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Analysis of Container Yard Requirements at Sorong Container Port

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***Abstract*— Along with the increase in trade activities by sea, the need for adequate port facilities, including the Container Yard, is becoming increasingly important. This study aims to analyze the needs of stacking yard facilities at Sorong Container Port. The research method used is a quantitative approach with data collection through documentation studies and observation at the research location, namely Sorong Container Port. The results showed that although the flow of containers is projected to continue to increase until 2026, the use of the stacking yard is still low with a Yard Occupancy Ratio (YOR) ranging from 12.43% to 14.59%. This indicates an opportunity to improve port operational efficiency. This study recommends optimizing the use of the piling yard, improving the loading and unloading process, developing infrastructure, and improving coordination with stakeholders. Further analysis of infrastructure investment and comparative studies with other ports are also recommended.**

Keywords— Container Yard, Container Port, Yard Occupancy Ratio, Container Flow, Port Efficiency.

I. INTRODUCTION

Indonesia is a country made up of many islands, two-thirds of which are oceanic, and is strategically positioned at the crossroads of global trade routes. For these reasons, ports play a significant role in supporting economic growth, social mobility and trade in the region. As a result, ports have a very important role for the government in running the country's economy [1].

The hinterlands cargo condition in Indonesia is divided into 4 catchment areas namely Sumatra, Java & Kalimantan, Sulawesi, Papua & other islands in Eastern Indonesia, as described below.

connectivity and development of 6 priority corridors

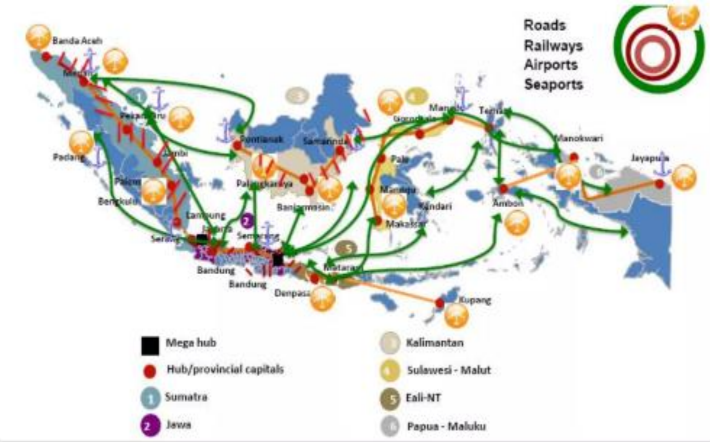

Figure 1 Intermodal distribution map of goods

Based on the distribution map, the port serves as the entrance to a region or country and as a tool to connect regions, islands, or even countries, continents, and nations. Ports play an important role in the flow of trade and distribution of goods in Indonesia and around the world, with 85% of world trade conducted by sea, and 90% of trade in Indonesia conducted by sea [2].

The development of Indonesian ports continues to be encouraged by the program of President Joko Widodo's administration to make Indonesia the world's maritime axis. Ports are an important element in building a strong maritime territory [3]. The definition of the port itself according to Law No. 17 of 2008 concerning Shipping is a place consisting of land and/or waters with certain boundaries as a place of government activities and business activities that are used as a place for ships to dock, embark and disembark passengers, and/or loading and unloading goods, in the form of terminals and ship

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berths equipped with shipping safety and security facilities and port support activities as well as a place for intra-and intermodal transportation movements [4].

Looking at the current state of the port, the traffic flow is quite dense, the high flow of containers and the limited area of container stacking field facilities need to be balanced with good service management that can smooth the process of entry and exit of containers in the container terminal environment, so as not to cause high utilization of the stacking field (Yard Occupancy Ratio / YOR).

Basically, the phenomenon of the global economic boom and the growth of international trade relations have caused catastrophic consequences for many transportation sectors [5]. The maritime supply chain is the most affected sector [5]. Maritime container terminals are essential in the global supply chain. According to [6], 17.1% of global trade volume is transported in containers; in 2017, ports handled more than 80% of global goods trade. Due to its cheapness, containerized traffic also accounts for a large portion of international trade. Therefore, maritime transportation is vital to the economic health of many countries [7].

According to Gharehgozli et al. (2020) [8], container terminals play a vital role in the container transportation network. To meet the needs of terminal owners and maintain competitiveness, terminals must operate efficiently and smoothly, which is essential for keeping operating costs low. In addition, terminals play a major role in the process of loading, storing, and unloading containers. In order for operations to run smoothly, the freight management design needs to consider avoiding congestion at the terminal. Simplifying this process is crucial as the smooth operation of both the sea and land side depends on the access of vehicles to pick up and load containers [9]. A container stacking yard consists of several blocks, with a number of rows and bays in each block, and tiers in each row and bay. As stated by [10], the increase in container flows every year is certainly positive. However, when the port is not prepared to handle the increased container flow, it can become a problem.

Container yard is a place to collect, store, and stack containers; loaded containers are given to the consignee, and empty containers are taken by the shipper [11]. A modern container terminal consists of several sections, namely: for export/import, reference, and empty [11]. According to the Port Reference series 3 Port Operation, a *container yard* is an area used to hand over and receive containers (*receiving/delivery*), stack export/import containers, empty containers, and *standby* container loading and unloading equipment [12].

One of the ports with heavy sea transportation flows is Sorong Container Port. Sorong Container Port is a container terminal located in West Papua Province (Pelindo, 2022). The port was inaugurated as a container port in 2021 (Media Indonesia, 2021). Sorong Container Terminal is planned to become a hub for container activities in Eastern Indonesia [13]. This can encourage the effectiveness of shipping to Eastern Indonesia and have an impact on cost efficiency [14]. The Sorong Container Terminal has also been operated for 24 hours a day (Pelindo, 2022). The construction of Sorong Container Port was carried out by Pelabuhan Indonesia II and the Sorong Regency Government in 2011. In the period of 2022, the container flow at TPK Sorong was recorded at 48,048 teus [14]. However, the potential container flow at TPK Sorong when it becomes a hub in Eastern Indonesia is estimated to reach 243,000 teus (Widarti, 2023).

By looking at the growth of container flow in Sorong Port, it will definitely increase every year along with the port development plan, so it is necessary to conduct a study to determine the stacking field (*Container Yard*) at Sorong Container Port. So, the authors are interested in conducting research on "Analysis of Container Yard Requirements at Sorong Container Port.

