Analysis of the Ship and Cargo Service Facilities at the Local Port of Sorong

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Abstract. Sorong local port is one of the ports in Sorong City that provides services for pioneer ships, machine-sail ships, and fast passenger ship for tourists. Currently, mooring locations for the pioneer ships and machine-sail ships are nearby the mooring location of fast passenger ships. This condition affects the safety and amenities of passengers, mainly when the loading and unloading of cargoes and passengers take place at the same time. Besides, there are not been proper supporting facilities such as passenger terminal, warehouse, and parking area. Therefore, this research aims to analyze the performance of existing facilities and the required capacity of supporting facilities for service improvement purposes. Some methods are being applied to assess the performance of berth (Berth Occupancy Ratio or BOR), passenger terminal, and warehouse (Shed Occupancy Ratio or SOR). The result shows that the ship calls grow by 13.33 % annually, where the highest number of visiting ships is the fast passenger ship (47.62%). Current BOR of Sorong local port can reach up to 77.88 %, which is higher than the standard BOR 70 %, while SOR of the warehouse is 20.98 %, which indicates that the utility of the warehouse is low. In the meantime, the required area for the passenger terminal is 617 m².

I. INTRODUCTION

The local port of Sorong is in the Sorong District, Sororng City, West Papua Province. Astronomically, the port located at 0º 53’22.92” S and 131º16.5’33” E. The local Sorong seaport is a port that serves pioneering transport, machine-sail ships (KLM), passenger ships, and fast tourist vessels.

The pioneer ships that visit the local port of Sorong include the sea toll ships, namely MV. Sabuk Nusantara 60 and MV. Sabuk Nusantara 42, which are the ro-ro passenger ships. Fast passenger ships include MV. Marina Express, MV. Express Bahari and others serving the Raja Ampat Islands include Waisai, Misool, Muturi, Sausapor, and Raja Ampat.
The facilities in the local port of Sorong include a causeway, trestle, berth, back up area, and warehouse. The passenger terminal facility, which is needed by tourists who will visit Raja Ampat and local passengers, has not been available. The number of ship visits at the local port of Sorong in 2017 was 1,699 units. The highest number of visits by the fast passenger vessels of 918 units, with an average growth of visits 13.33% in the last five years.

The high number of ship visits at the local port of Sorong requires adequate mooring facilities. Besides, several problems found at the Sorong Local Port, including:
- Current ship mooring conditions that often occur where there are 2 to 4 ships in the queue.
- The location of the pioneer ship mooring is in the trestle.
- Mooring locations for the pioneer ships and KLM are nearby the mooring location of fast passenger ships. This condition affects the safety and amenities of passengers, mainly when the loading and unloading of cargoes and passengers take place at the same time.
- The fast passenger and tourist ships must moor at the end of the berth

![Figure 1. The Local Port of Sorong](image1)

![Figure 2. Ship mooring condition at the Local Port of Sorong](image2)
Based on some of the problems, the objectives of this research are:

a) Identifying the availability of facilities in the Local Port of Sorong
b) Analyze the needs of land and water facilities at the Local Port of Sorong

2. Literature Review

2.1. General Review of Port

According to Government Regulation No 61 the Year 2009, a port is a place consisting of land and/or waters with specific limits as a place for government activities and business activities used as a place for ships to berth, embarking and disembarking passengers, and / or loading and unloading of goods, as the terminals and berths which are equipped with shipping safety and security facilities and supporting facilities as well as the intra-modes and inter-modes of transportation [1].

Port is an area that has the infrastructure (facilities and infrastructure) to support operational activities. The infrastructure is a facility that must be available at a port to support port operations or business. Port infrastructure or facilities consist of basic facilities and supporting facilities [2].

Comprehensively, the role of a port is not merely from its existence and future development. However, it is closely related to aspects of planning and management in supporting regional development, between regions/islands/ports to facilitate the interaction between development resources, such as population, natural resources (sectoral), investment, technology, and other development resources. Besides, as an infrastructure, a port becomes the transportation node and the place to switch various modes of transportation [3]. The critical role carried by the port in international, national, and local shipping, according to its function, requires operational strengthening presented in Figure 3.

