 63,698 | 64,259 | 127,958 | 7,20 |
| 2018 | 67,947 | 68,600 | 136,548 | 6,71 |
| 2019 | 72,196 | 72,942 | 145,138 | 6,29 |
| 2020 | 76,445 | 77,283 | 153,728 | 5,92 |
| | | | Average | 6,16 |

### 4.3. YOR Calculation

Due to development plan of Pantoloan Port's container yard, then in 2014, yard broad will be expanded from 18 860 $m^2$ (91 785 TEUS / year) to 34 705 $m^2$ (168 898 TEUS / year). YOR value is calculated by comparing the unused capacity with available capacity , where capacity utilization is the amount of current that passes through the Port container container, while the available capacity is the amount of container that can be served the port each year. Then the value of the Port Pantoloan YOR 2007-2020 year are:

**Table 2. Forecasting of Yard Occupancy Ratio**

| No | Year | Containers Flow (TEUS) | CY Capacity (TEUS) | YOR (%) |
|---|---|---|---|---|
| 1 | 2007 | 40869 | 91785 | 34,76 |
| 2 | 2008 | 52088 | 91785 | 44,3 |
| 3 | 2009 | 58196 | 91785 | 49,5 |
| 4 | 2010 | 69396 | 91785 | 59,02 |
| 5 | 2011 | 75636 | 91785 | 64,33 |
| 6 | 2012 | 85007 | 91785 | 82,17 |
| 7 | 2013 | 93597 | 91785 | 90,4 |
| 8 | 2014 | 102187 | 168898 | 60,5 |
| 9 | 2015 | 110778 | 168898 | 65,59 |
| 10 | 2016 | 119368 | 168898 | 70,67 |
| 11 | 2017 | 127958 | 168898 | 75,76 |
| 12 | 2018 | 136548 | 168898 | 80,85 |
| 13 | 2019 | 145138 | 168898 | 85,93 |
| 14 | 2020 | 153728 | 168898 | 91,02 |

### 4.4. Queuing Model

Queues that calculated is how much containers are lining up every day at the container yard. From the analysis, it is known distribution pattern of arrivals follow Poisson distribution and the distribution of the

average service rate follow an exponential distribution. So we can conclude poisson arrival distribution and level of service is exponentially distributed, infinite source queue and a single service (M/M/1). Queue values are presented in the following table:

**Table 3. Forecasting of Queueing Value**

| Year | Capacity (m2) | Capacity (TEUS) | Container Arrival Annually | Container Arrival Daily (λ) | Service Daily (μ) | Lq | Wq | Ls | Ws |
|---|---|---|---|---|---|---|---|---|---|
| 2007 | 11,316 | 91,785 | 40,869 | 112 | 251 | 0,36 | 0,003 | 0,800 | 0,007 |
| 2008 | 11,316 | 91,785 | 52,088 | 143 | 251 | 0,74 | 0,005 | 1,310 | 0,009 |
| 2009 | 11,316 | 91,785 | 58,196 | 159 | 251 | 1,1 | 0,007 | 1,730 | 0,011 |
| 2010 | 11,316 | 91,785 | 69,396 | 190 | 251 | 2,34 | 0,012 | 3,100 | 0,016 |
| 2011 | 11,316 | 91,785 | 75,636 | 207 | 251 | 3,86 | 0,019 | 4,680 | 0,023 |
| 2012 | 11,316 | 91,785 | 85,007 | 233 | 251 | 11,62 | 0,050 | 12,540 | 0,054 |
| 2013 | 11,316 | 91,785 | 93,597 | 256 | 251 | -52,67 | -0,205 | -51,650 | -0,201 |
| 2014 | 20,823 | 168,898 | 102,187 | 280 | 463 | 0,93 | 0,003 | 1,530 | 0,005 |
| 2015 | 20,823 | 168,898 | 110,778 | 304 | 463 | 1,25 | 0,004 | 1,910 | 0,006 |
| 2016 | 20,823 | 168,898 | 119,368 | 327 | 463 | 1,7 | 0,005 | 2,410 | 0,007 |
| 2017 | 20,823 | 168,898 | 127,958 | 351 | 463 | 2,37 | 0,007 | 3,130 | 0,009 |
| 2018 | 20,823 | 168,898 | 136,548 | 374 | 463 | 3,41 | 0,009 | 4,220 | 0,011 |
| 2019 | 20,823 | 168,898 | 145,138 | 398 | 463 | 5,25 | 0,013 | 6,110 | 0,015 |
| 2020 | 20,823 | 168,898 | 153,728 | 421 | 463 | 9,22 | 0,022 | 10,130 | 0,024 |