The novelty of this research lies in its approach that focuses specifically on analyzing the needs of container stacking yards in Sorong Port. Despite the strategic role of this port, the literature on port management in Indonesia is still minimal in exploring the potential and specific needs of this port. This research is expected to provide practical benefits for port managers by providing recommendations for planning the development of better port facilities, so as to support economic growth in the Eastern Indonesia region, especially Sorong, Papua. In addition, the results of this study are also expected to increase service user satisfaction by improving container handling services, reducing dwelling time, and becoming an important reference for further research on this port. Thus, the main objective of this study is to deeply analyze the needs of container stacking yard facilities at Sorong Port.

1.1 Literature Review

1. Transportation System

The transportation system is an important tool in the success of national development, especially in supporting people's economic activities and regional development. By definition, transportation systems combine the concepts of systems and transportation. Transportation itself refers to the process of moving goods or people from one location to another. Transportation systems, whether land, sea or air, serve as the main link that supports regional development, and are usually heavily influenced by technological advances [15].

According to Purwasih et al. (2023) [16] transportation is the activity of moving goods (cargo) and passengers from one place to another. In transportation, there are two most important elements, namely transfer / movement (movement) and physically changing the place of goods (commodities) and passengers to another place. According to Agusman et al., (2021) [17] transportation can be defined as an effort to move people or goods from one place to another using vehicles driven by humans or machines. Transportation is used to facilitate humans in carrying out their daily activities. Meanwhile, according to Asiyah et al. (2024) [18] the term “transportation” comes from the Latin word “trans,” which means “to lift” or “to carry.” Thus, transportation can be defined as the process of moving something from one location to another.

The transportation system is an interaction that occurs between three interrelated and influencing system components, namely:

1) Activity system
2) Transportation network system
3) Flow system

The relationship between these three subsystems can be illustrated in Figure 2.1:

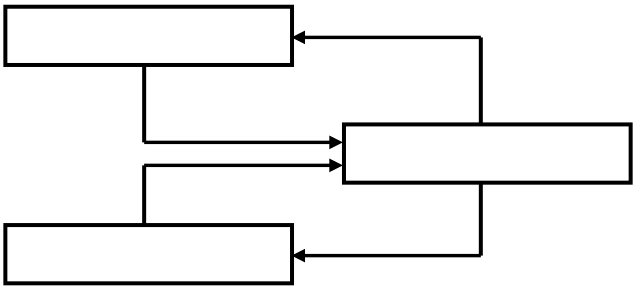

Figure 2 *Sub-system* and transportation relationships
Source: Manhien, 1979

As an illustration of the picture above is transportation flows from one place to another arise due to activities (economic, social, political, etc.) in these areas and the emergence of these flows is also inseparable from the availability of transportation infrastructure and facilities between the two regions. The interaction relationship of the three *subsystems* if: activity increases, then the flow also increases and infrastructure and facilities also increase again and as a result activity also increases. This interaction occurs in the form of a circle that will not stop. Sea transportation is an activity of transporting people or goods from one place to another using ship transportation facilities, as well as port facilities that function as the center of sea transportation activities.

Sea transportation is expected to bridge the gap between regions and encourage equitable distribution of development results. Sea transportation plays an important role in the smooth running of trade because it has economic value, including a lot of carrying capacity and relatively low cost. In order to support trade and cargo traffic, the port was created as a node point for the transfer of goods where ships can dock, lean, load and unload goods and forward to other areas [19].

2. Port

According to Law Number 17 of 2008 concerning Shipping that the port is a place consisting of land and / or waters with certain boundaries as a place of government activities and business activities that are used as a place to dock ships and take passengers and goods and is an area of the working environment of economic activities equipped with safety facilities, sailing security and activities that support the port and as a place of intra-and intermodal transportation. So that ports and transportation are inseparable parts.

The port system consists of 2 main elements, namely the facility or ship element and the infrastructure element (port facilities). Between port facilities and infrastructure have a close relationship, the development of sea transportation facilities technology should be balanced with the development of port infrastructure technology (Amran, 2020). This is a consequence of the emergence of the dimensions of speed and safety in sea transportation.

Basically, the port is another form of terminal that undergoes an IPO process (Input, Process, Output) as seen in Figure 2.2:

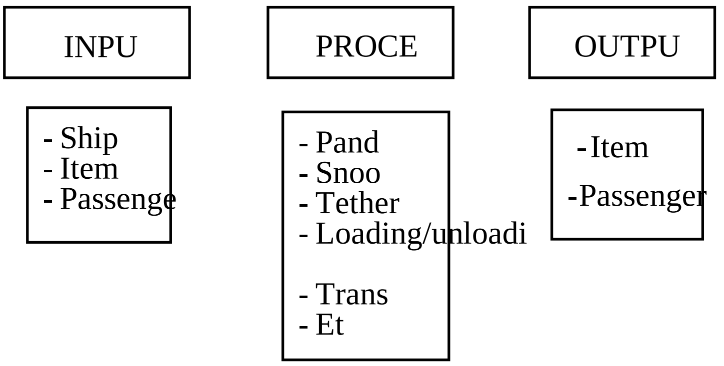

Figure 3 IPO process in port system
Source: Manhien, 1979

1) Facility and Equipment Needs at the Port

Port facilities and equipment determine the capacity of a port in serving its services according to its role and function, therefore determining the need for facilities and equipment is considered based on the type and level of service that must be carried. In order to fulfill these services, the port must have adequate facilities and equipment in accordance with its function. Port facilities and equipment are closely related to the type of ship, goods, packaging and technology and other related operational aspects, so that the calculation must take into account all these aspects.

In general, the main facilities that must be owned by the port consist of ([20], 2020)

a. Mooring facilities
b. Stacking and storage facilities
c. Tools

2) Loading and Unloading Equipment

According to Yuwono et al. (2024) [21] loading and unloading equipment is an important component in port services. Tools also determine the service capacity of a port or terminal, therefore loading and unloading equipment must be reviewed from various aspects as a whole. Some aspects that need to be considered in determining the system, the need for the number, type and capacity of equipment include:

a. Product, type and packaging to be handled
b. Quantity, number and frequency of items to be handled.
c. Route, concerning distance and difficulty and limitations of service conditions.
d. System, how the goods are handled (transportation and stacking).
e. Timing, goods handling time and loading and unloading speed.