![Figure 3. The functions of ports](image_url)
2.2. Port Facilities
For safety and seamless activities, the port requires two types of facilities, which are the main facilities and supporting facilities.

a) The main facilities are mainly used to ensure the smooth operation of port activities. The main facilities include berth, line I of warehouse, line I of yard, passenger terminal, container terminal, ro-ro terminal, waste storage and treatment facilities, bunker, fire engine facility, warehouse and hazardous and toxic materials/goods facilities, maintenance and repair facilities, as well as navigation equipment and navigation aids.

b) The supporting facilities are complementary facilities to support activities in the port. The supporting facilities include office areas, post and telecommunication facilities, tourism and hospitality facilities, clean water installations, electricity, and telecommunications, road, and rail network, sewage water, drainage, and rubbish networks, port development areas, waiting for areas for vehicles, trade areas, industrial areas and other public facilities.

2.3. Port Operational Service Performance
Based on the Decree of Directorate General of Marine Transportation Number UM.002 / 38/18/DJPL-11 that concerns the standard of port operational service performance, operational service performance is the measurable work results at ports in carrying out ship and goods services, facility utilities and equipment in specific periods and units [4]. The service performance indicators related to port services which consist of:

- Waiting time/WT; the time from mooring request after the ship arrived at the anchor location until the ship moves towards the mooring.
- Approach Time/AT; the used time for a ship to move from anchor location to tie the rope at the mooring or vice versa.
- Effective Time/ET; the actual time for loading and unloading of a ship at the berth.
- Berth Time/BT; ready for operation time to serve ship at the berth.
- Receiving/Delivery of container; the speed of delivery/receiving service at the container terminal, which begins from the time when the conveyance moves into and out of the port.
- Berth Occupancy Ratio/BOR; the ratio of occupied berth time by vessel to the available operation time of berth within a specific period.
- Shed Occupancy ratio/SOR; the ratio of occupied room to the available room in ton day or m$^3$ day.
- Yard Occupancy Ratio/YOR; the ratio of occupied yard space to the available yard space in ton day or m$^3$ day.
- The readiness of equipment; the ratio of ready equipment to the available equipment in a specific period.

3. Research Methods
3.1. Berth
The BOR calculated using the following equation, which depends on the type of pier [5].

\[
BOR = \frac{X (LOA + \text{distance between vessels}) \times \text{berth time}}{\text{available operation time of berth} \times \text{length of berth}} \times 100\%  
\]

(1)

where
- \(LOA\): the length overall of the ship (m)
- Distance between vessels: allowed space between vessels at berth, 10 m for small vessels, and 20 m for big vessels.
- The length of berth: length of berth area that vessel can use for mooring
3.2. Passenger Terminal
The passenger terminal of the port is a building area, including the passenger ship berth in which the passengers embark and disembark and other passenger activities. The passenger ships from different regions in Indonesia can visit the terminal.

The passenger terminal is for people who will travel using passenger ships. The terminal also functions as the facility to check baggage of passengers, so that security at the port can be effectively carried out.

The passenger terminal area can be calculated by the following equation:

\[ A_T = \beta \cdot \psi \cdot \frac{P}{\phi \cdot \text{Call}} \]  

where

- \( A_T \) = a required field of the passenger terminal (m²)
- \( \beta \) = coefficient of passenger peak season (1.25)
- \( \psi \) = required area per passenger (m²/person)
- \( \phi \) = a coefficient of supporting facility (200)
- \( \text{call} \) = the number of visiting ships

3.3. Port Warehouse
The warehouse is behind the berth, where the goods from inland transportation are stored before they loaded onto the ship or vice versa. Warehouses in the port can be classified based on their functions and uses, which are:
- The line I of the warehouse; customs area or transit shed.
- Line II of the warehouse; the warehouse is located behind line I. The goods in this warehouse waiting to be moved out from the port or typical long-stored cargoes.
- ‘Verlengstuk’ warehouse; the warehouse is functioned temporarily as warehouse line II.
- The entrepot warehouse; the warehouse is located outside the port, which is functioned as warehouse line I.

Ocean warehouse (or custom warehouse, the first line of warehouse transit shed) is on the edge of the harbor water area. This warehouse stores the goods that have just unloaded from the ship and which loaded onto the ship so that the cargoes protected from the rain and the sun.