Table 3 shows that the value of Lq (number of containers waiting queue) in 2013 showed the number -52.67. Minus figure indicates that the queue has reached infinity. Once there is development in 2014, the value of Lq down at 0.93 points.

### 4.5. Optimum YOR

Yard occupancy ratio (YOR) optimum is calculated by calculating minimum cost between operator (stacking investment costs and container handling equipment) and user fees (cost of container ships queuing and queuing costs).

Port operator costs include:

- The cost of construction and maintenance yard
- Procurement and operational costs of loading and unloading equipment

While user fees consist of:

- The cost per year of container waiting
- Ships waiting cost

**Table 4. Optimality of Yard Occpancy Ratio**

| NO | Broad of CY (m2) | Capacity (TEUS/YEAR) | Queue Containers | Load in 2020 (TEUS) | Total Cost of User (RP) | Total Cost Of Operator (RP) | Total Cost (RP) | YOR (%) |
|---|---|---|---|---|---|---|---|---|
| 1 | 60 | 292 | 1 | 153.728 | 21.981.214.688 | 62.396.819.596 | 84.378.034.284 | 52.65 |
| 2 | 55 | 267,667 | 1 | 153.728 | 21.981.214.688 | 57.197.084.630 | 79.178.299.318 | 57.43 |
| 3 | 50 | 243,333 | 1 | 153.728 | 21.981.214.688 | 51.997.349.664 | 73.978.564.351 | 63.18 |
| 4 | 45 | 219 | 2 | 153.728 | 22.003.189.875 | 46.797.614.697 | 68.800.804.573 | 70.20 |
| 5 | 40 | 194,667 | 3 | 153.728 | 22.025.165.063 | 41.597.879.731 | 63.623.044.794 | 78.97 |
| 6 | 35 | 170,333 | 8 | 153.728 | 22.135.041.001 | 36.398.144.765 | 58.533.185.766 | 90.25 |
| 7 | 34,705 | 168,898 | 8 | 153.728 | 22.135.041.001 | 36.091.360.402 | 58.226.401.403 | 91.02 |
| 8 | 30 | 146 | | 153.728 | - | 31.198.409.798 | 31.198.409.798 | 105.29 |
| 9 | 25 | 121,667 | | 153.728 | - | 25.998.674.832 | 25.998.674.832 | 126.35 |
| 10 | 20 | 97,333 | | 153.728 | - | 20.798.939.865 | 20.798.939.865 | 157.94 |
| 12 | 15 | 73 | | 153.728 | - | 15.599.204.899 | 15.599.204.899 | 210.59 |
| 13 | 10 | 48,667 | | 153.728 | - | 10.399.469.933 | 10.399.469.933 | 315.88 |
| 14 | 5 | 24,333 | | 153.728 | - | 5.199.734.966 | 5.199.734.966 | 631.76 |

Based on the table above it can be seen that the optimum capacity by 2020 is widely container yard of 45,000 $m^2$. With such widespread, occurring queues container is 3 TEUS / day with YOR value 70.20%. Total costs incurred by the port operator is Rp 46,797,614,697 and the total costs incurred by the service user port is not available due to facility is Rp 22,003,189,875.

## 5. Conclusion

Based on the analysis that has been done, it can be concluded that the optimum capacity of the container yard at Port Pantoloan 2020 ie 45,000 $m^2$ with YOR 70.20% which is able to accommodate 219,000 TEUS containers per year. Pantoloan Port development plan that will only expand the container yard in 2014 to 34 705 $m^2$ is not in accordance with the requirements in 2020.

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