As for the calculation of the number of tools for each category of lifting capacity, range and other technical aspects for the calculation of realistic cargo handling productivity, it is necessary to pay attention to things:

a. Estimated number of vessels
b. Statistical data of the number of ship hatches at work simultaneously
c. Load size and weight distribution
d. Location of stacking facility
e. Number of other readiness-related tools
f. Expected readiness level of the tool
g. Number of working hours in 24 hours

3. Container Terminal

Containerization is defined as the transportation of goods in large crates that have a certain size. The transportation of sea cargo by containers began in the fifties and began to develop towards the sixties. It turns out that containerization caused a revolution in the field of transportation and had an impact on all sub-systems in terms of operations and administration [22]. Currently, the world's attention in the field of transportation is focused on the container transportation system which has proven to be a success in the field of transportation, especially in industrialized countries. The main objective desired in this system is the speed of loading and unloading. To produce fast loading and unloading requires the organization of a perfect terminal, because the terminal (port) is a very determining factor in the chain of handling containers from ship to land or vice versa**.**

Based on the provisions of article I of the decision of the Board of Directors of Pelabuhan Indonesia II Number H 1<56/2/4/P.l.II-2000, what is meant by a container terminal is a terminal equipped with at least facilities in the form of moorings, docks, stacking yards (container yards) and equipment suitable for serving container loading and unloading activities, among others:

a. Container Terminal Unit

A terminal at a port specialized in serving containers with a large, hardened yard for loading and unloading and stacking containers that are unloaded or to be loaded onto ships. For loading and unloading a ship, UTPK requires a certain area for one ship to temporarily stockpile newly unloaded containers or arrange containers to be loaded because containers must be loaded in the order in which they are arranged on the ship [23]. The large field is called a *marshalling yard*.

At UTPK there is also a stockpile yard for stacking containers. The tools used to move and stack containers are *top loaders, straddle carriers and transtainers*. While the tools for transportation are *chassis* and *prime movers*.

b. Container Yard

Is an area in the port area that is used to store containers that will be loaded or unloaded from ships.

c. Container Freight Station

Is an area used to *stockpile* containers, carry out *stuffing* and *stripping.*

d. Inland Container Depot

Is an area inland or outside the port area under the supervision of Customs that is used to store containers that will be delivered to *consignee* or received from the *shipper.*

1) Container Load Handling

Activities at the container terminal are the transfer of the flow of land transportation goods to sea transportation or vice versa with the abbreviation *full container* with its activities:

a. Packages (PK) are transported by land transportation (*trailer*) to the port then PK is transported by *Rubber Tyred Gantry* (RTG) placed in the stacking terminal.
b. Using an RTG, the PKs are transported and laid out to await the transport vessel.
c. Once the transport vessel arrives and is ready at the dock, the PK from the stacking terminal is lifted by RTG placed on a *Head Truck* (HT) lifted to the dock apron where the vessel docks.
d. Using a *Gantry Crane,* the PK is lifted from the HT and loaded onto the ship.
e. After the goods are loaded onto the ship, the ship leaves the dock for the destination country/region.

Vice versa If it is described, the loading and unloading process is in accordance with Figure 2.3.

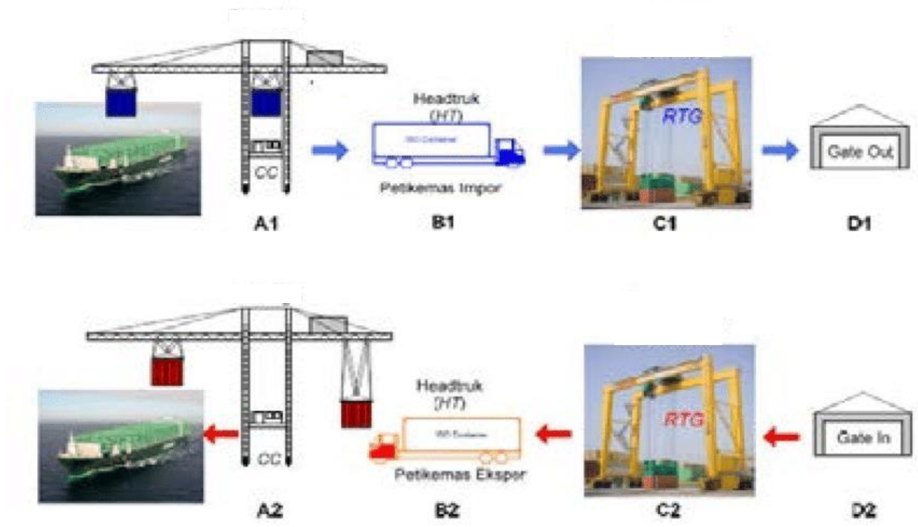

Figure 4 Container loading/unloading process
Source: Google

Description:
A1 : Service of unloading imported containers from ships (CC) at the wharf.
A2 : Service of loading export containers onto ships (CC) at the dock.
B1 : Transfer service of imported containers from dock to CY by HT.
B2 : Export container transfer service from CY to jetty by HT.
C1 : Service of import containers by RTG at CY.
C2 : Service of export containers by RTG at CY.
D1 : Import container service at the exit of the Multipurpose Terminal.
D2 : Export container services at the Multipurpose Terminal entrance.

From Figure 2.3, the activities that occur at the container terminal in relation to loading and unloading containers can be presented as in table 2.1.

TABLE 1
CONTAINER HANDLING ACTIVITY ELEMENT

No.	Activities	Description	Tools
1	*Unloading/Loading*	Unloading containers from ships to specialized trucks and vice versa	Gantry crane, Ship crane
2	*Haulage Head truck*	Moving/transporting containers from the apron to the stacking yard	Head truck
3	installments	Moving containers from special trucks to the stacking yard	Top loader, forklift
4	Lift on, Lift off	Lifting containers, unloading containers	Transtainer, top loader and forklift
5	Stripping, Stuffing	Loading containers, unloading containers	Forklifts
6	Delivery	Transporting containers out of the terminal	Head truck

Source: Banu Santoso 1998 cited in siswadi, 2005

2) Container Terminal Facilities

A container port should have an operating service system, where the area and equipment factors are very decisive. This all aims to support the speed expected by service users and trade. The factor determining the container operational system, the terminal is a determination in supporting activities, besides that it is also a determining factor for the field used, the shape of the field, the inflow and outflow of cargo, reefer, dangerous, and the location of the container freight station (CFS) [24].