Ocean warehouse stores the goods temporally before transported to the next destination. A time period of stored cargoes in this warehouse is a maximum 15 days for inland distribution and 30 days for goods which distributed to other seaports (with other ship). Some considered variables include:

- \( A \) : warehouse area (m²)
- \( T \) : throughput per year (cargo passing each year)
- \( TrT \) : transit time/dwelling time (transit time, day)
- \( Sf \) : storage factor (the volume required to stow a given weight of commodities or goods)
- \( Sth \) : stacking height (maximum height of cargoes can be safely stacked, m)
- \( BS \) : broken stowage of cargo (The amount of space that among the stacked cargo and the space for forklift and handling activities, %)
- 365 : the number of days in a year [5].

4. Analysis
4.1. Brief Description of the Local Port of Sorong
The existing condition of the local port of Sorong, as mention earlier, only KLM moored at the pier. While the pioneer ships moor on the trestle, which is a bridge that connects the land with the pier. And for fast passenger and tourist ships moored at the end of the pier.
The facilities in the local port of Sorong include causeway, trestle, pier, warehouse, and backup area, as presented in Table 1.

Table 1. Existing facilities in the Local Port of Sorong

| No | Facility       | Dimension | Description                  |
|----|----------------|-----------|------------------------------|
| 1  | Causeway       | 106 x 6 m²|                              |
| 2  | Trestle        | 77 x 5 m² |                              |
| 3  | Pier           | 50 x 10 m²| Pile, Beam and Concrete Plates|
| 4  | Back-Up Area   | 1.8 hectare|                              |
| 5  | Warehouse      | 400 m²    |                              |

Source: KSOP Class I Sorong

4.2. Port Operational

Ships visiting the local port of Sorong are pioneer ships, RORO ships, KLM, fast passenger ships, and tourist ships. However, since December 2017, the Roro ship no longer has visited the port as the RORO ship has diverted to the Arar Port. The number of call ships, embarking and disembarking passengers, as well as loading and unloading cargoes in 2013-2017 can be seen in Figure 5.
Figure 5 shows that the growth of the visiting ship is 13.33%. The highest number of visits is gained by the fast passenger ship which is 47.62% of the total of call ships.

4.3. Port Operational Performance
Based on the historical call ship data, the utility of berth in 2019 is higher than the BOR standard (70%) [6], which is 72.92%. Regarding the highest call ship frequency of the fast passenger ships with LOA 34.14 m and considering the length of the pier for mooring, which is 100 m, and average berthing time 18 hours, the utility of berth provided in Table 2.

Table 2. Berth performance of the Local Port of Sorong

| Year | Call Ship (unit) | BT (hour) | LOA + space (meter) | Berth Length | BOR (%) |
|------|-----------------|-----------|---------------------|--------------|---------|
| 2019 | 1809            | 18        | 44.14               | 100          | 72.92   |
| 2022 | 1971            | 18        | 44.14               | 100          | 79.46   |
| 2027 | 2173            | 18        | 44.14               | 100          | 87.61   |
| 2037 | 2458            | 18        | 44.14               | 100          | 99.08   |

4.4. The Required Facilities
To improve the current mooring condition of ships, in the development plan, the berth for different berthing purposes will be carried out, such as the fast passenger ships and the tourist ships, while the KLM with the pioneer ships.

The required berth for the fast passenger ships calculated by considering forecasting results of call fast passenger ships, the highest number of visiting fast passenger ships, which is MV. Marina Perkasa with LOA 34.14 meters and average berthing time 12.09 hours. Regarding BOR standard 70%, the required berth length shown in Table 3.

Table 3. The required berth length for fast passenger and tourist ship

| Year | Required Berth of Fast Passenger Ship (meter) | The Required Berth of Tourist Ship (meter) | Total Required Berth (meter) |
|------|-----------------------------------------------|------------------------------------------|------------------------------|
| 2019 | 1809                                          | 18                                       | 44.14                        |
| 2022 | 1971                                          | 18                                       | 44.14                        |
| 2027 | 2173                                          | 18                                       | 44.14                        |
| 2037 | 2458                                          | 18                                       | 44.14                        |
The required berth for the tourist ships calculated by considering the forecasting result of call tourist ships, the highest frequency number of visiting tourist ships, which is MV. Blue Manta with LOA 42.53 meters, 595 GT and average berthing time 23.44 hours, the required berth length provided in Table 3.