The operation of the container terminal requires an operating permit from the Director General of Sea Transportation and the tariff is determined by the Minister of Transportation. To be able to operate the terminal requires the terms - the requirements of the facilities that must be owned, among others PT. (Persero) Pelabuhan Indonesia IV

a. Docks

The container dock is a mooring used by container ships. In general, the layout of the container dock can be presented in Figure 2.4.

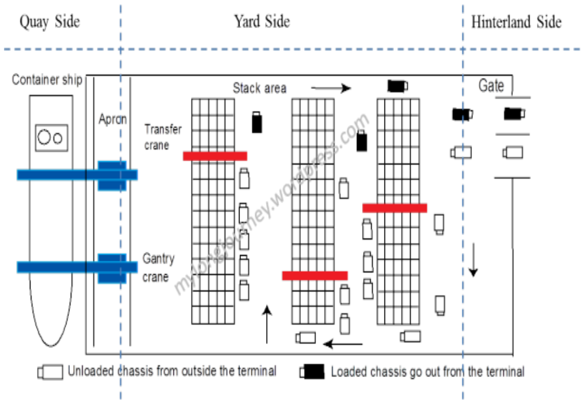

Figure 5 Container dock

b. Stacking Field

The stacking yard is divided into several sections:

1) Marshalling yard is an area at the container terminal used to accommodate container handling activities consisting of import stacking yards and export stacking yards.
2) Container yard is an area used to deliver and receive containers (receiving/delivery), to stack export, import and empty containers and also to accommodate container loading and unloading equipment that is on stand-by.
3) Maintenance Repair Shop is a place inside the container terminal that is used for maintenance, maintenance, and repair of container loading and unloading equipment.
4) Gate and Intercharge are used as entrances and exits of containers equipped with tools to check containers which are also equipped with scales.
5) Control Center is a place in the container location that is used to monitor all container movements from entry to exit.
6) Container depot is a place to accommodate empty containers, this container depot can be inside the container terminal or outside the container terminal.

c. Loading and Unloading Equipment

Container loading and unloading equipment consists of:

1) Container Crane (CC) is a mechanical device for loading/lifting containers from the side of the hull on the chassis to the ship or vice versa. This tool can walk along the dock because the tool stands on legs with wheels, on rails or with tires. For the loading/unloading process, this Container Crane is able to lift as many as 20-25 boxes per hour. By using this tool, many benefits can be achieved, one of which is the speed of loading/unloading goods so that it can save time.

The obstacles are the weight/capacity of the container load that exceeds the carrying capacity of the CC, unfavorable weather conditions, the rotation speed of each headtruck in moving the container so that the CC has to wait for some time, for example the tariff applied for the use of this tool. Many shipping companies still use the conventional system rather than this package system, as can be seen in Figure 2.5:

Figure 6 Container crane

2) *Rubber Tiret Gantry* (RTG) is used to carry out activities at the *container yard (CY)* where the tool will increase the use of more productive areas compared to other tools. This tool is for *stacking* containers in the container *yard* (CY) and when handing over containers to the recipient where the *Rubber Tiret Gantry* (RTG) will perform the *lift on* the *chassis* and *lift off* for the opposite treatment and for stacking, can be seen in Figure 2.6.

Figure 7 Rubber Tiret Gantry (RTG)

3) *Head Truck/Chassis System* is a tool used to transport containers from the side of the hull to the field (CY) or vice versa and move transportation between CY or CY to multipurpose field II *(stuffing/stripping).* This tool is equipped with adapters to lock the corners of the *container* (*Container casting*) and the length size consists of 20 'and 40', can be seen in Figure 2.7:

Figure 8 Head Truck

4) *Reach Stacker* is the same treatment as the restrainer for stacking, *lift on / lift off containers*. The *reach stacker* works with a digital system, can be seen in Figure 2.8

Figure 9 Reach Stacker

5) *Bottom Lift* is a multi-purpose field tool also used for stuffing/stripping activities. Except in certain circumstances where the *transtrainer* is damaged or busy, this tool is used in the CY for stacking, and *lifting on/lifting off containers*. For the *stuffing/stripping* process, containers are lifted through the hole at the bottom, so the process of transporting containers with the *Top Leader system can* be seen in Figure 2.9.

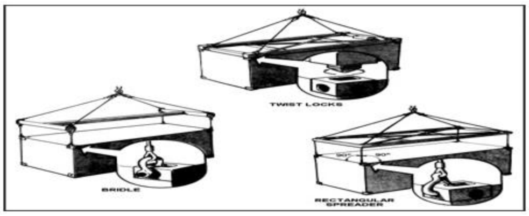

Figure 10 Bottom lift

6) *Fork Lift* This tool is used for *CFS* activities *(stuffing / stripping)* of goods from and to containers and can also be used for *Cargo Delivery* activities. Especially for *forklifts* that serve certain size container activities, especially at the highest size (*Low Must*). This is due to the limited height of the container, can be seen in Figure 2.10.

Figure 11 Forklift

3) Definition of Container

A container is a specially designed package of a certain size, can be used repeatedly and is used to store and at the same time transport the cargo inside. The philosophy behind containers is to wrap or carry cargo in the same crates and make all vehicles able to transport it as one unit whether the vehicle is a ship, train or truck and can carry it quickly, safely and efficiently.

In order for the operation of containers to run well, all parties involved must agree that the sizes of the containers must be the same and similar and easy to transport. The International Standard Organization (ISO) has determined the sizes of containers:

1. 20 feet container

a. Outer Size: 20' (P) X 8' (L) X 8'6" (T) Or 6.058 X 2.438 X 2.591M

b. Inner Size: 5.919 X 2.340 X 2.380 M
c. Capacity: Cubic Capacity: 33 CBM
d. Payload: 22.1 Tons

2. 40 feet container
a. Outer Size: 40' (P) X 8' (L) X 8'6" (T) Or 12.192 X 2.438 X 2.591M
b. Inside Size: 12.045 X 2.309 X 2.379 M
c. Capacity: Cubic Capacity: 67.3 CBM
d. Payload: 27,396 Tons

3. 45 feet container
a. Outer Size: 40' (P) X 8' (L) X 9' 6" (T) Or 12,192 X 2,438 X 2,926 M
b. Inside Size: 12.056 X 2.347 X 2.684 M
c. Capacity: Cubic Capacity: 76 CBM
d. Payload: 29.6 Tons

4. Previous Research

1) Judge (2022)

Research by Hakim and Sabaruddin (2022) [25] with the title "ANALYSIS OF CONTAINER YARD NEEDS AT THE ISLAND LANDS IN NORTH MALUKU". The purpose of the study was to determine the Berth Occupancy Ratio (BOR), Berth Throughput (BTP), Container Yard Occupancy (YOR) stacking field capacity as a consideration for optimization policies, and operational efficiency and development of port facilities to support economic growth. The regression method is used to determine the level of usage of the dock and container stacking field at the port. The results showed that the performance of loading and unloading equipment serving containers at Daruba port and Babang port is categorized as good, but in the calculation of the container stacking field (YOR) predicted for 2031 there has been over capacity with a YOR value of 135.6% at Babang port and a YOR value of 119% at Daruba port which has exceeded the specified standard.

2) Fetriansyah (2019)

Research by Fetriansyah and Buwono (2019) with the title "Analysis of Container Yard Needs at Baai Island Port Bengkulu. The research objectives analyzed the performance of the container stacking field. Planning short-term container growth projections (until 2016) at the port of Baai Island Bengkulu. Calculating field requirements for container growth to determine the face of container flow growth (until 2016) at the port of Baai Island Bengkulu. Based on the UNCTAD standard YOR classification, the YOR number is 78. Based on the UNCTAD standard YOR classification, the YOR figure of 78.11% indicates that the utilization ratio of the stacking field at the port of Baai Island Bengkulu is already high and if not anticipated it will cause congestion at the port. From the results of the projected growth in container flow until 2016, the expansion of the stacking field is needed to reduce the YOR value to 30.16% in 2016 and indicates that the expansion and arrangement of the container stacking field can accommodate container growth until 2016.

3) Somadi (2020)

Research by [26] with the title "Measurement of Container Yard Capacity Using Yard Occupancy Ratio in an Effort to Optimize the Use of Container Stacking Fields at PT XYZ. The purpose of this study is to determine the results of measuring the capacity of container yards using the yard occupancy ratio at PT XYZ. This study uses the Yard Occupancy Ratio (YOR) method to determine the capacity of container yards, while for forecasting using moving average and exponential smoothing. Meanwhile, to calculate the forecasting error using mean squared error and mean absolute percent error. Based on the results of the measurements carried out, the results of container flow forecasting for July 2019 to December 2019 are 1,487 containers, 1,493 containers, 1,614 containers, 1,377 containers, 1,532 containers and 1,495 containers, respectively. Based on the results of the YOR analysis, scenario 3 is the best scenario compared to scenario 1 and scenario 2, because it produces a lower YOR value, namely for July 2019 of 45%, August 2019 of 45%, September 2019 of 48%, October 2019 of 41%, November 2019 of 46% and December 2019 of 45%. This means that by using the YOR method there will be no overcapacity in the future because the YOR value does not exceed 100%.

III. Research Method

1. Type of Research

The type of research used in this study uses a quantitative approach (Sugiyono, 2018) with technical analysis using the Yard Occupancy Ratio (YOR) method. YOR is the quantity of container stacking field usage at the container terminal per certain period. The choice of problem-solving method is based on the relationship between the existing problems and the analysis related to overcapacity in the company.

2) Research Location

The research location was at the Sorong Container Port. This research uses data collection techniques using documentation studies and observations. Documentation studies are used for secondary data collection, while observations are carried out to complete information related to the types of containers available, the company's Gate in and Gate Out data, and the way of stacking in the container yard.

3) Data Collection

Data collection consisted of primary and secondary data;

1. Primary Data: This data is collected from surveys and field operational data, including:
   a. Stacking Field and
   b. Data on the number of loading and unloading equipment.
2. Secondary Data: This data comes from data obtained from Sorong Container Port operations. This data includes:
   a. Facilities
   b. Goods Flow

c. Ship Current
d. Container Flow
e. Stacking Field Capacity

4) Data Analysis

The container *yard occupancy ratio* is used to calculate the utilization of available moorings at a port. It is a percentage comparison between the use of container stacking yard facilities and the available capacity. The calculation of the utilization of the stacking yard can be calculated using the formula:

$$YOR = \left(\frac{Productivity \; x \; Dwelling \; Time}{Field \; Capacity \; x \; effective \; days} \right) x \; 100\%$$

Description:
· *Dwelling time* = Maximum stacking *time* in the field / port provisions (existing 7 days)
· Field capacity = slots x tiers

TABLE 2
YARD OCCUPANCY RATIO (YOR) CLASSIFICATION

Level	Description
< 20 %	Very Low
20 % - 39%	Low
40 % - 59%	Simply
60% - 79%	High
>80 %	Very High

Source: UNCTAD Standard

It is known that containers are placed for a short time in the stacking yard after arriving at the port. This yard is divided into several sections: those intended for export and import, those rejected or returned, those considered dangerous (dangerous goods), and empty ones. In some ports that have container terminals, there is also a *Container Freight Station* (CFS), an office that specializes in "*stripping*" and "*stuffing*". *Stuffing* is the transportation of various goods from different places into one container for export, while *stripping* is the process for imported goods in one container with different destinations.

The required stacking field area can be calculated by the formula:

$$A = \frac{T \; D \; Ateu}{365 \; (1 - BS)}$$

With:
T : container flow per year (teu's)
A : required container stacking yard area (m2)
D : *Dwelling Time* or the average number of days that containers are stored in the stacking yard.

Teu 's: The area required for one teu's which depends on the container handling system and the number of stacked containers on site.

BS: *Broken Stowage* (area lost due to roads or spacing between containers in the stacking yard, depending on the operating pattern applied, values range from 25-50%).