For the pioneer ships and KLM, in the development plan, the existing berth is still used. The berth length for pioneer ships and KLM presented in Tables 4 and 5.

### Table 4. The required berth length for pioneer ship

| Year | Call Ship (unit) | BT (hour) | LOA + space (meter) | Standard BOR (%) | BOR (%) |
|------|------------------|-----------|---------------------|------------------|---------|
| 2019 | 185              | 18        | 77.42               | 70               | 41.94   |
| 2022 | 201              | 18        | 44.14               | 70               | 45.70   |
| 2027 | 222              | 18        | 44.14               | 70               | 50.39   |
| 2037 | 251              | 18        | 44.14               | 70               | 56.99   |

### Table 5. The required berth length for KLM

| Year | Call Ship (unit) | BT (hour) | LOA + space (meter) | BOR Standard (%) | BOR (%) |
|------|------------------|-----------|---------------------|------------------|---------|
| 2019 | 218              | 28        | 34.36               | 70               | 34.25   |
| 2022 | 238              | 28        | 34.36               | 70               | 37.32   |
| 2027 | 262              | 28        | 34.36               | 70               | 41.35   |
| 2037 | 297              | 28        | 34.36               | 70               | 46.53   |

Analysis of the required passenger terminal facility is for the fast passenger and tourist ship's purpose. The analysis considering the coefficient of passenger peak season, which is 1.25 with the required area for each passenger, is 1.5 m$^2$. The required area of the passenger terminal provided in Table 6.

### Table 6. The required passenger terminal facility

| Year | Passenger/Year (person) | Call Ship | Passengers/call ship | The Required Area of Passenger Terminal (m$^2$) |
|------|--------------------------|-----------|-----------------------|-----------------------------------------------|
| 2019 | 518,924                  | 1278      | 406                   | 1269.17                                       |
| 2022 | 648,814                  | 1392      | 466                   | 1456.26                                       |
| 2027 | 836,407                  | 1535      | 545                   | 1702.68                                       |
| 2037 | 1,151,836                | 1736      | 663                   | 2073.61                                       |

The utility of warehouse considering the loading/unloading of cargoes and several assumptions such as the stored cargoes in the warehouse is 10% of the total loading/unloading cargoes, storage factor 1 m$^3$/ton, stack height 3 m, the average time of stored cargoes in warehouse 7 days, and available area of warehouse 400 m$^2$. The shed occupancy ratio presented in Table 7.

### Table 7. Warehouse facility performance

| Year | Loading/unloading Cargoes Ton/m$^3$ | 10% Loading/unloading Cargoes Ton/m$^3$ | SOR (%) |
|------|-------------------------------------|----------------------------------------|---------|
| 2019 | 1160                                | 116                                    | 31      |
| 2022 | 1334                                | 133                                    | 36      |
| 2027 | 1532                                | 153                                    | 41      |
| 2037 | 1782                                | 178                                    | 47      |
Table 7 shows that SOR is still adequate for extended periods; however, it needs to relocate to the reclamation area. Parking area planning for four-wheeled and two-wheeled vehicles and cargo trucks. The analysis of the required parking area, it considers the number of passengers per call ship, the car carrying capacity, and the required space for each type of vehicle. They need a domain for passenger vehicles is 12.5 m² per vehicle, for a two-wheeled vehicle requires 1.5 m² and a truck requires 25 m².

From the analysis results, the required parking area is 2,440 m² for a short period, 2,486 for the medium period, and 3,006 for the long periods.

5. Conclusions
The stage of terminal development in the local port of Sorong which based on its required facility analysis consists of the short-term development plan; pier construction for fast passenger and tourist vessels along the 80 meters that can be utilized on the right and left the side of the pier for mooring, causeway construction 108.54 meters, trestle construction 98.4 meters, passenger terminal and office construction 1,500 m². The medium-term development plan; development of warehouse facility 400 m², expansion of parking area 3,000 m², construction of passenger terminal. The long-term development plan; development of passenger terminal, extension of length fast passenger and tourist ship berth 20 meters.

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