III. Results and Discussion

1) Overview of Sorong Container Port

Sorong Port is one of the ports that has tremendous potential to support the economy in West Papua. Sorong Port is one of the gateways for sea transportation in West Papua and Papua Provinces serving the flow of passengers and goods. Sorong Port was inaugurated as a Container Terminal on Monday, September 20, 2021. And inaugurated by the Mayor of Sorong Lambert Jitmau, accompanied by the Head of the Port Authority and Port Authority Office (KSOP) Class I Sorong, Jece Julita Piris and President Director of Pelindo IV Prasetyadi, inaugurated Sorong Port as a Container Terminal of Sorong City Port in this case managed by PT (Persero) Port Indonesia Sorong Branch, providing facilities and infrastructure including grooves, moorings / docks, storage warehouses, stacking fields, loading and unloading equipment and navigation.

Sorong Port has a Main class or National class port type. From a technical point of view, Sorong port is a natural port, because there is no need to build a breakwater to ensure the safety of ships in loading and unloading.

2) Natural Conditions

a. Topography and Hydrographic Conditions

Sorong port is located at the position of 00"53'00 LS and 131"14'00 BT, Sorong port has a relatively narrow plain land mostly hilly. The bottom of the water in front of the pier has a depth of between 11-13 meters. From the pier the depth of the water has reached 20 meters.

b. Climatological and Hydro-Oceanographic Conditions

Based on data from the Sorong Meteorology Climatology and Geophysics Agency, rainfall and temperature data show that the average rainfall/year is 2,385 millimeters. With an average temperature of 32°C.

Data obtained from the Pelindo IV branch office in Sorong shows that the average wind speed is 7 knots / hour between September and December. While the tidal data as follows:

- High Water Spring (HWS): 1.50 m LWS
- Low Water Spring (LWS): 1.00 m LWS

The nature of the tides that occur in the harbor is double daily tides, i.e., there are two high tides and two low tides in one day.

The waters of Sorong harbor are relatively well protected by the surrounding islands and from the west by Doom and Dofior islands and from the south by Ombre and Nana islands. The length of the Sorong Harbor entrance channel is 3.5 miles with a width of 0.5 miles, so the distance of wave generation due to wind is relatively short and the waves generated are not too large. With the wave height that occurs in the waters of Sorong port generally around 1.8 meters.

The current speed in the waters of the Sorong harbor pond is 3 knots/hour. So, the influence of the current is very significant for ships that gain motion and carry out activities in the port of Sorong.

3) Port Facility Condition

a. Shipping Channel

Length of shipping channel 3.5 miles, Width 0.5 miles, Minimum depth 20 meters.

b. Harbor Pond

The port pool area is 93.3 Ha, minimum pool depth 11 meters, maximum depth 20 m LWS, depth at the dock 11-13 meters.

c. Sorong Port Jetty

The 340-meter-long Sorong port public wharf located on Jl. Jend. A. Yani No. 13 Sorong West Papua was built in 1954. The wharf is made of reinforced concrete construction on piles, designed with a floor bearing capacity of 2.5 tons/m3. The water depth ranges from 11-13 meters, with an elevation of ±3.20 meters LWS.

d. Stacking Field Area

The container stacking yard area is 40,356 meters² (existing) and 50,000 meters² (PMN).

e. Warehouse

This line I warehouse was built in 1954 with a corrugated asbestos roof, plate iron walls and concrete floors/iron pillars and has an area of approximately 2210 m^2, has a bearing capacity of 2 T / M^2 .

f. Passenger Terminal

The passenger terminal at the port of Sorong consists of a two-story building which has a ground floor area of 1,226.71 m^2 and an upper floor area of 773.29 m^2 with the year of manufacture 1992-1993. Parking lot for passengers with a capacity of 150 cars. For the next five and ten years forecast, the flow of passengers boarding at Serui port uses exponential regression, the flow of passengers disembarking uses linear regression, the flow of ship visits uses logarithmic regression, the flow of loading and unloading of goods uses exponential regression and the loading and unloading of containers uses logarithmic regression.

g. Data on the Number of Loading and Unloading Equipment

- 2 units of QCC (Quay Container Crane)
- 2 units RTGC (Rubber Tyred Gantry Crane)
- 5 units RS (Reach Stacker)
- 2 FL units
- 8 units HD. Truck (Head Truck)

h. Other Facilities

- Wharf: 470 meters (TOTAL), 250 meters (Container)
- Container Yard: 40,356-meter² (existing), 50,000-meter² (PMN)

i. Goods Flow

TABLE 3
GOODS FLOW OF SORONG CONTAINER PORT

Description	**Unit**	**Year**				
		2017	**2018**	**2019**	**2020**	**2021**
Goods Flow (General Dock)	T/M3	668,519	784,025	800,421	767,483	763,331
Container Flow (General Dock)	Box	42,003	46,078	56,439	48,398	47,157
	Teus	45,181	49,686	60,708	52,041	51,256
Passenger Flow	People	294,174	305,301	369,266	145,051	149,048

Table 3 shows the flow of goods at Sorong Container Port over the period 2017 to 2021. The data is presented in three main categories: goods flow at the public jetty, container flow at the public jetty, and passenger flow.

For the flow of goods at public docks, the volume handled fluctuated over the five years. In 2017, the number reached 668,519 tons per cubic meter (T/M3), rose to 784,025 T/M3 in 2018, then increased again to 800,421 T/M3 in 2019. However, there was a decline in 2020 and 2021, where the figures dropped to 767.483 T/M3 and 763.331 T/M3 respectively.

Meanwhile, the flow of containers at public docks also shows a fluctuating trend. The volume in boxes in 2017 was 42,003, increased to 56,439 in 2019, but decreased in 2020 and 2021. Likewise, the volume in standard container units (teus), which increased from 45,181 in 2017 to 60,708 in 2019, but decreased in 2020 and 2021.

Passenger flows, on the other hand, show a more complex trend. The number of passengers reached 294,174 people in 2017, increased to 369,266 people in 2019, but suddenly experienced a significant decline to 145,051 people in 2020, then slightly increased to 149,048 people in 2021.

TABLE 4
SHIP FLOW OF SORONG CONTAINER PORT

Description		**Unit**	**Realization (Year)**				
			2017	**2018**	**2019**	**2020**	**2021**
Ship Current	Public Dock	Call	939	976	973	1,027	1,020
		GT	6,674,211	7,050,053	7,738,855	6,261,917	6,755,201
	Non-Public Dock	Call	998	1,108	1,174	914	914
		GT	4,635,184	5,740,389	4,977,642	5,532,216	7,219,995

Description	Unit	Realization (Year)				
		2017	2018	2019	2020	2021
Total	Call	1,937	2,084	2,147	1,941	1,934
	GT	11,309,395	12,790,442	12,716,497	11,794,133	13,975,196

j. Ship Current

The table above shows that the data is divided into two main categories, namely ship flows at public docks and ship flows outside public docks.

For vessel flows at public docks, the number of calls shows a steady increase from year to year. In 2017, 939 ship calls were recorded, which increased to 1,020 ship calls in 2021. However, the gross tonnage (GT) handled experienced significant fluctuations. GT in 2019 peaked with 7,738,855, but experienced a sharp decline in 2020 to 6,261,917, and rose again in 2021 to 6,755,201.

Meanwhile, for vessel flows outside the public docks, the number of vessels calls also showed fluctuations, with the highest recorded in 2019 (1,174 calls) and the lowest in 2020 (914 calls). The GT handled also fluctuates, with the peak occurring in 2021 with 7,219,995 GT.

Overall, the total ship calls at Sorong Container Port experienced slight fluctuations from year to year, with the highest total GT recorded in 2021 (13,975,196 GT)

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k. Container Flow

Table 5 Container Flow of Sorong Port

Year	Container Flow (teu's)
2017	45.000
2018	50.000
2019	61.000
2020	52.000
2021	55.000
2022	46.000

Table 5 displays data on container flows or container productivity in standard container units (Teus) at Sorong Terminal over the period 2017 to 2022. This data gives an idea of how efficient the terminal is in handling containers over the period.

From the data presented, it can be seen that the flow of containers fluctuated during the period. In 2017, the number of containers handled reached 45,000 Teus, then increased to 50,000 Teus in 2018, and reached its highest peak in 2019 with 61,000 Teus. However, there was a decline in 2020 to 52,000 Teus, then recovered slightly in 2021 by reaching 55,000 Teus. It should be noted that in 2022, the number of containers dropped again to 46,000 Teus. This is clearly seen in the graph below.

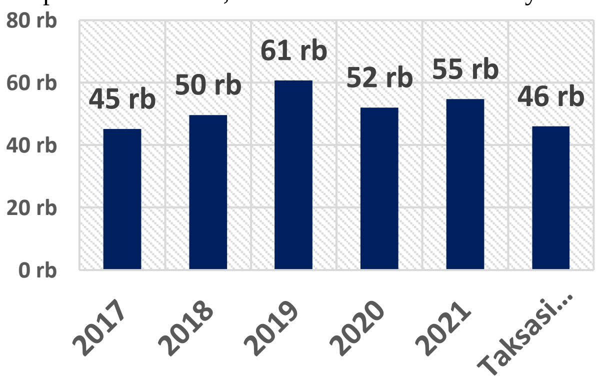

Figure 12 Container Flow Chart of Sorong Port

l. Stacking Field Capacity

TABLE 6
STACKING FIELD CAPACITY OF SORONG CONTAINER PORT

Year	Static Layout	Broken Space	Efective	% Teus With Void	% Broken Space
2017	3994	408	3586	89,8%	10,2%
2018	3994	391	3603	90,2%	9,8%
2019	3994	424	3570	89,4%	10,6%
2020	3994	447	3547	88,8%	11,2%
2021	3994	488	3506	87,8%	12,2%

Table 4.4 provides data on the stacking yard capacity at Sorong Container Port for the period 2017 to 2021. This data is divided into several categories, including static layout, broken space, effective, percentage of containers with voids (% Teus with Void), and percentage of broken space.

From the data provided, it can be seen that the capacity of the piling yard tends to stabilize over the period. The static layout remained at 3,994 throughout the time period under review. However, the broken space has increased year by year, starting from 408 in 2017 to reach 488 in 2021.

Despite the increase in damaged space, the effective capacity of the piling yard shows a decreasing trend from year to year. In 2017, the effective capacity reached 3,586, but then decreased to 3,506 in 2021.

In addition, two percentage indicators are given, namely the percentage of containers with voids (% Teus with Void) and the percentage of broken space (% Broken Space). The percentage of containers with voids tends to be stable, with the highest figure recorded in 2021 (87.8%), while the percentage of broken space has an increasing trend from year to year, reaching 12.2% in 2021.

Analysis of this data shows that while overall stacking yard capacity has remained relatively stable, there has been a significant increase in damaged space, which could impact the efficiency and productivity of Sorong container port operations.

m. Dwelling Time

- Stacking Period 1:
- ● 1a = 1-3 days = 1 production day
- ● 1b = 4-10 days = calculated per day
- Stacking period 2:
- ● 11 etc. = daily rate 200% of the daily rate of period 1
- Average number of days containers are stored in the stacking yard 3 average days containers are stored

4) Stacking Field Performance

TABLE 7
YARD OCCUPANCY RATIO (YOR) CALCULATION

Year	Container Flow/Productivity (teu's)	Field Capacity	Dwelling Time	Effective Working Days	Broken Stowage	YOR	Growth	Category	A (m2)
2017	45181	3586	3,00	365	10,22%	10,36%		Very Low	413,60
2018	49686	3603	2,92	365	9,79%	11,03%	0,68%	Very Low	440,62
2019	60708	3570	3,22	365	10,62%	15,00%	3,97%	Very Low	599,17
2020	52041	3547	3,21	365	11,19%	12,90%	-2,10%	Very Low	515,35
2021	51256	3506	3,40	365	12,22%	13,62%	0,71%	Very Low	543,91

Table 4.5 presents the calculation of Yard Occupancy Ratio (YOR) at Sorong Container Port. YOR is a metric used to measure how efficiently the stacking yard space is used at the port, with the percentage indicating how much of the space is occupied.

From the data provided, it can be observed that the YOR varies over time. In 2017, the YOR was 10.36%, indicating a very low level of space utilization. Subsequently, there was an increase of 0.68% in 2018, bringing the YOR to 11.03%, but still remaining in the very low category.

A more significant increase occurred in 2019, where the YOR reached 15.00%, indicating a substantial increase in the use of stacking yard space. However, in 2020, there was a decrease of 2.10%, bringing the YOR back to 12.90%. In 2021 in the data presented, the YOR rose slightly to 13.62%. Despite the increase, the YOR remains in the very low category.

Data analysis shows that despite fluctuations in YOR from year to year, the utilization of stacking yard space at Sorong Container Port still tends to be low. This can be influenced by various factors. Firstly, regional economic conditions play an important role, with international trade volumes still low in the remote Sorong region. Infrastructure limitations are also a constraint, with an inadequate land transportation network increasing overall logistics costs. Lack of investment in the maritime sector is another factor, resulting in a lack of modern equipment and technology at the Sorong Container Port.

On the operational side, slow loading and unloading processes and lack of coordination between various parties involved in port activities lead to inefficiencies and congestion. Competition from other ports also adds pressure to Sorong Container Port. Natural disasters such as earthquakes and tsunamis can cause unexpected disruptions to port operations.

To improve the utilization ratio of the stacking yards, several measures can be taken. These include increasing the volume of international trade by trade promotion and further infrastructure investment. Greater investment in the maritime sector, including the procurement of more modern equipment and technology, is also needed. Improvements in the loading and unloading process and increased coordination between the various parties involved will also help address this issue. In addition, strategies to deal with competition from other ports and the development of natural disaster-resistant infrastructure are also needed.

5) Projected Container Flow

TABLE 8
CONTAINER FLOW PROJECTIONS UP TO 2026

Year	Container Flow/Productivity (teu's)
2017	45181
2018	49686
2019	60708
2020	52041
2021	51256
2022	51774
2023	53093
2024	53774
2025	52388
2026	52457

Table 4.6 displays the projected container flow or productivity (TEUs) at Sorong Container Port until 2026. This data provides an overview of the estimated number of containers that will be handled by the port during the specified period.

The projections show a steady upward trend in container flows from 2022 to 2024. Starting from 51,774 TEUs in 2022, the projection increases gradually to 53,774 TEUs in 2024. However, there is a slight decline in 2025, where the number is projected to be 52,388 TEUs, before recovering slightly in 2026 with 52,457 TEUs.

6) Analysis of Stacking Field Requirement vs Container Growth Until 2026

Sorong Port since Monday, September 20, 2021 has started serving goods in container packaging so that it requires a stacking field facility according to the potential number of goods available even though the operating pattern at the pier is still the same, namely a multipurpose pier. Based on this, the container stacking field must meet the following minimum requirements:

1. The yard must have sufficient stacking space, so that no containers are stacked outside the yard.
2. Only trailers and container loading and unloading equipment should be allowed in the container stacking yard.
3. There is a separate area between empty containers and filled containers and a separate area for stuffing activities.

To meet the minimum requirements above with almost crowded existing conditions, it is necessary to expand the stacking field to increase container capacity. From the throughput projections that have been compiled by PT (Persero) Pelabuhan Indonesia Sorong Branch above, there is no need for field expansion to accommodate the increased flow of containerized goods in the next few years, because the resulting stacking field requirements are in the very low category.

TABLE 9
ANALYSIS OF STACKING FIELD REQUIREMENTS VS CONTAINER GROWTH UNTIL 2026

Year	Container Flow/Productivity (teu's)	Field Capacity	Dwelling Time	Effective Working Days	0	YOR	Growth	Category	A (m2)
2017	45181	3586	3,00	365	10,22%	10,36%		Very Low	413,60
2018	49686	3603	2,92	365	9,79%	11,03%	0,68%	Very Low	440,62
2019	60708	3570	3,22	365	10,62%	15,00%	3,97%	Very Low	599,17
2020	52041	3547	3,21	365	11,19%	12,90%	-2,10%	Very Low	515,35
2021	51256	3506	3,40	365	12,22%	13,62%	0,71%	Very Low	543,91
2022	51774	3562	3,15	365	12,43%	12,58%	0,65%	Very Low	502,53
2023	53093	3558	3,18	365	12,97%	13,03%	0,78%	Very Low	520,32
2024	53774	3549	3,23	365	13,51%	13,43%	0,80%	Very Low	536,26
2025	52388	3544	3,23	365	14,05%	13,11%	0,17%	Very Low	523,67
2026	52457	3544	3,24	365	14,59%	13,15%	0,63%	Very Low	525,34

Table 4.6 presents the analysis of stacking yard requirements compared to the growth of container flows until 2026 at Sorong Container Port. This data provides an overview of how well the stacking yard capacity can meet the demand generated by container flow growth.

From the data presented, it can be seen that the growth of container flow (TEUs) at Sorong Container Port shows a stable trend from 2022 to 2026, with the number of TEUs projected to increase from 51,774 TEUs in 2022 to 52,457 TEUs in 2026.

On the other hand, the stacking yard capacity and dwelling time were also analyzed. Piling yard capacity measured a fairly stable amount, ranging from 3,562 to 3,549 in 2022 to 2024, before increasing slightly in 2025 and 2026. Dwelling time, or the length of time containers remain in the stacking yard, is also relatively stable within a range of 3.15 to 3.24 effective working days.

In terms of analysis, the yard occupancy ratio (YOR) was also assessed. YOR indicates the percentage of stacking yards utilized, and from the data presented, the level of yard utilization is very low, with YOR percentages ranging from 12.43% to 14.59%.

1) In this context, despite the steady growth in container flows, the stacking yards appear to have sufficient capacity to handle the growth. However, the low utilization rate of the yard indicates the potential to improve the efficiency of space use and port operations. This can be done by improving operational coordination, increasing throughput and loading and unloading efficiency, and improving the overall logistics management system. By doing so, ports can maximize their service potential and increase their competitiveness in the maritime market.

IV. Conclusion

This study aims to analyze the needs of stacking yard facilities (Container Yard) at Sorong Container Port. From the analysis, it is found that the capacity of the stacking yard at this port is still sufficient to accommodate the projected increase in container flow until 2026. Although the volume of containers is expected to continue to grow, the current utilization of the stacking yard is relatively low, with the Yard Occupancy Ratio (YOR) ranging from 12.43% to 14.59%. This means that the available facilities are still sufficient and port operational efficiency can be further improved. To capitalize on this potential, it is recommended that the port optimize the use of existing stacking yards, improve loading and unloading processes to increase speed and efficiency, develop relevant supporting infrastructure, and enhance cooperation with stakeholders such as port operators and service users. In addition, the study also recommends more in-depth studies of infrastructure investment performance, comparisons with other ports for best practices, and analysis of the influence of external factors, such as policy changes or global economic conditions, on overall port performance. These measures are expected to help improve port competitiveness and efficiency in the future.

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